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A Knowledge Infrastructure Hierarchy Model for Call-Centre Processes

Greg Timbrell
(Queensland University of Technology, Australia
g.timbrell@qut.edu.au)

Stefan Koller
(Know-Center Graz, Austria
skoller@know-center.at)

Nev Schefe
(Queensland University of Technology, Australia
Nev.Schefe@dtftwid.qld.gov.au)

Stefanie Lindstaedt
(Know-Center Graz, Austria
slind@know-center.at)

Abstract: This paper explores a process view of call-centres and the knowledge infrastructures that support these processes. As call-centres grow and become more complex in their function and organisation so do the knowledge infrastructures required to support their size and complexity. This study suggests a knowledge-based hierarchy of 'advice-type' call-centres and discusses associated knowledge management strategies for different sized centres. It introduces a Knowledge Infrastructure Hierarchy model, with which it is possible to analyze and classify call-centre knowledge infrastructures. The model also demonstrates different types of interventions supporting knowledge management in call-centres. Finally the paper discusses the possibilities of applying traditional maturity model approaches in this context.

Keywords: Knowledge Management, Information Systems, Data Bases
Category: H.1, H.2, H.4

1 Introduction

A call-centre is an organisational unit where inbound calls are received or outbound calls placed for the purposes of sales, support, advice and other business transactions. This article focuses on support or advice-type call-centres and the hierarchical nature of the organisational knowledge infrastructures [Strohmaier 2004] that support them.

The motivation for this paper arises from research undertaken within private and public sector call-centres [Schefe et al. 2003; Timbrell et al. 2002]. This prior research suggests that targeted knowledge management initiatives and interventions have an impact on the quality of advice and the efficiency and cost of knowledge services to customers.

This paper presents a descriptive model that illustrates the relationship between call-centre processes and knowledge infrastructure. The developmental nature of this

relationship, as call-centres become larger and more complex, suggests a relational hierarchy of process and knowledge infrastructures. We introduce a model for a *Knowledge Infrastructure Hierarchy* for the analysis and classification of call-centre knowledge infrastructures. Call-centres are classified by size and analyzed in relation to specific process-oriented dimensions including maturity stages. The model also points out the kinds of knowledge management (KM) interventions that are successfully established in call centres. Examples of knowledge strategies for small (Building Codes Q), medium (CC1 and CC2: names not released) and large (Hewlett-Packard) call-centres are described based on Timbrell's and Schefe's empirical work in these centres.

2 The Call-Centre

The following introduces a typical process in a multi-agent call-centre. Please note this process is meant to be illustrative rather than comprehensive. The customer dials the call-centre number and is greeted with a number of options that include the following: 1) a recorded message followed by the placement in a telephone queue managed by an Automated Call Distribution System (ACD); or 2) an Integrated Voice Response (IVR) that offers the caller different options where caller interacts with the IVR using a touch-tone telephone or voice control; or 3) the call is immediately directed by an ACD to an agent who manages the query. If the agent cannot personally resolve the query they direct the call to someone who can answer the query.

To better understand the process of a call-centre that provides knowledge-based support (responses) to queries from a customer base, the following general theoretical schema, the Query-Response Cycle is proffered.

2.1 The Query-Response Cycle

The following model, the Query-Response Cycle [Timbrell et al 2002] provides a knowledge-based view of a call-centre encounter. See Figure 1.

In the call-centre context, the caller has a query but does not have the personal (expertise) or public knowledge sources to trawl for the response and / or their search strategies are deficient. Rather than abandoning the query, they may consign it to the call-centre.

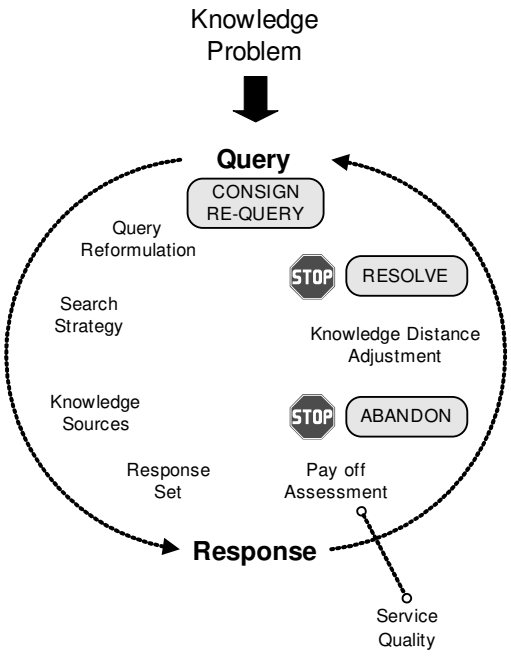

Figure 1: Query-Response Cycle

Das [Das 2003] suggests such problem solving as being the process of reducing differences between the known and desired state of knowledge of the caller. A problem is resolved when these two states are sufficiently close to satisfy the caller. There are two other outcomes from the process: (1) if the querist does not believe that the query can be resolved, or the payoff from pursuing the query is not worthwhile (e.g. in terms of time or money) then they abandon seeking a response; (2) if the respondent cannot resolve the query but believes that another party with superior knowledge sources and / or search strategies then they may consign the query to a willing third party. The authors believe that querists are continually assessing the payoff from their efforts in seeking a response to a query. The authors believe that a positive payoff assessment corresponds to the notion of superior technical service quality [Brogowicz 1990].

