Knowledge Management Model for Information Technology Support Service

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Abstract: User support has been in existence since the inception of computers in business and with their workforce dependent on technology, organizations depend on the quality of information technology (IT) support services to quickly restore and prevent any downtime due to any failure in technology or its use. Standardization of systems, and the speed with which knowledge becomes redundant, means that support-personnel technical knowledge is gained and discarded on a continuing basis. This research evaluates how an organization can conceptualize knowledge management (KM) of IT Support in order to maximize user productivity. Grounded Theory approach is used to explore the knowledge management activities and processes present within the Electronic and Information Technology (EIT) group of a multidisciplinary research centre called iThemba Laboratory for Accelerator Based Science (LABS). Firstly, the approach involved participant observation to gather information about the work flow of EIT support forming the first attempt at open coding. Secondly, semi-structured interviews, as well as the use of the Repertory Grid Technique were used to gather multiple perspectives of support personnel. Extant literature was then incorporated to develop the emergent theory. This research found that the knowledge management foundation for IT Support is strategy and culture based on the constructs of commitment and reciprocity. Further, communication and competency were identified as additional enabling conditions. From this, an adapted KM model for IT Support Service is presented. The model agrees with Nonaka and Konno's 'ba' concept within the Socialization-Externalization-Combination-Internalization (SECI) process. Every transition between the quadrants representing ba (knowledge platforms) requires 'conversion energy', in agreement with IT Service Management Service Management Functions of Microsoft's Operations Framework.

Keywords: knowledge management, information technology, support service, repertory grid, grounded theory

1. Introduction

There have been various terms used to describe user support, including helpdesk, technical support, and call centre. According to Bruton (2002: 5), user support is defined as "*a specialist function which retains, on behalf of the company's user population, technical knowledge about IT and the way the company uses it, in order to deliver that knowledge in a focused form to solve specific technical and business problems on both a reactive and proactive basis, such that user productivity is maintained and enhanced, thereby further enabling the user to contribute to the company's business goals*".

User support has undergone considerable changes with the introduction of newer and more powerful computing technologies. Presently, the Internet threatens to replace traditional support with technologies of e-support. With increased competition, greater access to information provided through these technologies, increased mobility and the globalization of markets, organizations are forced to think and learn faster (Davenport & Prusak, 1998; Gamble & Blackwell, 2001).

Increasing the amount of information available or accessible to an individual through these technologies does not ensure competitive advantage (Gamble & Blackwell, 2001; Davenport & Prusak, 1998). The beginning of the 2000s has seen a focus on knowledge as the new basis of competitive advantage. Knowledge Management comprises a range of practices used by organizations to identify, create, represent, and distribute knowledge (Keyes, 2006). According to Davenport and Prusak (1998), knowledge is a mix of experience, values and contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. In organizations, knowledge is embedded in its routines, processes, practices, and norms (Davenport & Prusak, 1998).

A real cost is incurred due to reduced user productivity when computer system related problems hinder the user from contributing to organizations profits (Bruton, 2002). This can be seen in critical systems such as those used by corporate central office in making rapid decisions about investments in both local and international markets, real time inventory control, safety interlock systems,

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production systems and so on. Support personnel's technical knowledge is augmented with skills in expressing complex technical terms, methodical approach to solving problems, as well as their network of information sources (Bruton, 2002). All this culminates in an appreciation of the knowledgeable expertise present in support to enable organizational growth.

According to a study carried out by the IDC (2008) on the IT services industry in South Africa, an imminent concern is the increasing difficulty in attracting and retaining qualified human resources. These are normally poached by competitors, and even clients (IDC, 2008). Due to this variety of options available to support-personnel, managers of IT support services need to focus on attracting and retaining such expertise/knowledge, and safe guarding organizational knowledge.

1.1 Aim and objectives

This research will look at the effectiveness of IT support service framework in (managing knowledge processes) codifying implicit knowledge into explicit knowledge to be stored and shared.

The objectives of the research are:

- To explore and describe the workflow of IT support which support knowledge sharing and retention
- To highlight the drivers, as well as obstacles to knowledge transfer and conversion
- To develop a knowledge management model for IT support service

1.2 Research strategy

The research problem to be addressed is essentially qualitative in nature. However, analysis is also supplemented with some quantitative data. Grounded theory approach is used to explore the social processes present within human interactions within an IT Support environment.

Primary sources of data include participant observation, interviews, and supporting sources. The main focus was on the IT Support group within iThemba Laboratory for Accelerator Based Science (LABS) organization. Secondary sources are reviews of extant literature. These include various books, journals, internet, as well as unpublished working papers.

2. Knowledge management

Knowledge Management (KM) has been an established discipline since 1995. The knowledge movement spawned through managements' realization that what an organization and its employees know is central to an organizations success (Davenport & Prusak, 1998).

2.1 Generations of knowledge management

Currently, there are four accounts of generations of KM:

- One account is proposed by Mark Koenig. His theory views the first stage of KM as a field driven by IT, the Internet, best practices, and knowledge sharing (Firestone & McElroy, 2003). The second stage is seen as KM focusing on human factors, organizational learning, and knowledge creation among tacit and explicit knowledge. The third stage of KM shifts focus to the arrangement and management of content through taxonomy construction and use (Firestone & McElroy, 2003).
- The second account by David Snowden (2002) suggests that we are reaching the end of the second generation where the first generation focused on timely information provision for decision support and business process re-engineering, and the second generation was triggered by the SECI model of Nonaka. He proposes that the third generation is in: context, narrative, and content management; knowledge as both a thing and a flow; sense making using the Cynefin model drawn from the science of complex adaptive systems; and scientific management and theories of chaos and complexity.
- The third account is proposed by McElroy (Firestone & McElroy, 2003) and highlights only two generations of KM. The first focuses on knowledge sharing, "supply-side KM". The second generation is on knowledge creation, "demand-side KM". Firestone and McElroy (2003) argue that the other two accounts have many weaknesses and that their own account is through the

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perception of change related more to the evolution of knowledge processing than to knowledge management. This third account has received a wider acceptance and various reviews have been carried out (Loan, 2006; Vorakulpipat & Rezgui, 2008; Campos, 2008).

