Measuring intangible assets: Assessing the impact of knowledge management in the S&T fight against terrorism.

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ABSTRACT

At present, there are no standards for assessing the value of intangible assets or intellectual capital. Historically, a number of frameworks have evolved, each with a different focus and a different assessment methodology. In order to assess that knowledge management initiatives contributed to the fight against terrorism in Canada, a results-based framework was selected, customized and applied to CRTI (a networked science and technology program to counter terrorism threats). This chapter describes the

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INTRODUCTION

Executives and managers would be hard-pressed to argue against the theoretical foundations, goals and intended results of the discipline of Knowledge Management (KM)[ii] as a potential benefit to their organizations. It is self-evident, even trite, to state that a successful organization must manage its intellectual capital well to achieve competitive advantage, be more innovative and enhance its value. The challenge lies not in accepting these maxims but in the practical application of knowledge management activities and subsequently to be able to demonstrate whether these same activities actually do contribute to the enhancement of the organization and its goals.

This was the challenge faced by Defence Research and Development Canada's Centre for Security Science. When its flagship program, the Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Research and Technology Initiative (CRTI)[iii] was originally created in 2002 in response to the changing North American domestic security environment, the need for a KM approach was obvious. This Canadian Government program intended to bring together multiple federal departments and agencies to strengthen a national science and technology (S&T) capability to counter the terrorist threats from chemical, biological and radiological or nuclear agents. Only a KM approach would be able to build communities, collaboration, knowledge sharing and creation where such a domain had not existed previously. A robust KM program was

created through consultation with stakeholders and the program thrived, becoming a model for others.

Yet, did the KM program contribute to the success of the program? Did it impact the federal laboratories' capability and capacity to respond to CBRN incidents or contribute to focused expertise, knowledge and capabilities of Canadian CBRN S&T performers in the short-term? Did it assist in any way in engaging the Canadian Innovation System in CBRN counter-terrorism or help the creation of industrial products, technologies and knowledge for CBRN counter-measures in the medium term? Finally, would the KM program contribute to the long-term goals of building the Canadian S&T capacity and capability to prepare for, prevent and respond to CBRN attacks, or enhance the communication, cooperation, collaboration, and interoperability amongst Canadian and international CBRN counter-terrorism communities, or eventually to a effectively positioned Canadian S&T innovation system that contributed to national and international security?

In order to answer these questions at some stage, it would be necessary to develop a meaningful measurement tool and process that would provide qualitative data that would be useful during an evaluation. Measurement tools often tend toward the quantitative side, measuring occurrences of activities. This is helpful to determine pull on services, increased (or decreased) need for resources and to measure trends. But can such measurement processes indicate whether the KM activities themselves actually contribute to the attainment of organizational objectives? The question for the KM Team was: do the KM activities contribute in a meaningful way to the mission and outcomes of the CRTI and can that be measured?

This chapter focuses on the search for a method of meaningful value measurement. The main goal will be to illustrate the use of a result-based management accountability framework (RMAF) as a tool to measure the impact of knowledge management activities on the intangible assets of an S&T counter-terrorism organization. The key alignment of the measurement framework and the strategic importance of the knowledge-based assets

will be presented as a recommended best practice. The case study will also describe the general approach to identifying the intangible assets and investigating and selecting the best approach to assessing these assets.

BACKGROUND

In the early 2000s the CRTI was born within a cultural milieu that recognized the need for breaking down knowledge stovepipes and the advantages of working collaboratively for common aims. KM authors were expounding the virtues of collaboration and the need leveraging knowledge in order to gain the "knowledge advantage." (Prusak, 1996) The Government's Standing Committee on Industry, Science and Technology had just released *A Canadian Innovation Agenda for the Twenty-First Century*[iv] in which it indicated the need for "more coordination of intramural S&T activities among federal agencies, as well as greater collaboration on major horizontal issues — those that cut across departmental and agency boundaries." Clearly, the time was ripe for a collaborative approach for finding new solutions to existing and emerging challenges.

Initially CRTI had 14 government departments and agencies participating in what was considered to be the first "horizontal" delivery model for S&T in the Canadian federal government. Knowledge-based in itself, the initiative partners determined investment priorities according to a consolidated risk assessment with both scientific and intelligence input. Clusters, or *de facto* communities of practice, in each of the chemical, biological, radiological-nuclear domains worked together to identify target investments and action plans for devising S&T in support of the prevention of and response to terrorist attacks. The program sought to deliver S&T solutions to the responder community and other operational authorities, as well as to enhance the national capability in research and development (R&D) and scientific support in these risk areas.