If the resolution of a query is a public sector responsibility then efforts to provide a response may be free to the querist i.e. tax-funded services rather than user-pays. This positively affects the payoff assessment applied by the querist. Moreover, if resolving the query is a public service responsibility then the caller knows that there is a high probability that the relevant government department will make all efforts to do so. A free advisory call-centre service reduces the chance that the querist will abandon the query. Subsequently, it is most important for government call-centres to provide effective and efficient service with high levels of technical and functional service quality [Brogowicz 1990]. Conversely, a time-based or per-use user-pays call-centre service from either the public or private sector will affect the payoff assessment of the querist throughout the process.

Once the agent receives the query, the Query-Response Cycle starts afresh. The agent applies relevant search strategies against their knowledge bases that may include databases, intranet, paper-based resources, other knowledgeable agents and staff inside the organisation, and contacts in other organisations. The maturity of the knowledge infrastructure, discussed later in the paper, is a key determinant in the ability of the call-centre agent to respond to the querist. Their searches may result in a single response that will resolve the query or an equivocal set of responses from which they must choose. The agent will assess the response set against their own 'payoff assessment / resolution value either (1) alone; (2) in conjunction with the caller; and / or (3) in discussion with other staff. In some cases, the agent will consign or refer the query to "2nd Tier" specialist call-centre or specialist organisational unit. This escalation represents additional cost to the organisation through cost of labour of specialists and the diversion of these specialists from other activities [Das 2003]. Queries may be consigned several times. Each consignment starts another Query-Response Cycle (Figure 2) until the resolution is passed back, either directly or via the tiers, to the original querist.

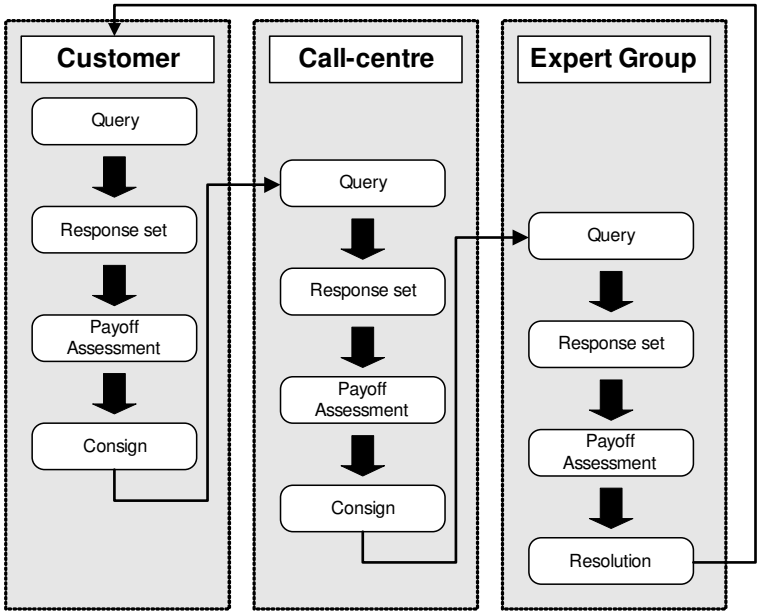

Figure 2: Tiered Query-Response Cycles

The elements on the left-hand side of the Query-Response Cycle model (Query reformulation, search strategies, use of knowledge sources, creation of the response set) and the final offering of one or more responses will vary according to the maturity of the knowledge infrastructure. The actions of the respondent will vary according to the perception of service quality of the querist [see Brogowicz 1990]. The type of knowledge problem entering the cycle has an effect on the knowledge

processing and subsequent consignments to more expensive knowledge resources such as expert group tiers. Zack [Zack 2001] offers a suitable framework for the typing of such knowledge problems.

2.2 Knowledge Problems

According to [Zack 1999] different types of knowledge problems are best processed by differing knowledge and information systems strategies. Zack's knowledge problems are summarised in Table 1. For each of his knowledge problems, [Zack 1999] suggests a number of information systems strategies. For problems of 'Uncertainty', he suggests: (1) providing central repositories to enhance the ability to locate codified and documented information; (2) providing automated capabilities to analyse large amounts of information; (3) configuring communication networks in highly flexible ways to respond to unpredictable information processing needs; (4) enabling communication regardless of geography or time; and (5) enabling broadcast at-large requests for information and knowledge, eliminating the need to know precisely where it is located.