- Vorakulpipat and Rezgui (2008) have built on McElroy's work and propose a third generation KM based on value creation. According to Vorakulpipat and Rezgui (2008), value creation focuses on the organizational and societal impact, highlighting five major factors towards value creation: Human networks; Social capital; Intellectual capital; Technology assets; and Change processes.

2.2 Intellectual capital

The term intellectual capital refers to an organizations investment in knowledge. The term was coined by Thomas A. Stewart (1997). In his book '*Intellectual Capital: the New Wealth of Organizations ',* Stewart (1997) describes intellectual capital as intellectual material such as knowledge, information, intellectual property and experience that can be put to use to create wealth. It consists of human capital (knowledge worker), customer capital (knowledge driving decision to buy) and structural capital (company knowledge) (Davenport & Prusak, 1998; Gamble & Blackwell, 2001). Organizational knowledge refers to companywide collective knowledge of its products, services, processes, markets, and customers.

2.3 Community collaboration

Communities of practice, as described by Gamble and Blackwell (2001), are collections of individuals who share a similar work role in a common context bound by informal relationships. According to Wenger (1998), communities of practice are the prime context in which individuals work out common sense, highlighting the social and negotiated character of both the explicit and tacit in one's life.

Further, Gamble and Blackwell (2001) identify social capital as a characteristic of communities of practice that affect the creation and sharing of knowledge. They define three inter-related dimensions of social capital. The first is the structural dimension which refers to informal networks that allow individuals to identify others with potential resources which they themselves are lacking (Gamble & Blackwell, 2001). The second is the relational dimension which addresses interpersonal dynamics such as trust, shared beliefs, and expectations (Gamble & Blackwell, 2001). Lastly, the cognitive dimension refers to a common context and language to build social capital (Gamble & Blackwell, 2001). Improvements in the performance of a community of practice through building social capital are argued to improve flexibility, agility, and the organization's ability to respond to problems (Gamble & Blackwell, 2001).

2.4 Information theory

In Polanyi's (1966) book, '*The Tacit Dimension'*, he considers human knowledge in the context that we know more than we can tell. He argues that limitations of communication display a knowledge that we cannot tell (Polanyi, 1966). Hence Polanyi (1966) states that the process of formalizing all knowledge to the exclusion of any tacit knowing is self-defeating.

According to Krippendorff (1986), information theory is more than a statistical tool; it is at the root of social phenomena by providing explanatory structures, theorems of generality, and calculus for information and communication. In 1995, two Japanese academics, Ikujiro Nonaka and Hirotaka Takeuchi, published the book '*The Knowledge-Creating Company'* (Davenport & Prusak 1998). They highlighted the conversion of internalized tacit knowledge into explicit codified knowledge for successful knowledge sharing. They created a model for knowledge conversion, called SECI (Socialization, Externalization, Combination, and Internalization). Later work by Davenport and Prusak focused on information theory (Davenport & Prusak 1998).

2.5 KM practices

Knowledge sharing strategies have focused on formal arrangements such as internships and apprenticeships, communities of practice, documenting processes, expert interviews, knowledge maps and audits, lessons learned debriefing (held during and at the end of projects to share knowledge as project snapshots) and mentoring programmes (Keyes, 2006).

Resources dedicated to KM can be found as part of Information Technology departments. A techno-centric view of KM is a focus on technology that enhances knowledge sharing and growth. KM technologies expanded in the mid 1990s and are referred to as knowledge enablers (Davenport & Prusak 1998). Examples include Lotus Notes, expert systems, collaborative software, and Web 2.0 technologies.

2.6 SECI model

Nonaka and Takeuchi (2004) describe a KM cycle as a knowledge spiral that depends on the interaction of tacit knowledge and explicit knowledge, leading to four modes of knowledge conversion – Socialization, Externalization, Combination, and Internalization, referred to as the SECI model (Nonaka & Konno, 1998; Nonaka & Takeuchi, 2004). Socialization involves the sharing of tacit knowledge between individuals, emphasizing capturing knowledge through close physical proximity (Nonaka & Konno, 1998). Externalization involves the conversion of tacit knowledge to explicit knowledge into a comprehensible form understood by others (Nonaka & Konno, 1998). This mode is founded in the semantics and semiotics of communication (Depres & Chauvel, 1999). Combination involves building explicit knowledge into a more complex set of explicit knowledge (Nonaka & Konno, 1998). Internalization involves the conversion of explicit knowledge into tacit knowledge which is actionable (Nonaka & Konno, 1998).

These modes view knowledge as context-specific and depend on a time, space and relationship with others (Nonaka & Toyama, 2004). This context is referred to by the Japanese term '*ba'*, originally proposed by Japanese philosopher Kitaro Nishida (Nonaka & Konno, 1998). The SECI model provides four modes of *ba* (see figure below) (Nonaka & Konno, 1998).

Originating *ba* is supported through direct interaction and shared experience (Nonaka & Takeuchi, 2004). Interacting *ba* helps promote reflection and interaction between individuals (Nonaka & Takeuchi, 2004). Cyber *ba,* is when externalization transcends the group to be combined (Nonaka & Takeuchi, 2004). Exercising *ba* is when individuals identify relevant knowledge within organizational knowledge and put this newly acquired knowledge into action (Nonaka & Konno, 1998).

