INFORMATION SYSTEMS AND TECHNOLOGY AS A STRATEGIC BUSINESS PARTNER: USING THE BUSINESS DISRUPTION IMPACT ASSESSMENT METHODOLOGY TO UNCOVER TECK HIGHLAND VALLEY COPPER'S TECHNOLOGY NEEDS

by

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Abstract

There is a consensus that Information Systems and Technology (IS+T) needs to become a partner of the business by understanding its needs and expectations and offering solutions that create value. At Teck's Highland Valley Copper (THVC)—one of Teck's largest mines and Copper producer—mixed perceptions about the value delivered by Teck's Enterprise IS+T exist. Although users understand the importance of utilizing the services and expertise from Enterprise IS+T, solutions are seen as being implemented without fully understanding the Site's "customer" needs. On the other hand, Enterprise IS+T sees the actions by THVC as failing to align with Teck's strategic focus and misusing resources. This situation has created a complex IS+T environment that is difficult to sustain and with tangible risks for the Teck Resources Ltd. IS+T environment.

The goal of this thesis is to respond to the question of how to best meet THVC's IS+T needs with the services provided by Enterprise IS+T so that the effort, cost, and quality of the solutions proposed are best suited to THVC. To respond to this question a detailed and objective examination of THVC's Business Critical Functions, Critical Applications and Technologies, and users' needs was conducted using the Business Disruption Impact Assessment methodology. The results of this assessment uncovered a number of areas that Enterprise IS+T focus on and provide practical recommendations for THVC. The findings of this thesis may be used as an example by other IS+T professionals to uncover the actual needs and expectations of their businesses as a means to position IS+T as a true business partner.

Keywords: Information Systems and Technology; Information Technology; Business Partner; Teck Highland Valley Copper; Business Disruption Impact Assessment; Business Critical Functions, Critical Applications and Technologies, User Needs; Technology Resiliency.

Executive Summary

Teck Highland Valley Copper (THVC) is one of Teck's most successful operations despite the complexity of its Information Systems and Technology (IS+T) environment. The findings from previous research suggest that there is room for Enterprise IS+T to become a strategic partner of the business.

Enterprise IS+T has much to offer towards "keeping the lights on" and for capabilities growth enablement at THVC as demonstrated by the exceeding of the service level agreement on IS+T asset availability and the successful delivery of Enterprise IS+T specific projects. However, the level of expertise and the services that Enterprise IS+T offers at THVC have not been sufficiently communicated to the users. As a result, THVC is not utilizing the full capability of Enterprise IS+T services and, conversely, Enterprise IS+T is missing opportunities to deliver value to this business.

In addition, there is a gap in problem analysis, solution-selection and implementation processes that has led to a dysfunctional working relationship between Enterprise IS+T and THVC which has contributed to users building solutions to fit their technology needs, resulting in a complex IS+T landscape that is difficult and costly to sustain. The problem is exacerbated by a multitude of alternative Enterprise IS+T providers, each with differing strengths and weaknesses, that can fulfil THVC users' business and operational IS+T requirements. Users are leveraging these alternatives in the absence of formal rules of engagement and awareness of what Enterprise IS+T has to offer. Alternatives to Enterprise IS+T need to be carefully examined because they could be a source of cyber security risk, which could potentially expose Teck to negative consequences.

The key business challenge that this thesis looked to address was how to best meet THVC's IS+T needs with the services provided by Enterprise IS+T so that the effort, cost, and the quality of the solutions proposed would be optimized. To respond to this question a novel analysis aimed at understanding THVC's IS+T priorities and needs was conducted. The results of this analysis help tailor THVC's IS+T needs to the services offered by Enterprise IS+T and better

position Enterprise IS+T as a strategic partner of THVC's business. Practical recommendations to improve THVC's IS+T landscape are discussed.

Dedication

A mis padres por su educación y los valores que inculcaron en mí que son la fuente de mis ideas y la fuerza que me mueve.

To my parents for their education and the values they instilled in me, which are my source of ideas and strength.

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Glossary

Teck Highland Valley Copper or THVC	Teck Highland Valley Copper is an open pit mine located in south central British Columbia, Canada, producing copper and molybdenum concentrates. Teck Resources Ltd. has a 97.5% interest in the mine.
Enterprise Information Systems and Technology (IS+T)	Department based out of Teck Resources Ltd.'s head office, responsible for providing technology-related support to both Teck as a whole and each of its Sites.
Business Disruption Impact Assessment (BDIA)	The Business Disruption Impact Assessment (BDIA) methodology utilized in this thesis is based on an adaptation of the OCTAVE Allegro methodology developed by Carnegie Mellon University. This methodology is typically used as a way to gather business requirements and data for IS+T resilience planning purposes. In collaboration with Sentry Partners Inc., the BDIA methodology was customized to allow for the analysis proposed in this thesis.
Critical Business Function	A Critical Business Function is a set of activities and processes performed by a department or group of people that are critical to an organization. Since the business functions of the organization are dependent on information assets, the IT department plays an important role in implementing protection and optimization strategies that support and improve the organization's information assets.
Critical Applications	Any technology solution deemed critical for the operation of the site (e.g., Wenco, Telephony, etc.).
User Needs	Stakeholders' perceived IS+T needs obtained through workshops.
Resilience	The ability of a business process, technology asset, or people to rapidly adapt and respond to internal or external disruptions and continue operations with limited impact to the business.

1: Introduction

1.1 Overview

Information Systems and Technology (referred to as "IS+T" going forward) has the potential of moving beyond an overhead expense necessary for mining operations or an unavoidable cost of doing business. MIT Sloan School of Management research has demonstrated a direct link between IS+T and market capitalization value of public companies (Brynjolfsson, McAfee, Sorell, & Zhu, 2008). Total market share over a 10-year period increased most significantly in industries where IS+T assets constituted a greater percentage (approximately four to forty five percent) of the organizations' total fixed assets. These organizations leveraged IS+T for agile rollout of innovative integrated business processes. As for mining companies, IS+T made up less than 1.5% of assets on average, and mining ranked forty fifth of the sixty one industries studied, so there is significant room for competitive growth and leading-edge companies will be at a distinct advantage.