For problems of 'Complexity' Zack suggests (1) auxiliary high-capacity memory for managing and rapidly analysing complex sets of information i.e. computer-based decision support systems, database systems, and expert systems; (2) develop searchable online repositories of explicit knowledge to leverage the organisation's experts; (3) develop the ability to spontaneously and quickly locate experts; and (4) facilitate decentralised decision-making by making local information available globally and global information available locally.

	Information	**Knowledge**
Lack of…	**Uncertainty** Insufficient factual information about the goal, situation or task, and some lack of confidence in the consequent inferences, estimates or predictions required	**Ambiguity** Inadequate knowledge (patterns/concepts) about, no explanation for, or understanding of a goal, situation or task
Variety / Diversity of…	**Complexity** Too many situational elements and relationships to coordinate or consider simultaneously	**Equivocality** Multiple interpretations of a goal, situation or task

Table 1: Summary of Zack's knowledge problems

Becker's strategy [Becker 2001] to reduce uncertainty involves acquiring increasing amounts of information until the problem is diminished in terms of uncertainty. He also suggests that a problem defined as ambiguous will not be resolved by this strategy; rather it may make it worse. The information already at hand needs to be processed in order to reduce an ambiguous problem to a complex one.

For issues of 'Ambiguity' and 'Equivocality', Zack suggests the provision of communication technologies to best support dialogue between a flexible and responsive network of experts and associates. The purpose of the dialogue is to transform problems of 'Ambiguity' and 'Equivocality' into problems of 'Complexity'

and 'Uncertainty'. In some ways Zack's approach is similar in nature to [Hansen et al 1999] who when describing their two knowledge strategies, codification and personalisation, promoted the use of information systems in their codification strategy and communication technologies in their personalisation strategy. The nature of the problem types (queries) directed at the call-centre effects the process employed to respond to that problem.

So, how this kind of process is executed, depends among other things on the specific size of the call-centre. The authors suggest the following classification of different sized call-centres: *Small* (to 12 agents); *Medium* (12 to 50 agents); and, *Large* (50 – 3000 agents and up).

By using this classification scheme, it's possible to build up a call-centre specific model containing a Knowledge Infrastructure (KI) Hierarchy.

3 Knowledge Infrastructure Hierarchy

The authors developed a model for a Knowledge Infrastructure (KI) Hierarchy. In this model, call-centres are classified by size.

Four call-centre specific KM interventions are mapped within this KI-Hierarchy model. Additionally, the model includes four process-oriented dimensions to analyze the call-centre types in terms of their organisational knowledge infrastructures for supporting business and knowledge processes within these companies.

In *Table 2* KM interventions for call-centres (Training, Metrics, Knowledge Policy applied, Knowledge Streaming and Use of Knowledge Sources) can be analysed in detail using the [Strohmaier 2004] B-KIDE framework. A special example of this is the application of a knowledge and information policy. Such policy would dictate the use of a particular sequence of activities for the creation, storage, transfer and application of knowledge. In chapter 4 the mentioned KM interventions are described in more detail.

3.1 Business Process Standardization Level

A process-oriented dimension is the Business Process Standardization Level (BPSL). This dimension indicates the level of business process implementation, formalization and standardization in a call-centre.

The level values we suggest as *Low*, *Medium* and *High*. A *Low BPSL* implies that the analyzed company has not modelled or implemented any business process yet or their occurrence is at a low level. Some decision-supporting criteria are, for example, the existence of ISO-certifications in a call-centre or the complexity and quality of employed process modelling tools. In a company classified with a *Medium BPSL* there is a high probability of existing ISO-certifications and modelled processes. Accordingly, a *High BPSL* requires high quality modelled and implemented business processes.

The BPSL forms the basis for the further analysis in the KI-Hierarchy Model. It influences the *Knowledge Process Maturity Stage* and the *Knowledge Process Scenario Type*.

	Call Centre Size	Small → Medium → Large		
Process dimensions	Business Process Standardization Level	Low	Medium	High
	Knowledge Process Scenario Type	B	A B	A
	Knowledge Process Maturity Stage	Initial	Aware	**Established** / Quantitatively Managed
	Knowledge Risk Level	**High**	**High / Medium**	**Medium / Low**
KM interventions	Training Approach	Mentoring on the job	Induction	Full preparatory training
	Use of Knowledge Sources	Personal knowledge sources	Static & dynamic databases	Variety of knowledge sources procedures in their use
	Knowledge Policy Applied	Little or no policy	Information use policy	Knowledge policy
	Knowledge Streaming Strategy	All agents are generalists - No streaming	Vertical knowledge streaming	Horizontal & vertical knowledge streaming
	Metrics	Few or no metrics	Call throughput & service quality metrics	Service quality & knowledge self-sufficency metrics

Table 2: KI-Hierarchy

3.2 Knowledge Process Scenario Type

An additional process-oriented dimension in the KI-Hierarchy is determined to be a Knowledge Process Scenario Type based on the B-KIDE (Business process-oriented Knowledge Infrastructure Development) approach from [Strohmaier 2004/2003] with which knowledge flows within and across business processes can be identified and analyzed. Based on this analysis key knowledge flows can be supported, business processes can be adapted accordingly, structures for organizational memories can be derived, and effective IT support can be designed. By using this methodology it becomes possible to analyze and classify knowledge infrastructures in a company, and in this case, in call-centres.