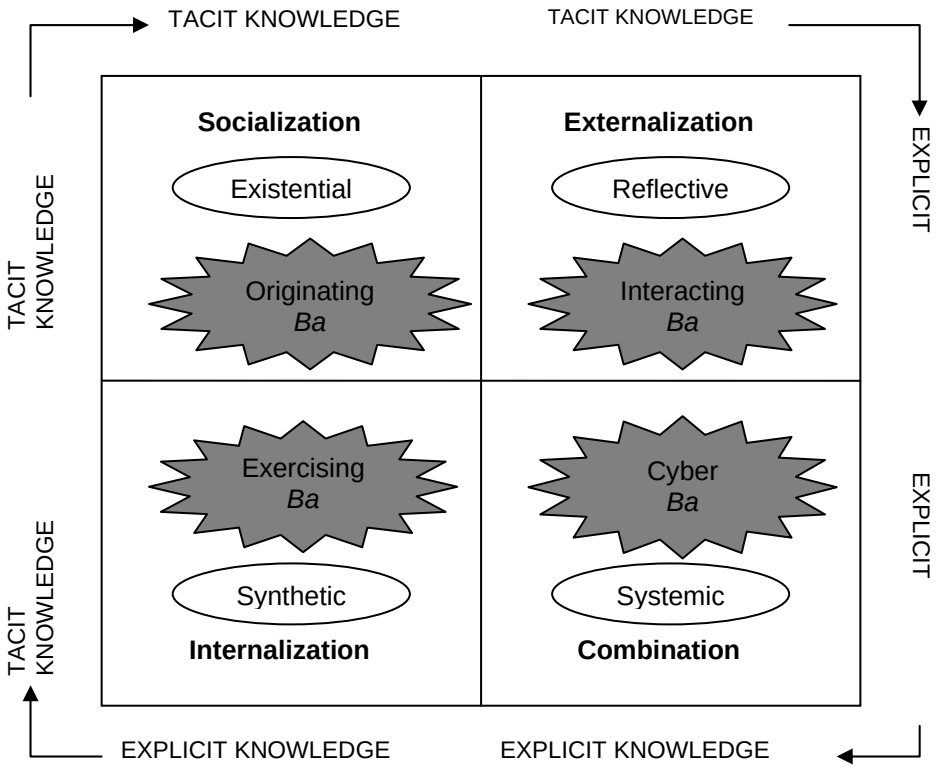

Figure 1: The four characteristics of 'ba' in the KM spiral evolution (Source: Nonaka & Konno, 1998)

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3. KM and IT support services

The lack of management of technical knowledge in IT support services has substantial costs in making the same mistake twice (or more), and inability in finding what the company knows fast enough in problem solving (Gamble & Blackwell, 2001). To mitigate these costs, IT Service Management (ITSM) looks at managing IT systems centered on the user's perspective of ITs' contribution to the business. ITSM as a discipline for managing information technology is a primary enabler of IT Governance objectives. ITSM audit is covered in the standard ISO/IEC 20000.

ITSM is supported by a number of standardized guidelines; an example is the Information Technology Infrastructure Library (ITIL). ITIL describes industry processes and best practices necessary for delivery of service solutions and is a registered trademark of the Office of Government Commerce (OGC) in the United Kingdom (MOF 2008). Microsoft has adopted and adapted ITIL to create the Microsoft Operations Framework (MOF). MOF highlights activities and processes into Service Management Functions (SMFs) which are grouped together in phases mirroring the IT service lifecycle (MOF, 2008). The IT service lifecycle has three ongoing phases and one foundational layer.

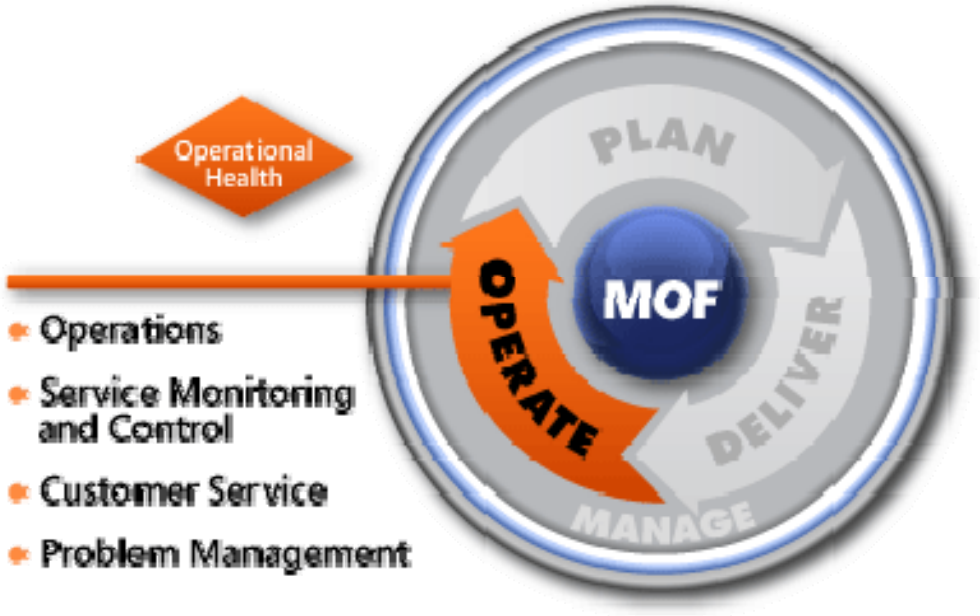

Figure 2: The operate phase within the IT service lifecycle (Taken from TechNet library solution accelerators: Microsoft operation framework 4.0. (MOF, 2008))

Plan Phase – optimize IT service strategy in order to support business goals and objectives

Deliver Phase – IT services developed and deployed effectively ready for operations

Operate Phase – IT services are operated, maintained, and supported in a way that meets business needs and expectations

Manage layer - Operates throughout all other phases, providing principles to ensure a return on IT investment

This paper considers the Operate phase as the main area where IT services are operated and maintained, highlighting the daily ongoing activities of IT support service personnel. Owing to the above, the Operate phase will be viewed through the SECI model to determine how knowledge flows and is diffused in a service environment.