A recent Gartner, Inc. assessment found the Teck Resources Ltd. annual spending on IS+T totalled 1.16% of revenue in 2013 compared to 1.29% at peer group companies in the same industry with comparable annual revenue (Huddleston, 2014). While this could be viewed as achieved IS+T efficiency at Teck as compared to peer companies, this annual IS+T spending gap offers Teck Resources Ltd. an opportunity to further optimize the role of IS+T in the Teck business.

In particular, at Teck's Highland Valley Copper (THVC) operation, mixed perceptions exist about the value delivered by Enterprise IS+T. Although THVC understands the importance of IS+T efforts to support their basic IS+T needs, there is a perception that Enterprise IS+T's efforts, at times, complicate the solutions implemented without listening to the "customer" needs. In this context, THVC stakeholders choose to seek alternative IS+T solutions to those proposed by Enterprise IS+T, potentially dismissing the value of synergy and creating threats for Teck as a whole. On the other hand, Enterprise IS+T sees the actions by THVC as failing to align with Teck's strategic focus and a misuse of resources. This has created a complex IS+T environment that, as will be described in the next section, is difficult to sustain.

1.2 The Situation: Complex IS+T Landscape at Teck Highland Valley Copper

With many groups at THVC initiating, designing, implementing and operating technology systems and networks, the IS+T landscape has become complex and difficult to manage from an Enterprise perspective. This results in an IS+T environment in which it is difficult to achieve targeted business value and the costs of maintaining this environment, as well as potential for risks to the business, both increase.

Creeping complexity occurs as users, to satisfy valid business needs, build their own one-off solutions; often done in isolation and, at times, without knowing what other systems and data are available to approach their needs or problems. Although these "home-made" solutions address immediate and specific requirements, local approaches may sidestep long term problem solving, broader participation, and organization-wide solutions. The outcome at THVC is an intricate web of software applications, vendors and solutions each requiring contract license and upgrade management, increasing the total costs of ownership.

The lack of clarity around rules of engagement between THVC and Enterprise IS+T has also led to delivery failures that perpetuate this problem and further deteriorate the collaboration between Enterprise IS+T and the Sites. As a result of this situation, antagonistic perceptions are formed that deteriorate the working relationship between THVC and Enterprise IS+T as illustrated in Table 1.

Table 1 Antagonistic Perceptions Between Enterprise IS+T and THVC

Enterprise IS+T perceptions about THVC	THVC's perceptions about Enterprise IS+T
• They do not want to align with Teck • They want their own independence • They develop their own solutions • They run their own projects • They do not work with us	• They want to take over everything • They are slow to respond • They are too occupied with the latest tools and gadgets • They make everything too complicated • They always want a role until things get too difficult, then they disappear • They will not get it done anyways

Enterprise IS+T perceptions about THVC	THVC's perceptions about Enterprise IS+T
	• They are really not listening to us • They are a "disaster" running projects • They do not know about mining

This increasingly complex landscape coupled with these antagonistic perceptions can have tangible side-effects such as:

- Lack of integration as one company
- Operational performance could be negatively impacted by a failure on operation-critical application software or hardware
- Decisions made based on incomplete or incorrect data
- Potential efficiencies are impeded by less than optimal data creation, modification, storage and/or distribution
- Exposure to cyber security risks
- From an Enterprise standpoint, systems and technologies that are costly and difficult to service and manage
- Some of the Enterprise IS+T services, which could be of benefit to THVC, are not being leveraged. As a consequence, THVC is not fully realizing the value of the Enterprise IS+T allocation charges

The key business challenge that this thesis will address is how to best meet THVC's IS+T needs with the services provided by Enterprise IS+T so that the effort, cost, and the quality of the solutions proposed are optimized. To respond to this question, a novel approach to understanding and prioritizing THVC's needs will be presented. This approach may be used by other IS+T professionals to uncover the actual needs and expectations of their businesses to drive the most effective and efficient solutions.

1.3 Literature review

The importance of understanding the needs and priorities of the business by IS+T departments as a means to deliver value and for Enterprise IS+T to become a strategic business partner has been the focus of recent studies.

Ferber, Gurgul, and van Overdam (2013) discuss how IT departments and CIOs can position themselves as value contributors within a company. As the authors suggest, the first step in becoming strategic partners speaks to the importance of aligning IT efforts to the business strategic goals and strategy:

> IT strategy and planning should always be aligned to the business requirements and objectives, to provide the value expected by the company. IT management must ensure that IT contributes to business strategic planning and identifies capabilities available to support enterprise goals and other opportunities. The cornerstone is a sound knowledge and understanding of the business by CIOs and IT employees. (Ferber, Gurgul, & van Overdam, 2013, p. 3)

That is, in these authors' view, a successful IT department is able to respond to the company's preferences and strategic needs in the company's language, something that requires a deep understanding of the business.

In the white paper *How to transform IT into a strategic partner*, HP reference a study they conducted where 99% of the Chief Executive Officers they surveyed said that IT was essential to business competitiveness but only 31% of Chief Information Officers believed IT was sufficiently aligned with business objectives and strategy. As the authors describe, this disconnect of perceptions comes as a result of the fact that, traditionally, IT has acted as a siloed department with concerns that are not necessarily the concerns of the business that it serves. This situation creates a gap between IT and the business that must be closed to allow the alignment that is required for IT to help the business execute its strategic initiatives.