[Strohmaier 2004] uses a set of specific knowledge activities to describe knowledge work within and between organizational business processes. The knowledge activities used (knowledge generation, transfer, storage and application) are based on [Heisig 2001]. The method of [Strohmaier 2004] also implies the importance of identifying relationships between business processes. B-KIDE tries to identify knowledge processes that span across multiple business processes. This is a crucial factor when analyzing larger and more complex companies.

[Strohmaier 2003] describes the knowledge flows, such as those found in call-centres, in a formal framework of knowledge processes. He illustrates three examples or scenarios of knowledge processes in *Figure 3*.

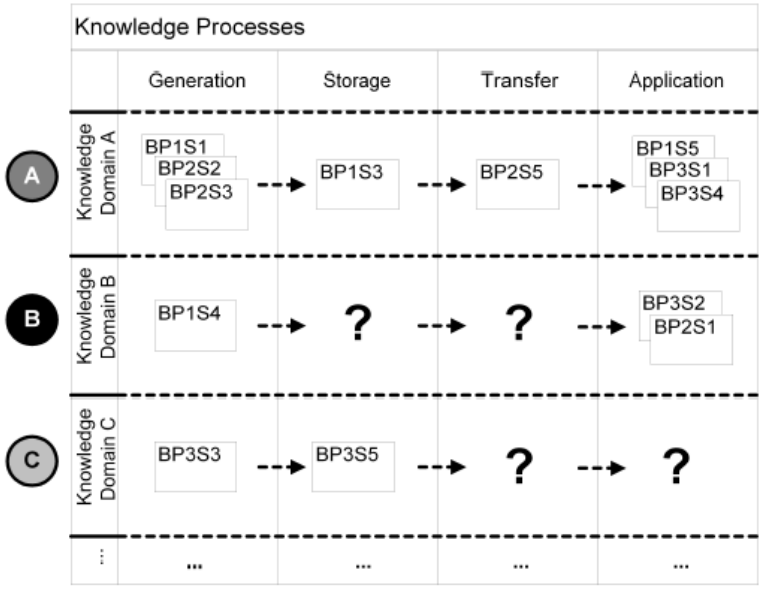

Figure 3: Illustration of potential knowledge processes [Strohmaier 2003]

As shown in *Figure 3*, related business process steps (in Figure 2 represented as e.g. BP1S4 – Business process 1 step 4) are illustrated, per knowledge domain, to give an idea, where that knowledge domain is being generated, stored, transferred and/or applied.

Knowledge Process Scenario Type A illustrates a complete knowledge process. All knowledge activities are supported and managed. *Knowledge Process Scenario Type B* shows, that knowledge storage and transfer are not defined and supported in any considered business process. From this it follows that the considered knowledge flow is identified, but there exist potential flaws in the appropriate knowledge process. *Knowledge Process Scenario Type C* gives an example for the waste of knowledge and resources. Knowledge is generated and stored but its transfer and application are not supported or managed by the knowledge infrastructure.

These scenario types (A, B, C) can be assigned to the different size types of call-centres.

3.3 Knowledge Process Maturity Stage

The authors propose an expansion of the classification of call-centres by using an appropriate KM- and process-oriented maturity model.

[Paulzen et al. 2002] developed the Knowledge Process Quality Model (KPQM). This model includes the following dimensions: *maturity stage, knowledge activity, management area* and a*ssessment structure.*

The maturity stage dimension forms the basis for an applicable model to define *Knowledge Process Maturity Stages* (for call-centres). *Table 3* gives a short overview

of the maturity stages of KPQM. A special benefit of the KPQM is its process-orientation concerning business as well as knowledge processes.

Maturity stage	Description
1 - Initial	The quality of knowledge processes is not planned and changes randomly. This state can be best described as one of chaotic processes.
2 - Aware	Awareness for knowledge processes has been gained. First structures are implemented to ensure a higher process quality.
3 - Established	This stage focuses on the systematic structure and definition of knowledge processes. Processes are tailored to react to special requirements.
4 – Quantitatively Managed	To enhance the systematic process management, measures of performance are used to plan and track processes.
5 - Optimising	The focus of this stage lies on establishing structures for continuous improvement and self-optimisation.

Table 3: Maturity stages of KPQM [Paulzen et al. 2002]

3.4 Knowledge Risk Level

The authors propose an additional perspective for analysis of knowledge infrastructures in call-centres: the *Knowledge Risk Level*. As the name says, this dimension handles with a special sort of critical corporate risks, so called *Knowledge Risks*. These risks concern the usage of knowledge and its possible danger for a company's success. According to [Lindstaedt et al 2004] Knowledge Risks are risks, which derive from a lack of knowledge and skills needed for critical actions and decisions in business situations. For example, interferences in knowledge (or information) flows, non existing transparency of knowledge or the change of technology are potential knowledge risks in this context.