The CRTI KM Team began its strategic approach by consulting with the primary stakeholders, primarily federal scientists and science managers who were involved in the

scientific Clusters. Intuitively understanding KM for what it could and must do for the growth of a new national community, they were able to articulate a number of approaches and requirements for the new program. In turn, the KM Team developed a strategic action plan that would support the community in their objectives. From the beginning, it was a holistic approach that would facilitate the creation of both tacit and explicit knowledge, use tools and techniques for capturing and sharing knowledge, and disseminate this knowledge to various stakeholders (including scientists, end-users and the citizens of Canada) in various and appropriate ways. Figure 1 below illustrates the high-level KM model that was used to guide the KM initiatives within CRTI.

Insert Figure 1 here

Figure 1. High-level model of KM processes (adapted from Dalkir, 2005).

The KM Team knew that facilitating intellectual capital growth involved the three elements of human, relational, and structural capital. It was evident that expertise was going to be developed on the individual and team levels because the CRTI was encouraging experts in multiple disciplines to apply their existing knowledge in new areas and that, in order to accomplish this, they were going to learn from each other. Initially, the KM focus was not expressly on facilitating the human aspect of intellectual capital, although it was fully anticipated and hoped that this would happen. Indeed, without this outcome, the initiative would not succeed in achieving its mission. It was determined, however, that without focusing on the other types of intellectual capital, the development of human intellectual capital would not happen to the required extent.

On the structural capital side, for example, it was evident that there was a need for a technology platform that participants could use to exchange, collect and disseminate their existing knowledge and knowledge that was being created as the initiative took hold and

evolved. Within 6 months, the InfoPort, a collaborative Community of Practice application was launched. There was also a need for a publication mechanism which would permit the creation of knowledge products that could not be published elsewhere given that there were multiple partners working together under this umbrella initiative. Soon the CRTI Secretariat was disseminating various types of documents primarily in electronic, but also paper, formats. And finally, structures, processes and tools, which would often be behind the scenes, were required to support the overall functions.

However, building relationships and developing community would surely be the most important first step. The Team knew that without a concentrated effort in facilitating opportunities where new relationships could be built or trust could be developed, there would be no possibility of moving ahead in innovative ways to create S&T knowledge and products that would ensure Canadian public security and resiliency. Therefore, the KM approach dedicated a great deal of effort to planning and hosting knowledge exchange events, workshops dedicated to finding novel solutions, exercises for experiential and shared learning, and communications to multiple stakeholders. It was after two years of the program, that the KM Team acknowledged that it was time to measure the impact of these activities on the CRTI program and went to work on a research project with McGill University's School of Information Studies to find a mechanism to do this.

INTANGIBLE MEASUREMENT MODEL AND METHOD

In order to select the best fit measurement model and method, the research team first undertook an extensive literature review. This review looked at both scholarly and practitioner publications in order to identify the major measurement models in use, the most widely applied measurement methods and to compare the strengths and weaknesses of each. All types of assessments were included in this review: quantitative, qualitative and anecdotal. Following the review, a recommendation was made as to the most compatible measurement approach to use for CRTI, together with suggested adaptations to best accommodate the CRTI assessment objectives. Next, the specific performance

indicators were established and a data collection method was developed. Once the design was complete, all that remained was to collect the data and analyze the results. The literature review surveyed intangible metrics best practices and discussed the pros and cons of quantitative, qualitative and anecdotal measurement approaches.

Literature Survey of Models to Measure Intangibles

> Intangibles are 96% of the value of the world's most successful company – Microsoft. The rest is book value (Nash, 2004).

The history of the measurement of intangible assets has run the gamut from extensions of purely financial methods from the accounting discipline to more value-based assessment frameworks (Bouteiller, 2002). In the disciplines of accounting and finance, intangibles or "intangible assets" are generally referred to claims (or assets) which have the potential to deliver future benefits (Lev, 2001). Intangible assets are more commonly referred to as intellectual capital (IC) and the terms have become synonymous. Intangible assets do not have a physical or concrete form but they are still capable of contributing to the value produced by the company (revenues or profit in commercial companies, innovations, service in non-profit companies). Contractor (2001) lists examples of IC such as reputation, brands, goodwill, customer loyalty, expertise, or a unique corporate culture. Intangibles which have direct influence on monetary gains are known as commercial intangibles e.g., copyrights, brands, patents, franchises, product quality and value, reputation, R&D, and so on. The rest fall into the category of "other" intangibles like creative employees, innovative workers, highly motivated staff, enhanced morale, etc. Alternatively, generative and commercial intangibles can be divided into individual and structural intangibles. Individual intangibles are qualities linked directly to individuals such as specialized knowledge and skills, customer loyalty and supplier loyalty. On the other hand, structural intangibles are assets that are attributed to interpersonal and inter-group relations rather than attached to individuals. The most apparent examples of these intangibles are team work and corporate culture, (Bouteiller, 2001).

One of the first IC models, the Skandia model, categorized intangible assets as human capital, customer capital and organizational capital (Edvinsson and Sullivan, 1999). Three types of IC were defined in this model, namely:

1. Human capital – includes employee brainpower, competence, skills, experience and knowledge;
2. Customer capital – includes relations and networks with partners, suppliers, distributors, and customers. It also includes the image of the organization in the market, its social identity, and brand equity;
3. Structural capital – covers every intellectual capital that can be owned by the organization including routines, business processes, practices, databases, systems and intellectual property.