While discussing the priorities of the "CIO of the future," Orellana (2013) also pointed out that IS+T must support the business strategy, customizing solutions to the business' needs in a timely manner that is conscious of budgets.

> The CIO's challenge is to enable the CEO's strategies, becoming the company's innovation branch and supporting the business strategies with ad-hoc solutions while meeting deadlines and budget constraints required by the business. A skilled CIO customizes solutions, aligning them correctly with the business strategies, at the right time and with competitive budgets. (Orellana, 2013, para. 4).

In a survey conducted by McKinsey's consultants Arandjelovic, Bulin, and Khan (2015) a link between active IS+T involvement with the business and the perceived effectiveness of IS+T was found: "At companies with the most involved CIOs, executives are also much likelier than others to say IT facilitates business activities, including new-market entry and the creation of new products". Unfortunately, however, as the authors in this study point out, IS+T oftentimes does not play an influential business partner role at many organizations with over half of all respondents saying that their CIOs are on their organizations' most senior teams, and only one-third saying that their CIOs are very or extremely involved in shaping the overall business strategy and agenda. As a result of these findings, Arandjelovic, Bulin, and Khan (2015) recommend for IS+T departments to improve their understanding of the business and cultivate IT leaders that have both business and technology know-how.

Guha and Filsoof (2013) argue that "a very different IT–business partnership model is arising at many companies" (p.4) where each business unit makes its own decisions about the technologies it needs to takes its product and services to market. In this context, a new partnership model—similar to the one presented in this thesis—between IT and the business must flourish, one where IT moves from being a transaction-based service provider to a strategic partner. Guha and Filsoof illustrate the path to this partnership model in their IT Business Engagement Maturity Path (Table 2).

Table 2 IT Business Engagement Maturity Path (in Guha & Filsoof, 2013)

Key characteristics	Service provider	Business enabler	Strategic partner	IT-business partnership model
Mission	Service the business IT as a cost center	Supply the business IT as a service provider	Collaborate with the business	Hybrid business and technology roles Technology innovation and value driver
Relationship between IT & business	Transactional	Combination of transactional and consultative	Consultative	Shared/joint ownership and accountability
Alignment to business	IT functional or technical alignment	Combination of IT process and business unit process alignment	IT aligned to business unit/business processes	IT–business matrix around differentiated strategic capabilities or processes
Resource management priorities	Technical expertise Back-office expertise	Process expertise	Solution/relationship expertise	Domain, front-office, information expertise

Key characteristics	Service provider	Business enabler	Strategic partner	IT-business partnership model
Budgeting and funding	Fixed, annual IT budget	Fixed, annual IT budget and chargeback	Fixed, market-based funding	Flexible, market-based funding

Furthermore, Pohle and Chapman's (2006) study identified integrating business needs and technology offerings as an integral component to innovation, however, as the authors of this study pointed out, most of the CEOs surveyed identified a major "integration gap" in their organizations and they acknowledged that, although they wanted to improve, they "didn't know how to do it" or found the task "too complicated".

In sum, although the importance of aligning Enterprise IS+T to the business needs and expectations is well known and documented as a way to deliver business value and a source of innovation, there are fewer studies analysing *how* to reach and sustain such alignment. This thesis will be focused on addressing this gap.

1.4 Thesis organization

In order to address the research question of this thesis, the next chapters will present a comprehensive review of THVC's current IS+T landscape identifying the IS+T engagement model and services, IS+T customers, the service provider alternatives to Enterprise IS+T, and Enterprise IS+T key differentiators.

Next, I will present the Business Disruption Impact Assessment methodology originally developed by Carnegie Mellon University and customized for this thesis to conduct an objective analysis of THVC's Critical Business Functions, Critical Applications, and key IS+T User Needs.

The results from the Business Disruption Impact Assessment will be used to draw conclusions regarding the areas where Enterprise IS+T must focus on to deliver value at THVC. Following the results and conclusion, recommendations will be offered and limitations of this study will be outlined.

2: IS+T Landscape in the Context of Teck's Copper Business Unit

This section provides an overview of the IS+T landscape in the Copper Business Unit. This business unit is comprised of three mine sites (Teck Highland Valley Copper, Teck Carmen de Andacollo, and Teck Quebrada Blanca), two projects (Relincho and Teck Quebrada Blanca Phase 2), and a regional office in Santiago, Chile.

This overview is useful to understand the environment in which Enterprise IS+T operates its services, customers, as well as to explain the complexities faced.