One of the authors (Koller) is currently working on a theoretical framework including a method, called *Knowledge@Risk*, which aims to introduce and manage Knowledge Risks. They are deduced from three perspectives: business and knowledge processes, human know-how and the corporate organisational business environment. The primary perspective focuses on business and knowledge processes. This builds up the link to this *KI-Hierarchy Model* and its process-oriented dimensions. Inconsistencies and gaps in knowledge processes as shown in the *Knowledge Process Scenario Type B* and *C* situations are the leading risk factors for the assessment of the *Knowledge Risk Level*.

By applying *Knowledge@Risk* and its process-oriented perspective special knowledge profiles (knowledge process-, business process- and activity role-profiles) are analyzed. These results are used for the identification of Knowledge Risks, which are assessed and summarized for the consolidation with the usual business risks in

further *Knowledge@Risk* process steps. *Figure 4* illustrates the basic elements of the *Knowledge@Risk Method*.

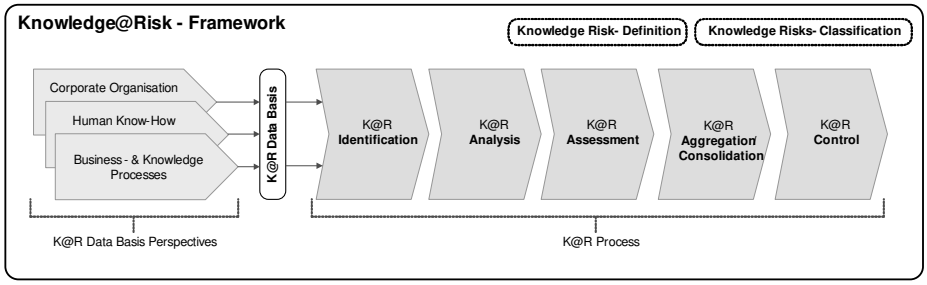

Figure 4: Knowledge@Risk – basic elements

The *BPSL* is an additional *Knowledge Risk Level* indicator. A low level of business process standardization offers a dangerous potential for the inefficient usage and the loss of critical knowledge.

We suggest *low* (knowledge infrastructure works sufficiently; no critical gaps in knowledge processes identified), *medium* (knowledge infrastructure is deficient; control actions should be taken) and *high* (knowledge infrastructure brings out a critical risk for the company's success; control actions should be taken immediately) as tentative values of the *Knowledge Risk Level*. *Table 2* shows that the *Knowledge Risk Level* grows inversely proportional to the *BPSL* values.

4 Application of the model

The following chapters demonstrate how KM interventions in different Call-centre size-types are adopted and how the KI-Hierarchy Model can be applied. The authors give a practical example for a small Call-centre.

4.1 Small Call-Centre

A small call-centre providing support services e.g. an internal information technology help-desk, might have a number of agents who provide analogous support services. They each manage customer queries and no knowledge specialisation strategy is in place. New agents acquire their skills on the job with assistance provided by their colleagues and supervisors. Calls are distributed using an ACD or manually by a reception agent. Support issues are not recorded or formally disseminated to the group. Agents use some standard information sources and build up their own materials over time. Mentoring and on-the-job learning are the principal training mechanisms. They gain an increased knowledge of common queries over time making them more efficient and able to provide greater service quality.

Using [Strohmaier's 2004] B-KIDE framework the knowledge processes in a small call-centre would generally coincide with his scenario B whereby knowledge

storage or transfer is not defined in any considered business process. Informal storage by individual agents may occur.

[Markus 2001] discusses this phenomenon in her work on knowledge re-use. Transfer can also occur independently of formal storage media through personal conversation rather than the passing of documentation but no formal business process is in place to facilitate such activities.

4.1.1 Example: Building Codes Q (BCQ)

Building Codes Queensland (BCQ) is a state government call-centre that has 12 agents. The centre advises building inspectors on the application of building codes, regulations and legislation. Agents are all experienced tradespersons, builders or building inspectors. New callers are routed to agents by a receptionist. Some callers dial direct to their favoured BCQ staff, knowing them to be experienced and knowledgeable or because they have a personal relationship with them built over years of advice.

BCQ agents use personal information materials and public information made available through the organisation's intranet. New agents learn on-the-job. Advice is given either on the phone, via email, or in more formal circumstances by letter. Prior to 1999, there was little sharing of advice given by agents to clients because there were no formal organisational storage and transfer knowledge processes. The consequences were that rework of research into issues was common and smarter clients could 'shop around' for advice i.e. try several agents until they got the advice that would best suit their purposes.