The Skandia model of intellectual capital has subsequently evolved, notably the term "social" or "relationship" capital has gained popularity over customer capital in order to include non-commercial organizations.

Sveiby (1997) described three types of "invisible" capital that are quite similar to the Skandia categories:

1. Internal structure – includes all the systems, databases, processes and routines that support an organization's operations and employees (corresponds to structural capital);
2. External structure – includes all external relations and networks that support the organization's operations, including support and administrative staff (corresponds to customer capital);
3. Competence - includes individual experience, knowledge, competence, skills and ideas (corresponds to human capital).

Both Sveiby and Edvinsson distinguish the different types of IC based on where they are located or where they can be found. In contrast, Andreissen and Tissen (2001) proposed that intellectual capital be viewed through the contextual lens of organizational competencies. They define the role of IC to essentially be to strengthen the core competencies that an organization would have has typically already identified. Al-Ali

(2003) argues that this may be too myopic a model for IC and notes that it tends to focus on what the organization is supposed to do now as opposed to looking at innovation, the capacity for the organization to learn and adapt (referred to as absorptive capacity by Cohen and Levinthal (1990). She describes the case of Xerox that decided not to invest in the PC leaving the field to Steve Jobs – Xerox focused on its identified core competencies and failed to recognize an exceptional opportunity to go beyond these core competencies.

Al-Ali (2003) goes a bit further with her CICM model (Comprehensive Intellectual Capital Model). She argues that although being able to define, recognize and appreciate intellectual capital is of great value, management needs a comprehensive guide as to how to develop and leverage intellectual capital. The CICM identifies not only the location but the function that the various different types of IC perform. In particular, the function of IC in an operational production process is quite different from that of an innovation process. Al-Ali (2003) further advocates grouping the various forms of intellectual capital should be further grouped into resources, processes, and products where the relation between them is made clear for the purposes of management, something that the older existing IC models do not do. The CICM classifies IC as:

1. Knowledge resources – the human or organizational knowledge that goes into the making of products and services of the organization and which supports the critical business processes and operations. This is a mix of human and organizational capital.
2. Innovation processes –the processes and networks that an organization needs to enable its innovation process and convert ideas and knowledge resources into marketable products and services. For non-commercial organizations, this encompasses the critical decision making. This is a mix of social and organizational capital.
3. Intellectual property – the technologies, products, processes, methods, software, publications and other works that the organization has protected legally and can commercialize independently as an intellectual product to maximize value. This is a mix of social and organizational capital.

Based on this classification the CICM model manages the various groups of intellectual capital under three stages of knowledge management, innovation management and intellectual property management.
Table 1 summarizes the key features of these IC models.

Table 1. Comparison of features of major intellectual capital models

Skandia Model (Edvinsson and Sullivan)	Sveiby Model	Andriessen and Thissen Model	CICM model (Al-Ali)
Human capital	Internal structure	Core competencies (organizational)	Knowledge resources
Structural capital	External structure		Innovation process
Customer capital	Competence (individual)		Intellectual property

For the CRTI assessment, all of the models are compatible and the one that was used was a combination of the Skandia and CICM models. One of the major goals of CRTI is to promote innovation in the S&T sector in the fight against terrorism. Also, the notion of knowledge resources fit quite well with the knowledge products that were to be assessed as stemming from the KM projects.

Bouteiller (2001) notes that the meaning and perception of value depend very much depends on whose perspective is being taken. Abdul-Samad and MacMillan (2004) argue that:

> In the field of accounting and finance, numerous studies have been carried out linking intangible assets to company performance and profit margin. Several empirical examples demonstrate that improvement in key intangible drivers translates into increased market value of commercial entities. These findings also suggested that intangible assets in organizations have both direct and indirect influences over a company's value. For instance, customer loyalty affects other

> factors of business operational functions like brands, marketing, services, communications, and so on. Through identification of critical success factors, intangibles can also be used to drive and enhance organizational business performance. In short, intangible assets are gaining widespread recognition as key value drivers of business performance. (p. 3)

Al-Ali also notes that a different perspective may be required to assess intangible assets.

> The confusion about intellectual capital management as a field is due to a great extent to its multi-disciplinary nature. This is because intellectual capital includes disparate types of resources and assets that are human based (brainpower, competence and skills) information and data based (databases, software & hardware), innovation based (R&D routines, processes and practices) and legally defined property rights (patents, trade secrets, trademarks/brands, and copyright). As such it is a field of interest and application to human resources professionals, IT , R&D, business and marketing managers, IP lawyers and business consultants. (available at: http://www.ipmall.fplc.edu/hosted_resources/al-ali/IC_main.htm).