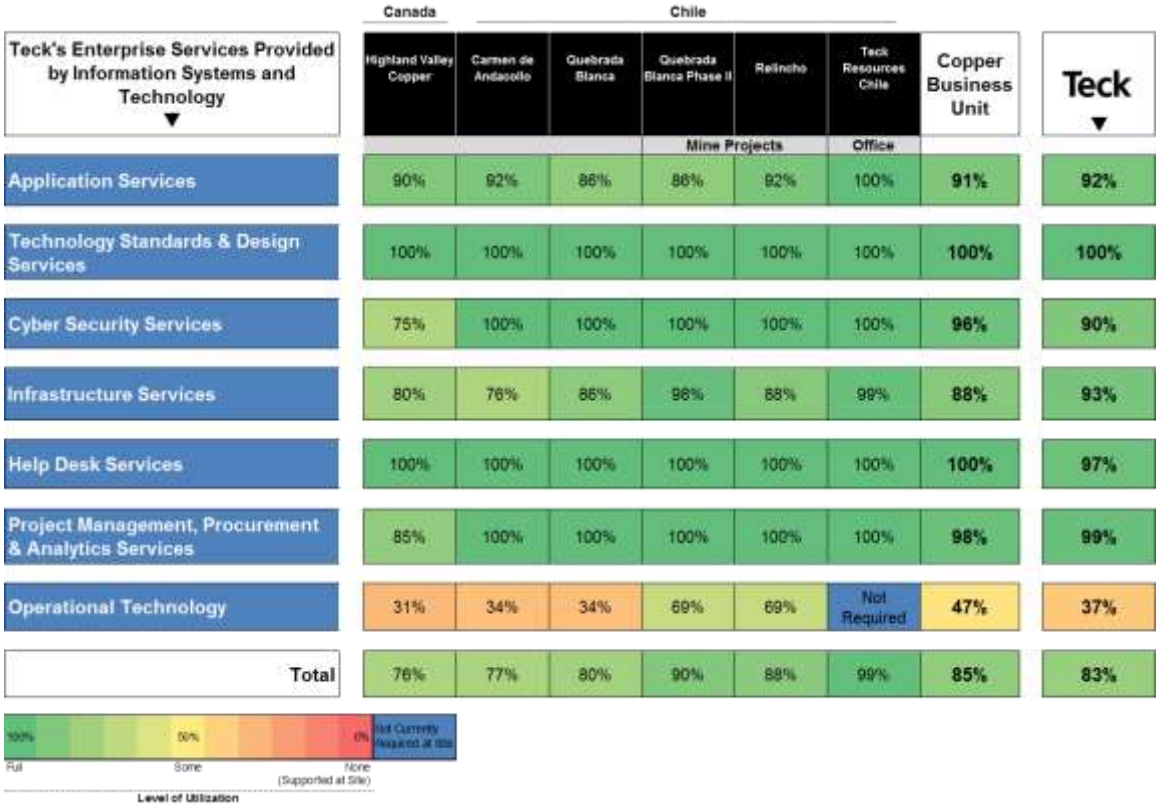
2.1 Enterprise IS+T Engagement Model and Services

Enterprise IS+T provides services to the business following a Service Oriented Framework, based on a *Service Catalogue*.

This IS+T Service Catalogue is comprised of the following services: (1) Application Sustainment: Provides support to Teck's software applications, managing incidents and application access requests, relationship with vendors, continuous improvements and source code. (2) Technology Standards and Design Services: Provides high-level design and planning services and/or solutions to ensure that Teck's technology frameworks and architectures are always aligned with Teck's business goals, while remaining within cost and time constraints. (3) Cyber Security: Protects Teck's corporate and operational technological assets from internal and external cyber security risks (4) Infrastructure Services: Provides cost-effective and built-for-purpose infrastructure including hardware, software, network resources and services required for the operation and management of an enterprise technological environment at Teck. (5) Help Desk Services: Provides 24/7 client support for all IT-related inquiries such as incidents resolution, hardware and software requests, IT asset management, and IT change control. (6) Project Management, Procurement & Analytics Services: Provides project governance and reporting to assist with the delivery of new and to enhance existing IS+T capabilities, from inception to commissioning. (7) Operational Technology: Includes the implementation of specialized information systems and technologies that directly support Teck's operations including mining, processing, engineering, maintenance, industrial networks, and analytics.

Table 3 shows the services offered by Enterprise IS+T and their utilization by each of the sites in the Copper Business Unit.

Table 3 Enterprise IS+T Services Utilization Matrix



Teck's Enterprise Services Provided by Information Systems and Technology	Canada	Chile					Copper Business Unit	Teck
	Highland Valley Copper	Carmen de Andacollo	Quebrada Blanca	Quebrada Blanca Phase II	Relincho	Teck Resources Chile		
				Mine Projects		Office		
Application Services	90%	92%	88%	86%	92%	100%	91%	92%
Technology Standards & Design Services	100%	100%	100%	100%	100%	100%	100%	100%
Cyber Security Services	75%	100%	100%	100%	100%	100%	96%	90%
Infrastructure Services	80%	76%	86%	98%	88%	99%	88%	93%
Help Desk Services	100%	100%	100%	100%	100%	100%	100%	97%
Project Management, Procurement & Analytics Services	85%	100%	100%	100%	100%	100%	98%	99%
Operational Technology	31%	34%	34%	69%	69%	Not Required	47%	37%
Total	76%	77%	80%	90%	88%	99%	85%	83%

The Copper Business Unit sites use a combination of Enterprise IS+T services and Site based services to cover their IS+T needs. The services detailed in Table 3 can be grouped according to their objectives, as follows:

(1) “Keeping the lights on” or maintaining the company's critical business operations: These are services that provide for a sustainable and smooth operation. Without these services, the operation would come to a halt in, presumably, a short time frame. This group of services also prevents the company from moving “backwards” and sets up the environment that is required to keep operating normally. These services include Infrastructure, Applications, Help Desk and Cybersecurity.

(2) Capabilities Growth Enablement: These services allow the company to grow and increase the efficiency of the current and future business processes. Without these services, it would not be possible to implement new technologies, upgrade to more powerful and up-to-date solutions or allow for the expansion and growth of the company's information systems and technologies capabilities. These services are Technology Standard and Design, Project Management, Procurement, Analytics and Operational Technology.

In general, maintaining the company's critical business operations or "keeping the lights on" is funded at the Enterprise level, new initiatives are funded by the Sites, and optimization opportunities may be funded by either entity. Users at THVC cite "keeping the lights on" as the highest priority expectation of Enterprise IS+T. The challenge is, however, that—on those rare occasions when an IS+T asset fails—this causes great setbacks for users. For this reason, optimization and capability growth is equally important to "keeping the lights on."

As depicted in Table 4, Enterprise IS+T has been successful in delivering innovative integrated solutions specific to the IS+T function at THVC. All these projects have been delivered successfully (on scope, time and budget). Where IS+T has fallen short, however, is in the implementation of solutions that impact two or more departments and where the accountabilities are unclear (Table 5). As a result, Enterprise IS+T is not optimally positioned to drive competitive advantage at THVC.