In 1999, BCQ trialled an advice-recording system. Agents would identify that advice had already been given on the matter to the caller and refer the caller back to the initial adviser ensuring consistency of advice. In effect, the system recorded that a 'transfer process' had already taken place. The system could also identify agents that had unresolved or 'open cases' i.e. the agent was still researching the case offline and would re-contact the caller when they had resolved the issue. Agents with a high 'open' case load could be taken off the support desk to let them clear their load (create knowledge). In conjunction with the advice-recording system, a search facility was implemented to data-mine past advice letters to reduce rework (transfer → application).

The take-up of these systems was poor. Agents did not think that the additional work to record issues and advice would reduce their work in the long term. One reason cited was that the changing nature of codes and regulations meant that re-using past advice without first checking its currency and validity could lead to the provision of flawed recommendations.

4.2 Medium Sized Call-Centres

A medium sized call-centre requires greater attention to knowledge re-use. One would expect to find in a medium-sized call-centre some central database system to which agents can refer when advising their callers. This database reference systems fall into two types: pre-recorded information prepared for the call-centre agents by third parties and recorded queries and responses recorded by the agents themselves. The use of such databases with call-centres correspond to *Knowledge Process Scenario*

Type A situation when agents can make full use of knowledge processes whereby knowledge is generated, stored, transferred and applied within the call-centre's intended business processes. Yet, research has demonstrated that inadequate training and lack of knowledge of the intended business processes within call-centres due to high turnover of staff can lead to ineffective use of the organisational knowledge infrastructure [Timbrell et al. 2003]. A *Knowledge Process Scenario Type B* situation can arise where knowledge is stored in central repositories by agents but ineffectively transferred to other agents. Agents may use one or both of these types of knowledge bases. ACD management tends to be more sophisticated often including a monitor within the call-centre that records real-time statistics on call rates and caller queues. While call throughput is important so is advice quality. However, advice quality is often secondary in the traditional management of call-centres. This is quite apparent when one reviews the traditional measures of call-centre management within the literature [see Feinberg et al. 2000].

The determinants of advice quality [Brogowicz 1990] are able to be empirically defined and include tangibles, reliability, responsiveness, assurance and empathy. Because of the greater potential for knowledge variance within a larger call-centre, and the propensity for larger call-centres to be dealing with a larger number of callers with greater varying advisory needs, a more structured knowledge infrastructure is required to meet these service quality and efficiency challenges. Some examples of knowledge strategies employed towards this end are: 1) Information and Knowledge Policy that determines the extent of advice given by agents 2) Cells of agents specialise in particular knowledge domains and operate as a community of practice stewarding the knowledge for that specific domain. This is called Vertical Knowledge Streaming. 3) Unresolved caller queries are referred to a knowledge broker (perhaps a supervisor) who re-assigns the query within the call-centre or refers it to staff within the organisation proper. 4) An 'all points bulletin' is sent to all call-centre agents who respond with suggested responses or suggested experts who may be able to help. [Markus 2001] and [Davenport 1998] both exhort the importance of access to experts and expertise as the hallmark of effective knowledge re-use.

4.2.1 Medium-Sized Call-Centre Case Study: CC1

CC1 operates within a government department whose principal business is to maximise the economic potential for agricultural industries on a sustainable basis. Assistance is provided to both domestic and commercial clients, with some services being on a fee for service basis. Agents in CC1 address queries on a wide range of scientifically based topics. Any caller can contact CC1 for the cost of a local call either to a direct number or via a 13 prefixed number.

Management implemented a policy not to use IVR technology to route calls. The policy that people, and not information systems, would handle call diversions is designed to heighten callers' perception of functional service quality [Brogowicz 1990]. The most significant investment in technology is the infrastructure used to manage call-centre operations and statistics. Continuous displays of calls in queue and average time in queue monitor centre performance in terms of call management. A range of databases and Intranet based information sets are used to support the agents. Scientists are encouraged to provide information to the call-centre to allow them to address hot issues.

The department which hosts CC1 makes a conscious effort to maintain its Internet site with the most current information. However, due to issues such as lack of access to the World Wide Web and degree of comfort with the technologies by the department's principal constituents (the agricultural sector), querists prefer to access the call-centre for advice and information. Scientists provide Tier 2 support mostly from research stations outside the central business district.

Although responses to callers are not scripted, agents are instructed not to give advice but only to provide information sourced from their standard information systems. They are supported by a range of fact sheets and databases populated by the scientists. These continually evolve through interaction between the scientists and the call-centre agents. Agents have responsibility for meeting with scientists and business groups to identify future events; report on issues being addressed by the call-centre; satisfaction levels with the call-centre; and, to request additional or updated fact sheets from scientists and other informants within the organisation.

Due to the technical and scientific nature of calls, substantial effort is placed on recruitment and training. The key selection criteria for call-centre agents contain a requirement to achieve superior functional service quality attributes by using techniques such as active listening; patience; and, when and how to speak [Thompson et al 2001]. Superior technical knowledge of the department's business minimises the time to reach acceptable levels of competence (typically 6-8 months). Maintenance of staff's capabilities is achieved via weekly meetings (operations close down) that allow discussion of important issues (able to be identified from records of the calls), future events and other issues of concern.