A combination of quantitative, qualitative and anecdotal measures must therefore be included as components of a comprehensive IC measurement model. The complexity extends to the specific indicators to be measured in this comprehensive IC model. A good guideline can be taken from the European Commission's (1999) MEANS framework.

MEANS is a program used by the European Commission to classify indicators for the evaluation of socio-economic programs based on their level of objectives.
The indicators are classified into five categories: resource, output, result, specific impact and global impact, which closely resemble the results-based evaluation framework. One type of indicator that is defined is a sustainable specific objective, as shown in Table 2.

Table 2. An extract from the European Commission (1999, p. 29) definitions of indicators (MEANS)

Level of objective	Type of objective	Definition	Example
Sustainable specific objective (e.g. to create and maintain a high-level of collaboration between different units)	Specific impact (as opposed to more general outcomes)	Sustainable effect as consequence beyond its direct short-term effect - an objective that is expected to maintained as opposed to being a one-shot endeavor	Results of output – a measurable result that attests to the attainment of the sustainable objective (e.g. number of new customers through phone calls over a period of x months, increased throughput per employee for the next 3 years, etc.)

The MEANS framework includes indicators for sustainable objectives and effects which is an excellent fit for the objectives and expected effects of the CRTI program. All KM initiatives should include an objective and an indicator of sustainability. In the case of CRTI, the objectives were:

- To create clusters of S&T labs;
- To create an S&T fund to build S&T capability;
- To accelerate technology development into the hands of the first responder community;
- To address any gaps in S&T capacity; and,
- To increase horizontal coordination across Government departments and agencies.

The subsequent CRTI KM objectives consisted of:

- Building relationships and organizational structure, processes and opportunities to encourage a knowledge culture;
- Collecting and organizing programmatic and scientific knowledge;
- Facilitating the creation and dissemination of CBRN knowledge including methods for data, information and knowledge exchange;
- Proving, evaluating and adjusting KM activities.

Both the overall CRTI and the KM objectives address sustainable goals. This in turn means sustainability needs to be assessed. The MEANS framework includes such an objective in a results-based assessment framework and was therefore included in the CRTI assessment.

Finally, the assessment of intellectual capital in R&D or innovation projects was surveyed in order to identify the best possible framework and indicators (Subramaniam and Youndt, 2005). In R&D, human capital plays a significant role in triggering innovation and performance. Satisfied and highly educated knowledge workers tend to improve organizational capital (e.g., process, culture, and brand value) which is owned by organizations and accumulated for a long-time. Human capital is only "rented" by the organization. Thus, organizations' efforts focus on encouraging employees to concentrate on their job as well as on providing them satisfaction to prevent them from leaving the organization or retiring (Pike et al, 2005).

In addition to reviewing the major measurement models, the literature review also surveyed the major measurement methods such as EVA (Economic Value Added), value chain scorecard, Balanced Scorecard, Skandia navigator, Intangible Assets Monitor, and the Results-Based Management and Accountability approach. Each model was reviewed and assessed according to its applicability to this specific KM approach and to the objectives of the impact assessment.

Selection of the Results-Based Measurement Model

Following this review the Results-based Management Accountability Framework (RMAF) was selected (Treasury Board Secretariat, 2005). RMAF is a tool designed specifically to help track, manage and measure the outputs and outcomes of an

organizational initiative and is ideally suited for ensuring that strategy is continuously aligned with the objectives and goals of the organization. The selected RMAF evaluation was chosen because of its heavy focus on the cause and effect relationships. Using the RMAF helped to characterize the impact that the two major CRTI KM initiatives, collaboration support and the InfoPort, were having on CRTI's broader goals of increasing its preparedness, capability and capacity to respond to CBRN terrorist attacks. The creation of the logic model was the critical component that allows the RMAF to maintain accurate and measurable links between the activities and their outcomes. The logic model graphically shows the chain of results between the activities and the final outcomes and identifies the steps in between that must occur for the achievement of the final outcomes. Designing the logic model was an iterative process, the results of which represent a shared understanding between management, stakeholders, and the eventual evaluators of the initiative's activities, outputs and most importantly, their outcomes. Designing these metrics then, consisted of moving step by step through the various levels of the logic model and identifying the most appropriate and relevant measurements for each output/outcome. Figure 2 shows the logic model developed for one of the KM objectives, the knowledge repository "InfoPort."

Insert Figure 2 here

Figure 2. Logic model of CRTI InfoPort

Next the team was able to identify metrics that would measure each output and outcome. In this step, the final or ultimate CRTI objectives were identified (what impact is expected on the organization?) together with the activities and outputs and outcomes. The flow diagram can be derived forwards from outputs or backwards from final objectives. Plot models were used to verify the logic. Finally, indicators were chosen for each outcome level.