Table 4 Solutions Delivered at THVC with Sole Accountability from IS+T

	Scope	**Time**	**Budget**
THVC VoIP Deployment	Successful	Successful	Successful
THVC Wireless Backhauls	Successful	Successful	Successful
THVC Core Network Refresh	Successful	Successful	Successful
THVC Edge Network Refresh	Successful	Successful	Successful

Table 5 Solutions Delivered at THVC with Shared Accountability from IS+T and other Department

	Scope	Time	Budget
THVC Performance Mgmt. Product & Carbon	Not achieved	Not achieved	Not achieved
THVC Mobile Equipment Monitoring	Not achieved	Not achieved	Not achieved
THVC Ultipro/UTA Implementation	Not achieved	Not achieved	Not achieved
THVC Ore Tracking Tool (Mine to Mill)	Successful	Not achieved	Not achieved

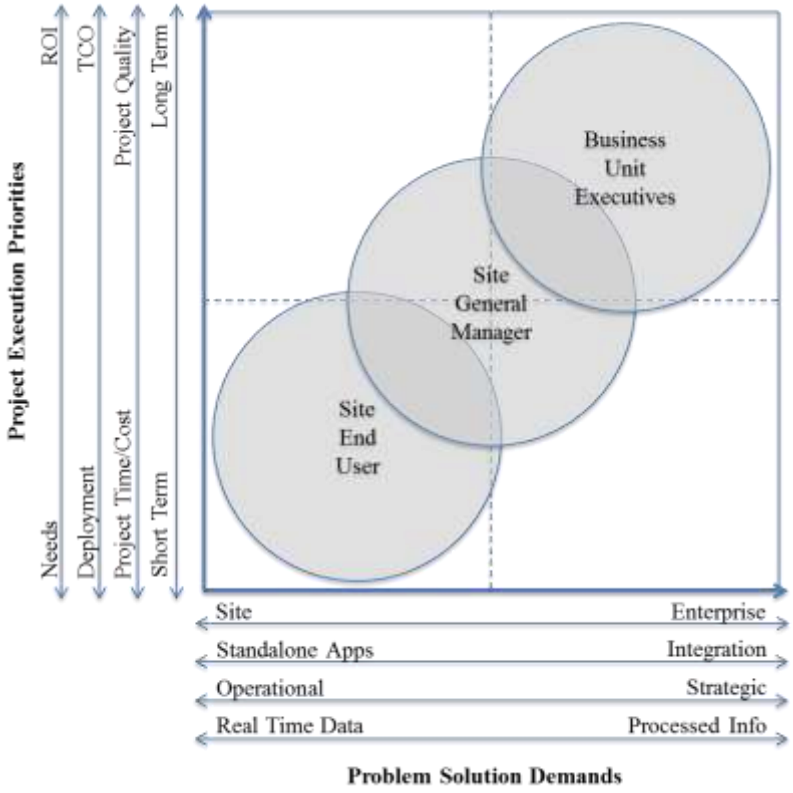
The delivery failures have led to subsequent rollouts being halted and a breakdown in the relationship between THVC and Enterprise IS+T. This, in turn, led to a shift whereby THVC presents one-off solutions to Enterprise IS+T without prior engagement. As mentioned earlier, this scenario has left Enterprise IS+T trying to sustain a complex landscape that impedes operational excellence and improvement.

2.2 IS+T Customers

Enterprise IS+T serves a wide spectrum of customers at THVC. At a high level, the IS+T customer base, which is currently comprised of 1,366 users, can be categorized into Site End Users, General Managers, Business Unit Executives and Corporate Executives.

Each of these Enterprise IS+T customer groups has their unique priorities and demands when it comes to deployment and sustainment of information technology solutions and services. Figure 1 illustrates these differences by plotting customer groups against their problem solution demands (horizontal axe) and their project execution priorities (vertical axe).

Figure 1 Enterprise IS+T Customers' Problem Solution Demands against Project Execution Priorities



The Business Unit Executives focus on the following business attributes:

- Enterprise Requirements
- Integration Across Systems
- Strategic Positioning
- Processed & Analyzed Information
- Longer Term Business Planning Horizon
- Project Quality balanced against Time, Cost, and Quality
- Total Cost of Ownership
- Return on Investment

At the other end of the spectrum, the Site End Users focus on the following business attributes:

- Site Requirements
- Standalone Application Functions

- Operational Focus
- Real Time Data Collection & Consumption
- Shorter Term Operational Horizon
- Project Time and Cost focus over Quality balance
- Deployment focus over Total Cost of Ownership
- Needs Fulfillment

There is further divergence among users within these categories, as apparent in the number of operating departments (Table 6). The total number of Copper Business Unit customers is sizable at just under 3,000 users in total.

Table 6 Teck Copper Business Unit's User Count

Department ▼	Highland Valley Copper	Carmen de Andacollo	Quebrada Blanca	Quebrada Blanca Phase II	Relincho	Teck Resources Chile	Copper Business Unit
Mine Operations	413	146	175				734
Mine Engineering	25	22					47
Mine Maintenance	286	90	46				422
Mill Operations	199	178	161				538
Powerhouse Maintenance			2				2
Powerhouse and Services			46				46
Operational Projects		13	11				24
Projects				14	4		18
Mill Technical	31	36	34				101
Mill Maintenance	252	133	88				473
Tailings	26				1		27
Site Engineering	11	14	39	8	6		78
Reliability	15	5					20
Cont. Improvement	4	1	2				7
Envir. & Community	9	19	12	9	3	9	61
Strategic Planning	9	4				10	23
Executive	7	8	8			4	27
Accounting	12	8	8		1	23	52
Information Systems	4	13	8			9	34
Materials Mgmt	36	27	10	1			74
Human Resources	9	13	16		3	13	54
Protective Services	10	2			1		13
Exploration						25	25
Legal						6	6
Marketing						4	4
Ops. Tech. Support						19	19
Safety	8	8	10				26
Total ▶	**1,366**	**740**	**676**	**32**	**19**	**122**	**2,955**

In this context, the challenge for Enterprise IS+T is to achieve that optimal balance between these diverse business demands and operational priorities when delivering information technology solutions and services.