The focus of the call-centre is on client satisfaction and speed of service (80% of calls answered within 20 seconds). Normal days involve each operator taking approximately 80 calls. However in peak times caused by staff shortages or increased activity from emergent events, CC1 can cope with up to 200 calls per operator per day. All calls are recorded, with a library of calls dating back several years.

Performance measures which are collected and used in reporting include response rates (grade of service and occupancy statistics are most used in reporting and decision making), quality issues (the team leader "hot links" to an operator in order to gauge quality of responses via a sampling process) and staff satisfaction. Currently 60% of calls are resolved in CC1 while the vision for the future is to have 80% of all calls completed by the call-centre staff (80% knowledge self-sufficiency). Only 20% of calls will be consigned to 2nd tier support groups.

4.2.2 Medium-Sized Call-Centre Case Study: CC2

CC2 is a call-centre in a government department that provides consumer advice. CC2 is an integral component of a Customer Service Centre (CSC) which also includes counter staff both in the central business district and at regional centres. Calls to the widely publicised 1300 number (free) are routed to the nearest available reception point; either a regional office or the call-centre located in the central business district. The IVR system then routes the call based on whether it is a general query or complaint (more complex) or transaction relating to the regulation of business. Transactional functions are performed in real time while client issues may involve further research, be consigned to 2nd tier experts or investigations officers where breaches of legislation have occurred.

Prior to a reorganisation in October 2002, the CSC comprised of approximately 60 Brisbane based staff. Regional staff generally processed over the counter enquiries or took calls directly. The CSC consisted of teams with clearly defined roles separating transaction processing (lower level of staff), complaints via the phones, written complaints and other business services such as data entry and bank reconciliation of payments. The situation was characterised by very little communication between teams, limited written procedures and no ability to load balance during peak times. Training was minimal, on the job and ad-hoc.

After October 2002, the organisation corrected the (both real and perceived) inequities in work through the formation of work clusters and multi-skilling of all staff in the CSC. The supporting information systems in the regional offices were integrated with the Brisbane systems and staff performing customer service roles in the regions were included into the CSC division. The PABX system commenced routing callers to the nearest available service staff to both decrease communications costs, but also to provide local recognition for services of the department. Strategies included rotation of staff, production of procedure manuals, targeted training (including regular meetings) and other technology upgrades.

The CSC consists of front counter staff who predominantly serve face-to-face customers, a call-centre taking IVR directed calls and the business process area. This model is consistent with that of other service industries [Graumann et al 2003]. The CSC established a matrix of teams across functional areas and regional offices. These teams are encouraged to share knowledge and discuss decisions across these lines of responsibility.

Management sees technology as the best option to drive efficiency while still providing advice and management registers to support the State's businesses. All CSC staff have access to the departmental Intranet. This includes staff contact lists, self publishing, threaded discussion and event driven capabilities. Specific work groups have also created sub-webs for their specific use.

Transaction systems include registers for management of business details and history of client complaints. These systems are accessible to all CSC staff. A static database has been developed in house to hold hierarchical lists of information, categorised by functional area to allow fast access to the information. The information is placed in this database by staff with a degree of expertise in that particular area and only contains statements of fact – no interpretive information is provided.

Reported performance measures include:

- response rates (including statistics on number of calls by type, time in queue and dropout rates. Approximately 1/2 million calls per year are processed),
- quality issues (mystery shopping exercises have been performed to test a range of criteria including consistency and accuracy of advice and service focus) and
- staff satisfaction (no measures available for this but at Dec 2002, the longest serving employee in one team had 4 months experience).

An attempt to embed continuous performance improvement through training has led to the appointment of a dedicated training officer. The role includes the normal formal training sessions, but also includes responsibility for maintenance of the information database. Other strategies include regular team meetings and externally

facilitated workshops to build trust and shared vision through identification of improvement strategies by the teams. Action plans developed and reviewed 6 monthly include identification of knowledge gaps and processes to address these. New staff "hot link" with an experienced operator for 2 weeks prior to going solo while each operator has a buddy nominated by management to match experienced with new staff for mentoring and support.

CC2 calls are not recorded. However, analysis of calls via "hot link" (where a researcher tracks the IVR path of a caller) suggests the IVR system effectively directs callers with "uncertain" problem types to agents with expertise from experience and others with predominantly "complex" (mainly due to legislative interpretation) and "ambiguous" problems to agents who need to do further research before the problem is resolved.

4.2.3 Comparison of CC1 and CC2

CC1 has developed from a planned strategy to provide accurate and timely information as part of an integrated approach to client management. Based on a personalised service and supported by training and coaching, the approach is to protect clients from the technology driving the call-centre. CC2 has evolved from business pressure to cope with increasing demand for timely and accurate advice. Efficiency continues to be the major business driver in CC2. Table 2 summarises the strategies employed in each of the call-centres.