DATA COLLECTION, ANALYSIS AND RESULTS

A combination of quantitative, qualitative and anecdotal data was then collected. As Mouritsen (2001) argues, "intellectual capital is "no ordinary accounting concept"" (p. 760). He strongly advocated a mixed approach to measuring and reporting IC, one in which

> …intellectual capital activities (need to) be related to narratives of innovation, the information society and 'we-live-from-knowledge claims… to create a persuasive intellectual capital statement … (that) consists not merely of numbers, but also of stories/narratives and visualization/sketches that allows a series of translations to take place. (pp. 760-761).

The RMAF measurement was as comprehensive as possible (Dalkir, et al., 2007). Quantitative, qualitative and anecdotal data were integrated in order to provide a more complete portrait of how well KM objectives were met. Quantitative measures were included as typical multiple choice questions, ranging from yes/no answers to Likert-scale multiple choices to assess attitudes. Qualitative data was gathered both in the interviews and in the short-answer section of the data collection survey. Anecdotes were also included as data. In their book *Working Knowledge* (1998) Davenport and Prusak discuss a concept that they have coined as "serious anecdote management." This concept refers to knowledge that is often passed through stories. A "serious anecdote" is a story that has a "lessons learned" punch line. These anecdotes are excellent for capturing the context of a valuable piece of knowledge and providing a memorable medium in which to transfer that knowledge. Often, the punch line carries a quantitative measurement that can then have more meaning for employees because it is delivered within the context of a story that they can easily relate to. Serious anecdotes also illustrate the value of KM and as such are useful metrics to include when evaluating certain initiatives (Wiseman, et al., 2005).

Next, a series of stakeholder interviews and auditing of internal documentation was completed in order to clearly identify the expected outcomes for the CRTI assessment. In

consultation with the KM Team, it was determined that five activities would be selected for the measurement framework:

- Collaboration support – to support existing and new communities of practice in achieving their objectives; to enable effective both within the community, with other communities , and with the wider CRTI community; to create synergy and trust; to create opportunities for learning and creating knowledge from CRTI experiences; and to encourage reciprocal dissemination of knowledge between CRTI stakeholders and First Responders;

- Intranet portal solutions (IPS) - to offer centralized online access to CRTI information, CBRN expertise and knowledge, and to encourage virtual exchange by creating tools and methods for sharing knowledge;

- Knowledge products - to capture, create and disseminate knowledge products that apply CBRN knowledge to help attain ; to ensure that this knowledge is synthesized and packaged in a manner that meets the needs of each target audience.;

- Knowledge and information management structures - to create and implement processes and tools to assure CBRN and CRTI knowledge are accessible now and in the future, and

- Communications and media relations - to establish guidelines to help ensure effective communications among CRTI stakeholder groups and with the media; to develop and maintain positive relationships; to increase CRTI's visibility; and to help promote CRTI as a legitimate and credible voice on CBRN issues.

The CRTI objectives address both social and organizational capital. Although the value added to human capital was not directly measured, it was expected that increased value in

structural and relationship capital would in turn contribute to enhanced human capital (Nahapiet and Ghoshal, 1998).

The next step involved the formulation of an appropriate data gathering strategy. It was decided that the most added-value method would be to design an electronic qualitative survey, using Likert scales and open ended questions, which would be distributed to CRTI members through CRTI's InfoPort and then followed up with interviews to gather additional anecdotal information on the impact that KM has had on CRTI's ultimate goals. The survey was run for two months in order to maximize the response rate as much as possible. The consisted of 32 questions, half of which were multiple-choice (Likert scale) and the other half were open-ended questions. In addition, structured interviews were conducted with members of the CRTI KM team and volunteers in order to validate the RMAF logic models, the metrics to be used and the questionnaire design. The survey was initially emailed to 213 members. Of these, 129 were actually reached and 26 completed the survey, resulting in a response rate of 20%.

RESULTS

The results obtained using the RMAF model and method served to "quantify" and render more concrete the value of the not-so-visible knowledge assets. For example, the team was able to show that CRTI KM initiatives aimed at supporting collaboration were highly successful. A majority of respondents felt that CRTI workshops, conferences and exercises had increased the communication of CRTI CBRN information and documentation, permitted them to expand their personal network or partners and afforded valuable learning opportunities for them. A number of new ideas, project or papers were the direct result of CRTI collaboration support activities and suggestions for improvement included encouraging greater audience participation and providing more cluster-specific follow up activities.

These findings indicate that CRTI collaboration support has helped increase trust and synergy within the CRTI community, helped ensure more valuable knowledge was exploited, that collaboration and communication had increased and the organizational memory has grown[v].

The results for the CRTI InfoPort were more mixed. Table 3 below shows the RMAF used for the InfoPort.