4. Overview of iThemba LABS

iThemba LABS is a multidisciplinary research centre sponsored by the South African National Resource Foundation (NRF). iThemba LABS provides basic and applied research using particle beams, particle radiotherapy for the treatment of cancer, and supply accelerator-produced radioactive isotopes for nuclear medicine and research. The organization has a number of groups, namely

Accelerator, Material Research, Physics, Radiation Biophysics, Medical Radiation, Radionuclide Production, Electronics and Information Technology (EIT), Technical Support Services, and Financial/Administration Group. The organization structure is largely project-based, where individuals and groups work together on defined projects. It has approximately three hundred personnel, with an EIT Support group of roughly thirty five personnel.

EIT support handles the daily provision and maintenance of hardware and software to all other ten internal groups. Support also goes beyond simple reactive activities such as error logging and trouble-shooting to more proactive activities such as development, research, and the identification of new technologies and solutions. All this translates to availability of the particle radiation beam, providing greater return on investment.

Use of iThemba LABS for fieldwork was due to easy access to data, information, as well as people. Further, a number of organizational issues were of concern:

- IT support of new service and technologies, as well as the complexity of services in the nuclear facility born in the 1970s (legacy systems);
- implementation of a request tracker (incident management and knowledgebase) which forms part of the Integrated Management System (IMS) evaluation tools;
- increasing rate of innovation in nuclear research requires replacement of informal knowledge with formal methods;
- the amount of time available to experience and acquire knowledge is diminished as competitive pressures have reduced the size of the workforce;
- a need for succession training and lifelong learning as the personnel are largely older people reaching retirement age, and are the only individuals who hold specific knowledge about the intricacy of certain vital systems

4.1 EIT Support workflow

The support organization has a centralized structure. Both email and telephone calls are all logged to the same place through the use of the ticketing system. This is considered first-line support. If first-line support is unable to resolve the incident, it becomes a 'problem' which is referred to second-line support for further diagnosis and action. A list of roles and responsibilities is provided below. In order to log incidents and track their status till resolution, management introduced a ticketing system.

Table 1: Roles and responsibilities

Roles	Support Personnel	Head of System Support	EIT Group Head	EIT Quality Representative
Responsibilities	Day to day support (query handling, trouble-shooting) Monitoring status and progress toward resolution Keep affected users informed about progress Research and development Procurement, ordering and invoicing	Drive efficiency and effectiveness of support process Management information and feedback on support operations Manage first- and second-line support personnel Develop and maintain incident management system Sign off on cost centers	Production and maintenance of major incident communication plan Facilitating production and maintenance of major incident restoration plan Facilitation of management team reviews Production of major incident progress updates Participation in major incident reviews EIT Budget	Customer representative (customer feedback) Ensure procedures and process in place Monitoring service quality

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4.2 Ticketing system

A ticketing system is normally used for incident and problem management. It provides a knowledgebase for support personnel to fast track solutions through looking up similar past incidents, and the people involved in resolution of incidents (Best Practical, 2008). Hence, the technology acted as a knowledge enabler. Various software, called Request Trackers, enable a group of individuals to efficiently manage tasks, issues and requests submitted by user communities via its web or email interface (Best Practical, 2008).

When an event or incident is reported, it is given a unique tracking number or ticket and is placed in a queue. Several queues were created: 'ITSupport' queue for initial ticket creation; 'ITPurchases' queue for procurement; 'ITHotSeat' for major errors/issues/bugs; and 'ITNetwork' for network incidents. Watchers of the queue receive notification when a trouble ticket is created and/or changed. The duty of monitoring the 'ITSupport' queue was on a rotational basis. Responsibility involved creating new tickets from calls received at the helpdesk (for users who preferred to call), moving tickets to different queues, and assigning tickets to owners.

Implementation of the ticketing system adhered to the MOF service monitoring and control management flow (MOF, 2008): Define Request Tracker requirements; Implement service; Continuous monitoring; Control and reporting.

Table 2: Service monitoring and control management activities (adapted from MOF, 2008)

Flow Phase	EIT Group Head	System Support Head	Support Personnel	Quality Rep	Activities
Defining Request tracker requirements	○	●	○		Define IT service to be monitored ; prepare service component health model ; review reliability requirements
Implement Service activities	△	○	●		Align new IT service to existing processes and functions; align new IT service to existing IT organization; align new IT service to existing SMC tools
Continuous monitoring activities	△	○	○	●	Receive notification; analyze event; resolve or escalate event
Control and reporting activities	△	●	○	△	Produce reports and statistics; conduct operational health management review; plan and execute service improvement

● -Primary Responsibility ○ -Secondary/team member △ -Need information to/from

5. Research method

5.1 Grounded Theory methodology

Grounded theory (GT) is a qualitative research approach that is inductively derived from the study of the phenomenon it represents (Corbin & Strauss, 1990a; Fernandez, 2004). Pioneered through the work of sociologists Glaser and Strauss (Glaser & Strauss, 1967; Corbin & Strauss, 1990a; Fernandez, 2004), it is a form of field research where theoretical explanations of key social processes are derived from or grounded in empirical data (Speziale & Carpenter, 1999; Fernandez, 2004). Hence, one does not begin with a theory, and then prove it; rather one begins with an area of study and allows theory to emerge (Corbin & Strauss, 1990a; Glaser 1992; Speziale & Carpenter, 1999; Fernandez, 2004). Therefore, data collection, analysis, and theory stand in reciprocal relationship with each other (Corbin & Strauss, 1990a).

Glaser and Strauss later separated, each developing their own approaches on how to conduct grounded theory research. This research uses the Glaserian description of the methodology, where

emergence and theoretical sensitivity form the central role in interpretation. The basic principle of open coding, theoretical and selective sampling, and abstraction still remain crucial. Issues of bias and preconceptions are dealt with through grounded theory's systematic approach that takes into consideration extant theory but is not driven by it (Fernandez, 2004; Glaser & Strauss, 1967).