Strategy	***CC1***	***CC2***
Use of IVR/Call Routing	No	Yes
Call Rate	80 calls per person per day	Up to 200 calls per person per day
Information recorded on calls	Minimal – for reporting and return contact purposes	Minimal – for reporting and return contact purposes
Updating of information repository	Meetings with scientists / 2nd Tier operatives	Not involved
Internet site	All information available	Limited information available
Consignment Policy	Consignment if query cannot be resolved with standard information	Research performed by agent prior to consignment
Training	6-8 months	2 weeks

Table 4: Comparative Strategies of two medium-sized call-centres

4.3 Large Call-Centre

Invariably these call-centres introduce the complicating elements of multi-sited agents, usually multi-country and possibly a multi-lingual customer base. Advanced ACD or IVR are the normal entry path diverting customers to either general or specialist groups of agents depending on customer choice within the IVR pathways and / or general agent call handling procedures. Call agents use both pre-recorded and

recorded knowledge repositories. A large call-centre, such as that found in Hewlett-Packard, corresponds to *Knowledge Process Scenario Type A*.

Typical knowledge infrastructure strategies include: 1) Multi-layered call-centres where general agents handle the majority of initial responses and have a selection of specialist groups to which more difficult queries are referred. 2) A subset of the Intranet based reference materials is made available to customers to reduce the call pressure on the centres. Customers are referred to this repository by agents thereby encouraging knowledge self-serve. 3) Customers with more complex knowledge needs are assigned specialist knowledge brokers and call-centre agents. They may also have access to a greater subset of the internal call-centre knowledge reference repositories to alleviate call rates (specialist knowledge self-serve). 4) Some advanced call-centres use knowledge 'self-sufficiency' measures [Timbrell et al. 2002]. Knowledge self-sufficiency is the ratio of queries resolved to the total queries within a call-centre (or group within a call-centre responsible for a specialist knowledge domain). Unresolved queries referred to more specialist groups represent the percentage balance of this ratio. 5) Measurement of query incidence and the proactive knowledge transfer responses to specific knowledge deficiencies in the customer base e.g. email bulletins, seminar series, product re-configuration and agent/customer education strategies.

5 Discussion

Over the past years maturity models were successfully developed and applied in research and industry. They are primarily used to analyze systems (e.g. companies) in terms of their KM readiness and to assist in developing KM strategies. The effects of applying maturity models on call-centre Knowledge Infrastructure analysis are not explored sufficiently so far.

Is an adjusted maturity model, like the one introduced by the authors, able to assist managers in developing and improving KM and quality management strategies? The authors suggest that maturity stages provide a guide towards an optimal state for knowledge process management.

Another open issue concerns the correlations between *call-centre size-type*, *BPSL value* and *Knowledge Process Maturity Stage*. Our future work focuses on the refinement of the KI-Hierarchy Model (in a broader context beyond call-centres) and its validation through empirical research.

Table 5 shows a comparison of the four case studies using the *Knowledge Infrastructure Hierarchy* and *Knowledge Process Maturity* model for call-centres. Whilst certain facets of the model do not necessarily apply to the differing sizes of the call-centres this may be due to the background and experience of the call-centre management and the evolutionary growth of each call-centre.

	Building Codes Q	**CC1**	**CC2**	**HP**
Business Process Standardization Level	Low	Low - Medium	Medium	High
Knowledge Process Scenario Type	B - C	C	B	A
Knowledge Process Maturity Type	Initial	Initial	Aware	Quantitatively managed
Knowledge Risk Level	High	High	Medium	Low
Training approach	*Mentoring*	*Full preparatory training*	*Induction*	*Full preparatory training*
Use of knowledge sources	*Personal only*	*n/a*	*n/a*	*n/a*
Knowledge policy applied	*Little policy*	*Knowledge policy*	*Information use policy*	*Knowledge policy*
Knowledge streaming strategy	*None*	*Horizontal*	*Horizontal and vertical*	*Horizontal and vertical*
Metrics	*No metrics*	*Call throughput*	*Call throughput/service quality*	*Service quality and knowledge self-sufficiency*

Table 5: Comparison of the case studies

6 Conclusion

As call-centres get larger, the knowledge processes become more formal to ensure consistency of advice and efficiency. This paper suggests a *Knowledge Infrastructure Hierarchy* and discusses a *Knowledge Process Maturity* model for call-centres to advance and frame future discussion of these knowledge intensive environments.

Call-centres will benefit from taking a knowledge process and infrastructure perspective; it informs them in determining knowledge interventions that improve service quality and efficiency. A classification by *Business Process Standardization Level*, *Knowledge Process Maturity Stage* and *Knowledge Risk Level* helps to build a funded basis for further process-oriented analysis.

The four case studies presented are a first step towards the application of these generic models. Further research is required to advance and confirm these models.

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