Table 3. InfoPort RMAF

Activity		**Output**	**Immediate outcomes**	**Intermediate outcomes**	**Final outcomes (impact)**
ISP1	Develop, manage and facilitate usage of virtual workspace for exchange of knowledge between cluster members, across clusters and with other CRTI stakeholders	▪ CRTI InfoPort ▪ Portal maintenance, training, etc. ▪ Automated profiles, Push/pull dissemination, filtering and alerting (automatic and bulletins)	Centralized and timely access to CBRN S&T knowledge is provided (on demand, as needed) Available CBRN knowledge is current and vetted Communication and dissemination of CRTI information and documentation is enhanced Virtual knowledge sharing and collaboration is enabled Assistance in connecting members with experts is provided	Exploitation of valuable knowledge is increased ▪ Increased use/re-use of available knowledge Awareness of existing knowledge and expertise at CRTI is increased Exchange of knowledge (tacit and explicit) is increased Collaboration and communication within and between clusters is increased	CBRN S&T knowledge and expertise in support of operations is developed, managed and leveraged Horizontal capability, links within CRTI communities are built Capability and capacity to respond is increased (operational readiness) ▪ Performance is improved ▪ Improved skills or competencies ▪ Improved decision-making ▪ Enhanced S&T advice and services
ISP 2	Collect and disseminate CRTI documentation (internally generated) electronically	▪ Electronic repository of internal documentation			
ISP 3	Create an repository of relevant external knowledge products	▪ Electronic repository of external CBRN documents and sources			

ISP 4	Develop expertise locator system	▪ Expertise directory (see also C4: competency map) ▪ Expertise locator system	Input to the creation of a secure, collective lab management system is provided	Organizational memory is preserved Knowledge base is perceived as complete	provided
ISP 5	Develop dynamic lessons learned system	▪ Lessons learned database			
ISP 6	Explore secure web processing options	▪ Options for secure web processing for clusters (PSEPC pilot)			

Knowledge management project:	**Indicators** **(Quantitative)**	**(Qualitative)**
ISP. Intranet portal solutions - CRTI InfoPort & other online tools	▪ Number of unique visitors, percentage of total using system (trend) ▪ Number of hits, downloads on portal, dwell time (trend) ▪ Searching precision and recall / time to find object ▪ Number of experts in directory / domains covered ▪ Time required to find expert ▪ Number of contacts / relationships made through portal (directly or indirectly) - (SNA) ▪ Number of referrals made ▪ Number/range of knowledge objects available on portal ▪ Number of contributions made to the portal / knowledge base ▪ Number / range of lessons learned in database ▪ Number of alerts sent out ▪ Number of alerts made use of ▪ Frequency of contributions / Contribution rate increase / decrease	▪ Perceived value of portal and knowledge objects ▪ Frequency of use ▪ Time to access information/knowledge ▪ Number/examples of occurrences where access to knowledge from portal, expertise directory or other databases resulted in acquiring a new skill or competence, an improvement in quality or efficiency, or solving a problem ▪ Estimate of time or cost avoided by leveraging expert knowledge or knowledge base (also, reduced learning curve, reduced training) ▪ Improvement in awareness of available information ▪ End-user satisfaction / increased ability to work ▪ Perception of confidence

A summary of the results for each of the InfoPort indicators, as obtained from the survey, are presented in Table 4.

Table 4. InfoPort questions and results (extracted from survey).

No.	Question Text	Response
1	Are you able to find information on the InfoPort in a reasonable amount of time?	68% Yes
3	Does the InfoPort's search function meet your needs?	68% Yes
5	Do you feel you have centralized access to CBRN S&T knowledge through the InfoPort?	68% Yes
7	Have you accessed workshop and conference proceeding summaries from the InfoPort?	32% Yes
9	Do you feel the information available on the InfoPort is up to date?	79.2% Yes
11	Have you filled in your user profile on the CRTI InfoPort?	73.9% Yes
13	Can you locate an expert through the InfoPort when you need one?	65% Yes
15	Have you ever been contacted as an expert through your profile on the InfoPort?	0% Yes
17	Has the CRTI InfoPort helped increase your awareness of CRTI expertise, projects, gaps and successes?	52.2% Yes
19	How often do you use the information/knowledge available through the InfoPort to accomplish a task?	18.2% never 54.5% rarely 27.3% sometimes
20	The information on the CRTI InfoPort represents the best/most complete information that you need for your job.	4.5% strongly disagree 27.3% disagree 59.1% no opinion 9.1% agree
25	How frequently do you look at "alerts" or notices of new	9.1% never

	additions to InfoPort?	36.4% rarely 22.7% sometimes 22.7% often 9.1% very often

In summary, with respect to the InfoPort, ¾ of participants had filled out their online user profile but others stated they were reticent due to issues with unsolicited emails and general privacy. While the majority felt the content was easy to access and up to date, there were a number of qualifiers to be found in the qualitative data collected, both in the survey short answers and in the interviews. Participants expressed some concerns with the user-friendliness of the system and the fact that the content needed to be much more complete and updated more frequently in order to serve a more operational support function. The greatest gap was that not a single person reported locating an expert through the InfoPort. This appears to be due to the large number of competing information sources, most of which are more mature, better maintained due to more abundant resources and almost all were external links (international). Another issue with expertise location was that the level of specificity was not sufficient to enable users to locate the specialized, technical expertise they would require to fulfill their responsibilities. The top content picks for the InfoPort were

- Lessons learned reports from exercises;
- Descriptions of cluster activities and projects in progress; and,
- "As was said" summaries.