5.2 Repertory grid

The Repertory Grid interview technique which focuses on human judgment and psychology (Easterby-Smith, Thorpe & Holman, 1996) ties in with the grounded theory approach since grounded theory is renowned for its application to the study of human behavior (Goulding, 2002). The Repertory Grid Technique is derived from personal construct theory originally developed by George Kelly, a clinician, in the 1930s (Fransella, 1977; Easterby-Smith, Thorpe & Holman, 1996; Song & Gale, 2008). The technique was borne through Kelly's discontent with the then psychological theory and from his engineering background. The technique addresses three main concerns in theory development: observer bias, precision and prediction for the individual, and over-reliance on the expert (Fransella, 1977).

5.3 Research procedure

After the completion of a project to implement a ticketing system for the Electronic and Information Technology (EIT) Support sub-group, a study of its usage and knowledge management activities was conducted. This study was carried out within a three month period. Entry into the field of research is through participant observation whilst serving an internship as a Software Engineer. All participants were made aware of this study, and their involvement was voluntary.

Firstly, information was gathered about the work flow of EIT support from discussions with three support personnel, the head of support, the deputy group head, as well as the group head. From there, the ticketing system was installed, configured and customized according to their workflow. Training on the system was provided through documentation and also one-to-one training of the helpdesk (first line support). This formed preliminary observation and information which formed the first attempt at open coding and the first cycle of theory generation.

Further, semi structured interviews and repertory grid technique interviews were carried out. This, together with data from the ticketing system, formed another cycle. These findings were then swept into the emerging theory, supplemented by extant theory to inform and refine coding. At this point, theoretical concepts were dense enough to present a substantive theory. From this theory, a KM model of a service framework is presented.

5.4 Data collection

5.4.1 Participant observation

The stance is that of *participant as observer* (Kawulich, 2005). The group was aware of this research activity. Observation provided a way to check for nonverbal expression of feelings, how personnel communicated with one another, and also how much time was spent on activities (for example, problem solving and use of the ticketing system tool).

5.4.2 Interviews

Semi-structured interviews were used to gather multiple perspectives of the support personnel. Selection of interviewees (eight in total) provided full coverage of EIT support function, from technical support, software engineering, electronics-research and development, and electronics-installation and maintenance. The interviewees experience within the organization range from three (3) years to twenty-nine (29) years, giving an average of 11.125 years. Theses interviews were taped. Although the Glaserian approach denounces taping of interviews, taping allowed fewer false conclusions due to researchers own bias or interpretation.

The interviewees also participated in a repertory grid interview. Elements were elicited through the interview discussion on workflow, knowledge sharing and transfer. Constructs were generated through the Triading method (Easterby-Smith, Thorpe & Holman, 1996). The grid technique was based on ratings. In the rating grid, elements were rated on a scale of 1 to 5 defined by two construct poles. The method allows flexibility of response but the resultant matrix is not easy to deal with by

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hand and requires a computer programme (Fransella, 1977). Principle component analysis (PA1) programme is required to analysis the matrices (Fransella, 1977). It analyses the total variance of the data (by row and column but not the two together), requiring no assumption of the data (Fransella, 1977). The excel spreadsheet add-in called XLSTAT provided for principle component analysis.

6. Results and analysis

This chapter presents the findings for each data source, then ties them in to form a framework of knowledge management for IT support services. It also shows how extant literature informs the study, and fortifies the theory grounded in the data.

6.1 Participant observation

Observation was carried out for a period of three months, during meetings and whilst the ticketing system was in use. Three major observations stood out during this period. Firstly, there seemed to be a need to discuss and share ideas on how to implement the system, format to record incidents, and how to divide the workload. Despite the ticketing system tool, support personnel still relied on informal and collaborative contact, such as wikis, email lists and mentoring, in discussing problems, issues, and ideas. This emphasizes the importance of the reliance on each other, almost like a community of practice. Each support personnel had a specialization, with only medium overlap with their peers. Hence, each had a role within the community in which they are a member. This reflects activity within the socialization mode.

Secondly, there was joint agreement on experience rather than formal education as being the major contributor to both individual and group knowledge. Strict discipline had to be exercised in documenting incidents and their solution using the ticketing system. Time constraints on the individual were a pressure that prevented or compromised document quality. Lastly, there is a great concern for communication from both senior and junior personnel. Both see the value in effective and efficient communication. Junior personnel complained that normally all information pertaining to the solving of incidents were not provided to them by their supervisors, instead they are only provided with an abbreviated version of the solution. Supervisors, on the other hand, blame poor communication on the receivers' ability to comprehend all aspects, as well as their own inability to articulate the complete solution.

6.2 Semi-structured interviews

Semi-structured interview questions focused on: troubleshooting methods; how knowledge is typically shared; reasons why this process is followed; reasons for sharing; where knowledge is created; what is considered critical; what are the obstacles/constraints. From these base questions, interviewees were encouraged to talk about their experiences, feelings and thoughts on the topic. Transcription involved putting key words and constructs into categories. Also observed were differences in constructs between senior personnel (within the organization for more than ten years) and junior personnel (ten or less years within the organization). The categories table can be found in Table III.

6.3 Repertory grid

The major themes identified from using covariance principle component analysis were: research; interest; benefits; communication; experience; and resources. These were found to increase together (positive covariance). The various components from individual matrices (interviews) were ranked in order of Eigen value, highest to lowest. From there, the identified three principle components were selected from each matrix (Table IV and Table V). Owing to some overlap in components between the matrices, six themes were found to be of greater significance.