2.3 Service Provider Alternatives to Enterprise IS+T

When it comes to choices of service providers for fulfilling information technology requirements, THVC users have a multitude of practical and de facto choices. This collection of service providers acts as "competitors" to Enterprise IS+T in the delivery of services to fulfil

Teck's user requirements. The list of alternate information technology service providers to Enterprise IS+T at THVC includes:

2.3.1 Users

The User organization possesses resources with information technology capabilities. When faced with a business need, keen users may approach the implementation of the technology solution directly or call on members of the local business team with knowledge in information technology to help.

2.3.2 External Vendors

Numerous external vendors offer their information technology services to THVC users. These external vendors may contract directly with THVC and, in doing so, may not engage with Enterprise IS+T. In some instances, these external parties will be successful in influencing the user of a standalone site solution implementation which may not be in alignment with Teck's Enterprise IS+T standards or strategic focus.

2.3.3 Enterprise Support Groups

These groups are similar to the "Users" group described earlier in that they are part of a business or an operational team, however, these groups operate at the Enterprise level and they possess specific mining technology knowledge. These groups deploy their knowledge in support of specialized information technology solutions or they directly engage vendors to the same end. These groups are comprised of Exploration, Project Development and Engineering, Sustainability and External Affairs, and Operating Excellence.

2.3.4 On-site IT Support Groups

These are on-site groups who are called on by Users at THVC for information technology consultation and support. These groups are comprised of local THVC IS+T staff, Mill Technical Support group, and Mine Engineering Technical Support group.

2.4 Attributes of Enterprise IS+T Service Provider Alternatives

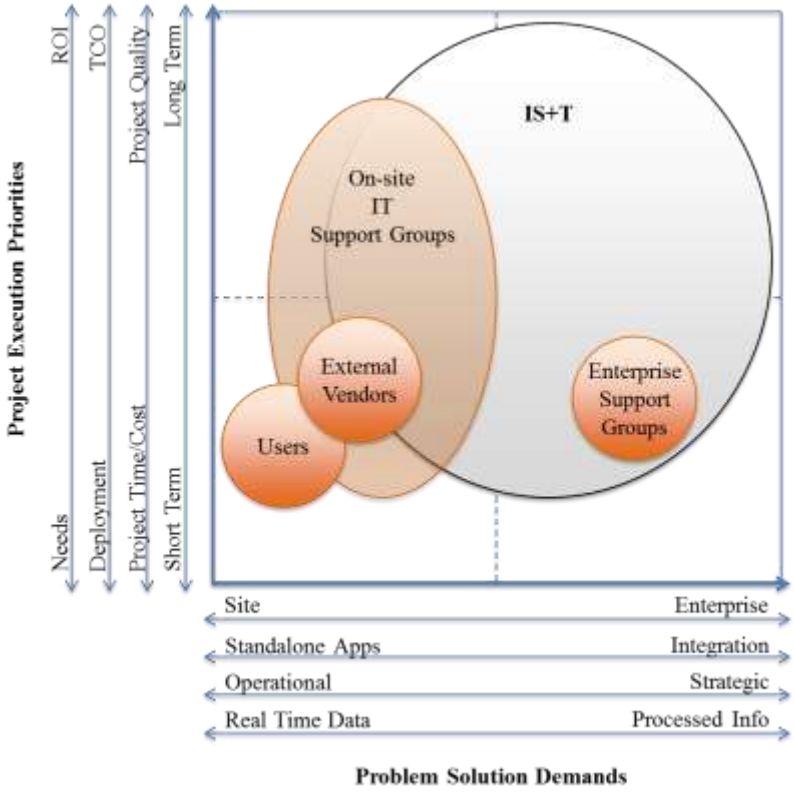
As illustrated in Table 7, each of the Enterprise IS+T service provider alternatives has advantages and disadvantages to offer Users in fulfilment of their business and operational IT requirements.

Table 7 Advantages and Disadvantages of Alternative Service Providers to Enterprise IS+T

Alternative Service Provider	Advantages	Disadvantages
Users	• Understand the site's concerns and business processes • Agile	• Do not understand the value proposition of Enterprise IS+T nor the incremental cost of sustaining one-off solutions • Delivery cost not transparent
External Vendors	• Direct specialized skillset targeting requirements	• Focus on short term engagement revenue • Inherit disadvantages of Users
Enterprise Support Groups	• Specialized skillset and Teck experience on specific operational business functions	• Lack implementation and corporate integration capabilities
On-site IT Support Groups	• Local operational knowledge of user applications • Experience on solution platforms relating to site specific business functions	• Lack Enterprise integration capabilities

Figure 2 illustrates the difference between Enterprise IS+T and the various service provider alternatives by plotting them against their problem solution demands (horizontal axe) and their project execution priorities (vertical axe).