It is interesting to note that these three types of content represent value added content: that is to say, they were not simply cut and pasted into the InfoPort as is from another source but the CRTI team had contributed to the creation of new knowledge and to the contextualization of existing knowledge. There is clearly a value perceived by the InfoPort clients when the original content has been enhanced in this way.

The major suggestions to improve the InfoPort included:

- Make it easier and more efficient to use
- Organize the content better;
- Make information with a short shelf life available much sooner while posting more scientific content at a later date;
- Broaden the scope of content – more technical, more international, more connected to external sites; and,
- The expert directory and its objectives need to be revisited.

As with the collaboration support project, the InfoPort also contributes to the final or impact outcomes of developing, managing and leveraging CBRN S&T knowledge in support of operations, building horizontal capability and links with the CRTI communities.

Only anecdotal data was collected to support the final outcome of increased capability and capacity to respond:

- Improved performance;
- Improved skills or competencies;
- Improved decision-making;
- Enhanced S&T advice and services provided.

SOLUTIONS AND RECOMMENDATIONS

The overriding result from the InfoPort evaluation was that there was a strong preference for person-to-person contact within and between CRTI clusters, as well as with external networks. This result is not surprising given the effort devoted to creating the clusters as vibrant communities of practice in the first place. However, the results do indicate that technology still falls short in providing a virtual conduit for knowledge sharing interactions. The measurement model and method selected proved to be a good fit for the CRTI objectives as there was a strong case for "contribution" if not outright causality. What is even more important, however, was the development of the correct indicators. As is the case with every intangible assessment approach,

it is crucial to customize the metrics to fit the organizational objectives at hand. The research team found that at least three months were required for the stakeholder interviews, determination of measurable objectives and the customization of the RMAF method. While this is a substantial up-front cost in terms of time and effort, the end results are certainly worth it.

In the case of CRTI, the RMAF represented a summative assessment of specific KM contributions to CRTI goals at the five-year stage of the CRTI program. What is interesting is that now the model and the indicators have been developed and validated, the approach is easily re-applied as future formative measures (for example, on a yearly basis) to better monitor progress towards organizational goals. At the same time, the measurement model can be used to ensure a continually re-aligned model with respect to evolving organizational goals.

This particular approach should be easily applicable to other research-based organizations, S&T government programs and any organization that needs to address a sustainable innovation goal as part of its core mission.

FUTURE RESEARCH DIRECTIONS

The focus in this assessment was on organizational and social capital. It would be interesting to extend the RMAF to include indicators of the value added to the human capital that can be harnessed in the S&T domain to fight terrorism. These indicators could be applied over time to assess whether the expected increase in the human expertise and competencies that can be harnessed to provide a response to terrorist threats would be a strong addition to this measurement model. Some of the data collection questions could, for example, include:

- Do you feel you are able to locate the appropriate person to help you out more easily than 5 years ago?
- Do you feel you have a good overview of the type of human resources available to you through the CRTI clusters? Has this overview improved over the last 5 years?

Additional indicators could also be added to measure innovation and research productivity, such as number of patents over the 5 years studied, number of publications and citation index measures (Mouritsen, et al, 2004).

Additional work is also needed to triangulate the results obtained using the RMAF model. Given that causality cannot be rigorously demonstrated, the use of other valuation methods such as the Balanced Scorecard (Kaplan and Norton, 1997) would serve to strengthen the validity and reliability of the results obtained.

Finally, a future research direction would be to extend the results-based management accountability framework used to assess individual CRTI intellectual assets to a more holistic or systems-based evaluation framework. Chen et al (2004) notes that there is a need to understand the causal relationship among the intangibles to be able to measure and monitor them so as to steer them towards the firm's success. The systems thinking approach (Richmond, 2001; Sternman, 2000) is also an excellent means of visualizing the entirety of intellectual assets and valuing not only each individual one but also assessing the value of their interactions.

Recently, value maps have been advocated as holistic measures of the value added by knowledge assets that are visualized as "unbreakable" wholes or a gestalt (Jhunjhunwala, 2009). In value maps, the performance of each intangible is linked to others. Bygdas et al. (2004) describe an activity-based value map approach for measuring IC that consists of three phases: modeling, measuring and action. The modeling phase begins with a mapping and description of the company's critical value processes, the activities in those and a description of how they are interrelated. In the measuring phase, the resources required for each activity is mapped. For each activity there is a mapping of what intellectual (critical and necessary) resources are needed to give sufficient quality and frequency of the activities. This approach is quite compatible with the result-based assessment that was carried out on CRTI KM activities and would prove a useful extension to the existing framework.