- Research refers to the need to seek a solution to a problem through identifying the root cause.
- Interest in the problem area highlights a need or value in entering the knowledge marketplace, either as a seller or buyer.
- Benefits of sharing include fast tracking the solution, learning new skills, competency, multiple perspectives and solutions, self-improvement, and a give-and-take two-way street regarding sharing.
- Communication was a core construct of both junior and senior personnel. The semantics of language play a huge role in transferring and sharing ones knowledge. As Stewart (1997) wrote in

his book 'Intellectual Capital', "Even the smartest people in the world need a mechanism to assemble, package, promote, and distribute the fruits of their thinking". Effective communication aids smooth knowledge flow.

- Experience gives rise to lessons learned and hence proven methods of tackling an incident.
- Resources are important in converting knowledge from tacit to explicit and vice versa. Resources include, time, funding, infrastructure.

Table 3: Interview categories

Category	Junior Personnel	Senior Personnel
Problem solving process	External documentation; interesting reference; communities of practice; own experience and knowledge	prior knowledge (depend on oneself) (extends to knowledge of where to find documentation); guidelines; reference from people; teamwork; historical problems; common-sense; elementary; expert in field
Learning process	Self-help; research due to limited solution provided by people; supervision; individual interested in knowledge	facility problem-faster using teams; programming problem-rely on oneself; logical problem solving steps; no hard fast rule; proven methodology; experience; DIY-self dependence
Useful/critical knowledge	Through collaboration; procedure; multiple solutions; overlap in expertise	fundamentals; people skills; communication skills; complex system skills; experience; technical background; formal qualification
Knowledge creating process	During implementation; problem solving (trial and error); research; sharing problems/ideas; supervisor communication; upgrades/changes	formal education; group learning; research; changing tech environment-learning curves; individual/group faults; interest
Knowledge as action	problems occur; upgrade/improvement system requirements; struggles; through asking; implementation	daily work; formalizing experience through documentation - gain perspective; training; social informal communication; collaboration-alternatives; explanation from different specialists
Constraints/obstacles	resources (time, workload, infrastructure, funding); lack of documentation; training; management approval; knowledge hoarding	resources; personalities (protective over information, shy, confidence, communication, language); shortage of personnel; funding; lack of documentation; ability to understand (competency); job preservation; recipients interest/ability/absorption of knowledge and information
Sharing	observation; explanation; example; talk; supervisor; presentation; communication; asking advice; problem fault finding; tagging along	verbal; practical example; work alongside; talk sessions; log events (self discipline); wikis (informal documentation)
Benefits	broaden self knowledgebase; faster solution; help others; continuity; two way street; multiple perspectives; more people (resources)	empowerment; learn new skill/tool; reinforce learning; two way street; reduced workload; sustainability; resource usage; quick solution; cannot write everything down-transfer through peers; economic; job satisfaction

Table 4: Repertory grid PCA

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	Eigen values				Principle constructs		
1		F1	F2	F3	1.1	practical and documentation to help individual	individual not interested will not make use of documentation
	Eigenvalue	14.777	4.590	0.822	1.2	sharing when interested	does not depend on interest, documentation will exist
	Variability (%)	73.191	22.736	4.073	1.3	begin/start that leads to	result in knowledge sharing
	Cumulative %	73.191	95.927	100.000			
2		F1	F2	F3	F4	2.1	ways to share	benefits of knowledge transfer
	Eigenvalue	14.640	6.846	2.754	1.405	2.2	benefits of sharing knowledge (getting help, faster problem solving)	when sharing is useful (actively seek knowledge) problem solving
	Variability (%)	57.086	26.696	10.741	5.478	2.3	give and take; how it helps an individual	when to help others and share knowledge
	Cumulative %	57.086	83.782	94.522	100.000			
3		F1	F2	F3		3.1	informal; two way; speak or ask more freely	more one way communication (people may not ask questions)
	Eigenvalue	16.747	4.408	2.129		3.2	sharing with other people	doing it for your own use
	Variability (%)	71.926	18.931	9.143		3.3	sharing and communicative	by one's self
	Cumulative %	71.926	90.857	100.000				
4		F1	F2	F3	F4	4.1	assist to get information on the system (direct interaction) two way	keeping people in the loop (one way interaction)
	Eigenvalue	16.379	5.108	1.733	1.293	4.2	knowledge providing better understanding (help with job skill)	knowledge created if there is a need
	Variability (%)	66.818	20.839	7.069	5.274	4.3	integrated together to find a solution	specific to one incident/problem
	Cumulative %	66.818	87.657	94.726	100.000			
5		F1	F2			5.1	gain of knowledge	lack of knowledge distribution
	Eigenvalue	19.154	6.164			5.2	derived from casual exposure to work environment	derived from research
	Variability (%)	75.654	24.346			5.3	how to gain knowledge	benefits of knowledge
	Cumulative %	75.654	100.000					
6		F1	F2	F3		6.1	workload decreases through sharing knowledge and ideas (working together)	Sustainability
	Eigenvalue	14.256	3.987	1.803		6.2	need communication between people	no communication involved
	Variability (%)	71.119	19.888	8.993		6.3	improved resources and workload	improved communication
	Cumulative %	71.119	91.007	100.000				

Table 4: (Continuation of repertory grid PCA

	Eigen values				Principle constructs		
7		F1	F2	F3	7.1	critical (not positive)	Positive side
	Eigenvalue	14.265	4.251	0.254	7.2	have similar technical background	sharing with people in unrelated field
	Variability (%)	75.999	22.650	1.351	7.3	thinking and experience is re-lived (and storing it)	no technical background
	Cumulative %	75.999	98.649	100.000			
8		F1	F2	F3	8.1	conscious negative state of mind	sharing in positive sense
	Eigenvalue	19.203	7.024	0.152	8.2	negative aspect actually chosen	external constraint
	Variability (%)	72.797	26.628	0.575	8.3	not sharing knowledge	sharing knowledge
	Cumulative %	72.797	99.425	100.000			