Figure 2 Differences between Enterprise IS+T and Service Provider Alternatives in Problem Solution Demands versus Project Execution Priorities



The Users group as an alternative to Enterprise IS+T service delivery typically focuses more on:

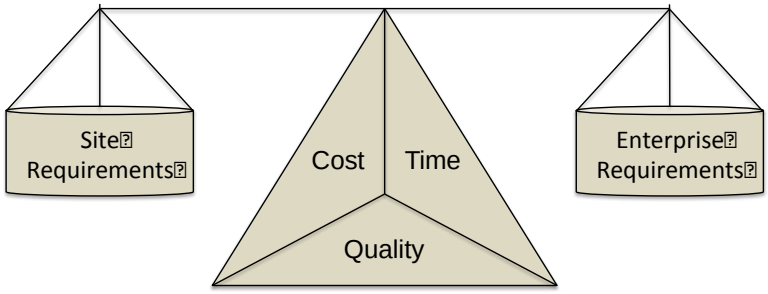
- Site Requirements
- Standalone Application Functionalities
- Operational Considerations
- Real Time Data Collection & Consumption
- Shorter Term Operational Horizon
- Project Deployment Time & Cost Focus
- Operational Needs Fulfillment

In addition to the Users group focus, the On-site IT Support groups are more concerned with:

- Longer Term Operational Horizon
- Balancing Project Quality with Project Time & Cost
- Total Cost of Ownership
- Return on Investments
- IS+T capabilities in support of enterprise level integrations

Different from the various service alternatives, the purpose of Enterprise IS+T is to balance across these operational and business dimensions. For example, a total cost of ownership and quality-oriented focus will deliver a technology solution that is more robust and stable in the long run. A solution that is properly integrated—while leveraging experience and skillset obtained from other Teck technology deployments—will have a longer useful life at Teck. Therefore, as depicted in Figure 3, balancing Enterprise and Site requirements, as well as short and long term cost and delivery considerations, is Enterprise IS+T's mandate resulting in solutions with the most optimal total cost of ownership for Teck overall.

Figure 3 Enterprise IS+T Mandate: Balancing Site and Enterprise IS+T Requirements



2.5 Key Differentiators of Teck Enterprise IS+T

The key differentiating attributes of Enterprise IS+T when it comes to delivery and sustainment of technology solutions and services include sustainment considerations, total cost of ownership, cross systems integration, skillset and knowledge synergies, enterprise-wide focus and project time-budget-quality trade-offs.

2.5.1 Operational and Strategic Value Curves

The Operational and Strategic Value Curves shown in Figure 4 and Figure 5 represent the business values driven by Enterprise IS+T and the various competitors in the operational and strategic contexts for THVC.

Figure 4 IS+T Operational Delivery Value Curve

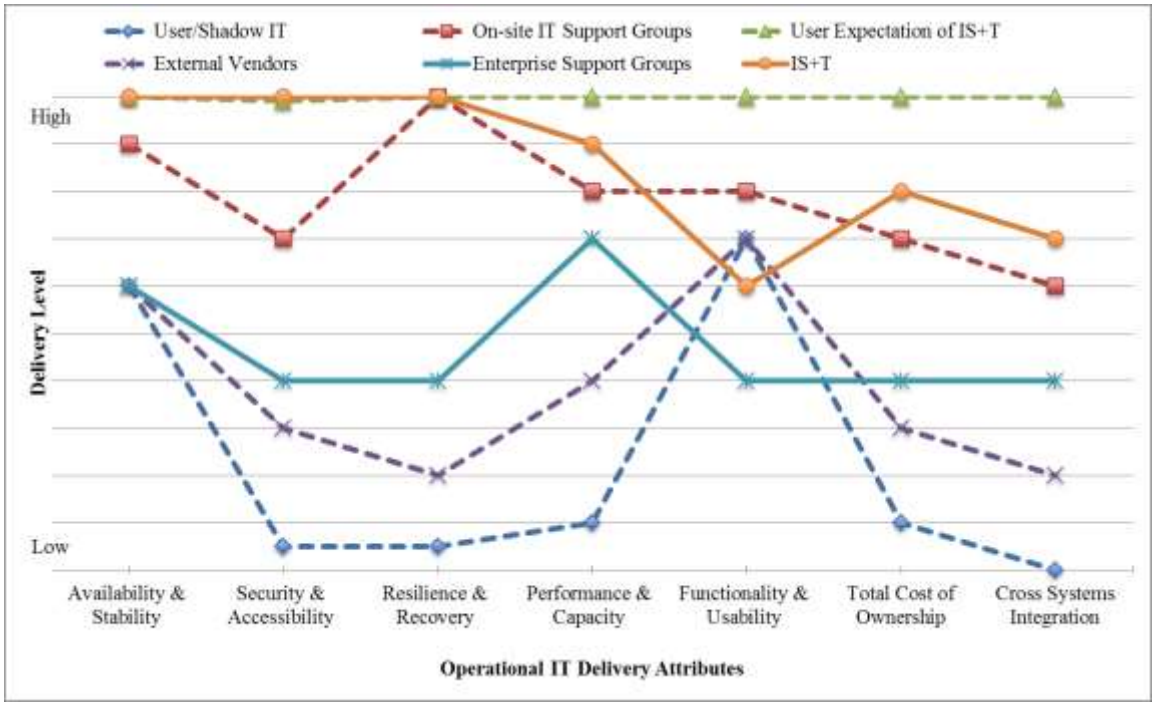
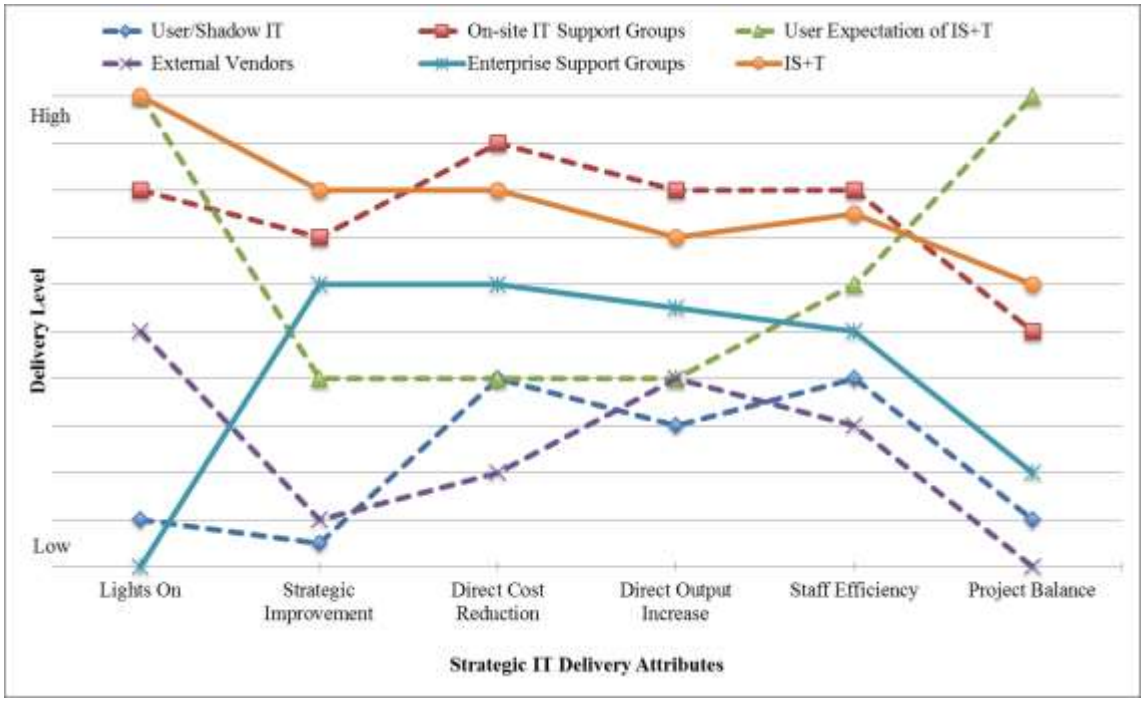