CONCLUSION

Without the existence of generally accepted KM measurement tools, in general, and those which would address impact on outcomes, in specific, the CRTI KM Team solicited expert KM advice and research to final a novel solution. While many models exist for measuring or evaluating intellectual capital, most were exceedingly complex for a small organization or directed at for-profit enterprises. The RMAF approach afforded the ability to evaluate the impact of KM activities on outputs and outcomes. The final evaluation has permitted the CRTI to acknowledge the relative success of its program and to adjust future efforts according to these results.

The RMAF also provides a broader KM opportunity in that by using it as a dynamic planning and management tool from the onset, the measurement process will be facilitated and will result in a natural measurement and evaluation output. In future efforts, there will be a need to address all types of intellectual capital with a focus on the impact of KM activities on human capital creation, development, and outcomes. The current analysis indicates that KM activities do have an impact and it will be essential to include a holistic approach in measuring intangible assets on a continuing basis.

The RMAF measurement model has also proven to be very compatible with the major models (and types) of intellectual capital. The comprehensive, integrated assessment framework and guide presented here should prove to be useful to researchers and practitioners in the assessment of intangible value.

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ADDITIONAL READING SECTION

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KEY TERMS & DEFINITIONS (SUBHEAD 1 STYLE)

Intangible Asset

Intangible assets are claims to future benefits (e.g., cost savings, increased revenues) that do not have a physical (e.g., factory) or financial (e.g., a stock or a bond) embodiment (Lev, 2001).

Knowledge Management

Knowledge Management is the discipline that systematizes the capture, codification, sharing and dissemination of knowledge in order to leverage individual, group and organizational intellectual capital for increased innovation, value and productivity. (*CRTI McGill KM Team)*

Innovation Management

Innovation management is a term used to refer to new practices and tools improve the organization's ability to innovate by creating the right culture (e.g. soliciting and encouraging employees' submission of ideas, and developing new products and solutions). (Al-Ali).

Intellectual Asset

Intellectual assets is the term preferred by intellectual property lawyers and professionals to refer to intellectual property (particularly patents, trademarks and copyrights) since their value can be more accurately perceived or evaluated - hence the word "asset". (Al-Ali).

Intellectual Capital

Intellectual capital is the part of a country's or a firm’s capital or an individual’s human capital that consists of ideas rather than something more physical. It can often be protected through patents or other intellectual property laws. (The Economist).

Human Capital

Human capital is defined as the knowledge that employees bring and take with them when they join or leave the firm. It includes the knowledge, skills, experiences and abilities of people. (Grasenik and Low, 2004)

Structural Capital

Structural capital is defined as the pool of knowledge that remains with the firm at the end of work, after employees have left (Stewart, 1997). It comprises the organisational routines, procedures, systems, cultures, databases, etc. Some of this may be intellectual property. (Grasenik and Low, 2004)

Relational Capital

Relational capital is defined as all resources linked to the external relationships of the firm such as customers, suppliers or R&D partners. It comprises that part of human and structural capital affecting the firm’s relations with stakeholders (investors, creditors, customers, suppliers, etc.) plus the perceptions that are held about the firm (brand, reputation, etc.). (Grasenik and Low, 2004)

Outcome Based Evaluation

Outcomes Based Evaluation is an approach to measuring the effects of a project or an institution's services and activities on the target audience that these programs seek to benefit or serve. (Publishers Bindings Online).

Qualitative measurement

Qualitative measurement attempts to provide context and value to notions that are either difficult or irrelevant to quantify, such as the value an individual employee gains from being a member of a community of practice (Smith, 2001).

Quantitative measurement

Quantitative measurement means assigning a numerical value to an observable phenomenon, such as the number of times an employee visits a specific KM web portal. This type of measurement would be described as a usage metric (Hall, 2000).

Results-based evaluation

Results-based management is a life-cycle approach to management that integrates strategy, people, resources, processes and measurements to improve decision-making, transparency, and accountability. The approach focuses on achieving outcomes, implementing performance measurement, learning and changing, and reporting performance. (Treasury Board of Canada).

END NOTES

i. The Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Research and Technology Initiative Science)
ii. Defined as: the discipline that systematizes the capture, codification, sharing and dissemination of knowledge in order to leverage individual, group and organizational intellectual capital for increased innovation, value and productivity.
iii. The Initiative originally covered only CBRN. Explosive threats were added in 2006.
iv. http://www2.parl.gc.ca/content/hoc/Committee/371/INST/Reports/RP1032098/indurp05/indurp05-e.pdf

v. Excerpt from Dalkir, Kimiz, Erica Wiseman and Michael Shula. CRTI Knowledge Management Metrics Project Report: a survey evaluation of major knowledge management objectives. Submitted February 2007.