Table 5: Themes and constructs

No.	Theme	Constructs
1	Research	5.2; 7.1
2	Interest	1.1; 1.2; 7.2; 8.2
3	Benefits	1.3; 2.1; 2.2; 2.3; 3.2; 4.3; 5.3; 8.1; 8.3
4	Communication	3.1; 3.3; 4.1; 5.1; 6.2; 6.3
5	Experience	4.2; 5.2; 7.3
6	Resources	4.1; 5.3; 6.1; 6.3; 7.1; 8.2

6.4 KM Model for IT support service

Results from data collection were then used to form a tentative KM model for the support service framework:

SECI model and EIT support

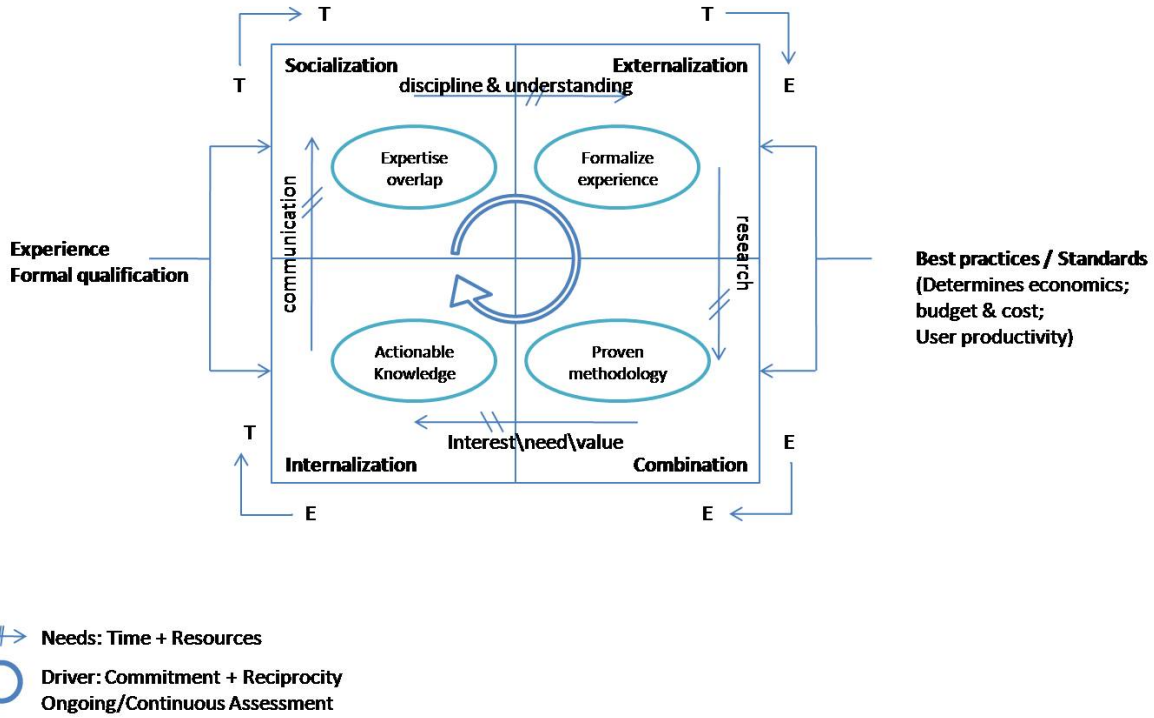

Figure 3: SECI model and EIT support (adapted from Nonaka & Konno (1998))

It was found that every transition between the quadrants representing *ba* (knowledge platforms) requires 'conversion energy'. This energy can be compared to that needed in changing the state of a material. For example, ice to water, water to vapour, vapour to water, and water back to ice requires the use and conversion of energy. This 'conversion energy' is in the form of resources. Resources are both tangible and intangible. Tangible are in the form of funds, tools and infrastructure. Intangible resources include time and quality. The driver was found to be commitment and reciprocity. From the transition between quadrants, it was found that the MOF Operate phase Service Management Functions can be linked to the four *ba* quadrants. The socialization quadrant referring to an overlap of expertise comes into play in problem solving activities carried out by the Customer Service Service Management Function. This requires interaction with not only peers but customers and suppliers', forming the beginning of the knowledge spiral as problem solving requires physical proximity and joint activities at the actual job site.

Movement to the externalization quadrant involves monitoring and capturing IT health knowledge. This resembles the Service Monitoring and Control Service Management Function which observes IT services to minimize impact of service incidents and events (MOF, 2008). The outcome is improved understanding and quicker, effective responses to service incidents (MOF, 2008). The quadrant also focuses on knowledge enablers required to aid in the capture of experience and knowledge. As the use of the ticketing system showed, service monitoring and control aided faster and efficient service by providing a description of the problem and its solution, persons involved, trends, workload, escalation of incidents, and other incident data.

Transition to the combination quadrant requires research encompassing other knowledge to form a more complex set. This resembles the Problem Management Service Management Function where the main deliverable is effective problem resolution process (MOF, 2008). This is in line with findings which showed an outcome of proven methodology in problem solving.

Finally, transition to the internalization quadrant which looks at the need, value and interest of knowledge resembles the Operations Service Management Function. This is in line with findings of knowledge as action. Knowledge drawn from procedure and methodology needs to be absorbed by personnel. This is restated in the findings where absorptive capacity was argued to be a limitation in proper sharing of knowledge. Addressing the issue of absorptive capacity will require a look at the learning process of the individual (how lessons can be internalized for personal development or training) and bounded rationality, which is beyond the scope of this study.

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The main themes highlight two important enabling conditions for knowledge flow. The benefit theme highlights faster problem solving through increasing the competency (self-knowledge base – skills) of personnel which in turn affects the quality of knowledge and transfer. Hence the give and take relationship (reciprocity) effectively enhances competency. The communication theme stresses the importance of conversations and the recipients' ability to understand which in turn aids in resource (time, funds, infrastructure) bargaining. Presented below is a representation of a KM Model for IT support service. It has been developed from the Kao Corporation Five-phase Model of the Organizational Knowledge-creation Process (Nonaka & Takeuchi, 1995).

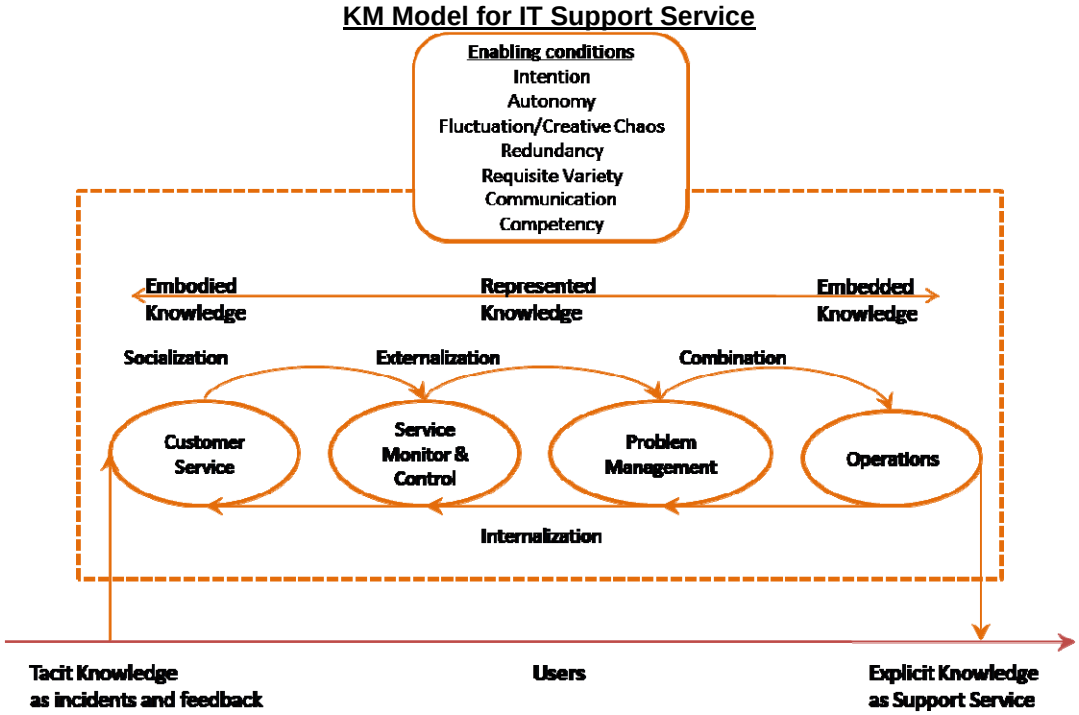

Figure 4: KM Model of IT support service (adapted from Nonaka & Takeuchi, 1995)

The enabling condition of intention is through the goals and objectives of EIT support. The support environment is in constant fluctuation due to changes in technologies and solutions, and normally results in self-organizing groups according to the nature of the particular incident. This provides for a certain degree of fluctuation/chaos and autonomy. The other enabling conditions of redundancy and requisite variety are provided through rotational basis of workflow (overlap in expertise) and interaction with the external environment (users and suppliers).

7. Conclusion

Incorporating data collected from the substantive area and aligning with MOF leads to a more general KM model for a service environment. This framework agrees with Nonaka and Konno's (1998) *'ba'* concept within the foundations of IT Strategy and Culture. This is based on the constructs of commitment and reciprocity. These constructs reinforce and build-on each other. Further, communication and competency were identified as additional enabling conditions.

IT strategy needs to be linked to the overall goals and objectives of the organization (intention) to ensure that resources (tangible and intangible) are directed towards the right projects and people, providing knowledge when it is needed at specific decision points. As pointed out by the findings, knowledge becomes actionable through daily work experience, where the major obstacle is resources (time, funding, and infrastructure).

Improving and implementing strategy involves commitment not only from management, but all IT personnel in realizing both human capital (skills), and structural capital (that which remains after people leave). As observed and presented in the findings, discipline had to be exercised in documenting incidents and their solution using the ticketing system. This discipline is a form of commitment needed to carry out work tasks. As Day (2007) also commented, organizations are made and run through commitments.

This commitment is brought about through communication (Day, 2007). From the findings, communication depends on both the receivers' ability to comprehend all aspects, as well as the senders own ability to articulate the complete solution. Knowledge workers are able to identify what they know, who knows what, and share their knowledge through conversations with colleagues. Communication was found to be an enabling condition in knowledge creation, providing the mechanism for resource bargaining.

To encourage such productive conversation and interaction, culture plays an important role. This can be seen from the findings where the cultural limitation or obstacles were language, and the concept of 'knowledge as power' belief held by older personnel. Freedom to share ideas, and removing the negative association of asking for assistance as a sign of incompetence, promotes an environment ideal for knowledge management. This is largely driven by reciprocity.

Reciprocity reflects two-way interaction, in giving and receiving. This involves measures of trust and common ground, which is reiterated by Davenport & Prusak (1998), and Gamble and Blackwell (2001). At iThemba LABS, a culture of openness and reciprocity comes through trust in the knowledge source or competency of the knowledge owner. Competency of personnel enhances the quality of knowledge and transfer.

Since this study looks at IT Service Operate phase only, further research could look at the other phases forming IT Service Life Cycle to see if knowledge processes can be identified. It would be worthwhile to have an analysis of all phases, since each affects the other in IT service management, forming a wholly KM model for IT service.

Also, it could be argued that the need for improved user productivity through value added by IT Support falls within the third generation of knowledge management (value creation) proposed by Vorakulpipat & Rezgui (2008). Future research can take a closer look at value creation and knowledgement management in the context of IT support service.

In addition, the issue of absorptive capacity in the KM spiral will require a look at the learning process of the individual. This includes how lessons can be internalized for personal development or training and bounded rationality in actions and decision making.

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