Figure 5 IS+T Strategic Delivery Value Curve



A higher business value index represents a higher degree of preference or focus on the specific attribute as well as higher capabilities and experience in fulfilling the specific needs of the attribute (operational and strategic). The values for each of these attributes were collected in conversation with THVC users.

As illustrated, Enterprise IS+T ranked favourably in delivery of business value in most of the operational information technology delivery attributes. The only exception being Functionality and Usability as compared to the User and Business Unit expectations. These are areas where Enterprise IS+T will need to foster collaboration with Users and On-Site IT Support groups to close the service delivery gap. In addition, Enterprise IS+T and On-Site IT Support groups should collaborate in delivering value in the areas of Availability, Resilience, Performance and Capacity, Total Cost of Ownership (i.e., direct or indirect cost of the application or technology), and Cross System Integration (i.e., integration among applications and services). Functionality and Usability (i.e., the ability for the application or technology to meet the user's functional expectations) should be a shared responsibility of On-Site IT Support groups and Users. Security and Accessibility should be a responsibility of Enterprise IS+T.

Enterprise IS+T also ranked favourably in most of the strategic information technology delivery attributes. To note is the low delivery value index ranking for all IS+T service providers in achieving an optimal Project Balance; this is indicative of the gap in the analysis phase at the early stages of projects. To improve this, more collaboration and communication between Enterprise IS+T and THVC's Users is required.

Users at THVC do not expect from Enterprise IS+T a high delivery level around strategic improvement, direct cost reduction, direct output increase and staff efficiency. Enterprise IS+T needs to work with the business unit to promote its potential strategic contributions and should put in place a marketing campaign focused on improving Enterprise IS+T's perception in the areas of Strategic Improvement, Direct Cost Reduction, Direct Output Increase, and Staff Efficiency. More details about this will be described in the Recommendations section of this thesis.

3: Methodology: Business Disruption Impact Assessment

3.1 Goals

As indicated earlier the key business challenge at THVC remains that of finding the alignment between THVC's priorities and the Enterprise IS+T offerings. The reality of the current IS+T environment has resulted in a higher total cost of ownership for some deployed solutions. Enterprise IS+T needs to better understand what THVC's needs and expectations are to determine where it can partner with this business in order to provide solutions that drive the most value.

To find a way to address this issue, an assessment of THVC's IS+T landscape and users expectations was conducted. The purpose of this assessment was to establish an objective evaluation of THVC's Critical Business Functions and Applications as well as the THVC's User Needs via discovery sessions with each of this site's operating areas. This assessment—promoted as "*The Voice of the Customer Assessment*"—was focused on:

- Assessing THVC's Critical Business Functions (CBFs) and their impact on business continuity, cost and production output
- Identifying Critical Applications and Technologies (CATs) and how they impact the Critical Business Functions that they are serving
- Assessing the resilience of the Critical Applications and Technologies based on a set criteria
- Understanding THVC's User IS+T Needs from Enterprise IS+T

The ultimate goal of this assessment was to better understand THVC's IS+T landscape and match their priorities to the services offered Enterprise-wide by IS+T, identify potential areas of improvement, and increase efficiencies.

3.2 Workshops and Participants

A number of workshops were conducted at THVC during December 2014 to obtain the input from users of 14 operating areas including Administration, Human Resources, Environment

Health Safety and Community, Mine Operations, Mine Maintenance, Mill Operations, Mill Technical Support, Mill Maintenance, Mine Engineering, and Continuous Improvement & Strategic Planning. In total thirty one stakeholders–all of them key representatives from their areas—were invited to participate. (Appendix A includes the email invitation that was used to recruit participants.)

3.3 Methodology

3.3.1 Overview

The methodology utilized for this assessment is based on an adaptation of the OCTAVE Allegro methodology developed by scholars from Carnegie Mellon University (Caralli, Stevens, Young, Wilson, 2007) and adapted by Sentry Partners—a consulting firm engaged by Teck to assess the resilience of its IS+T environment. Sentry Partners refers to this methodology as the *Business Impact Assessment* (BIA) and is typically used as a way to gather business requirements and data for resilience planning purposes. In collaboration with Sentry Partners Inc., the BIA methodology was customized to allow for the analysis proposed in this thesis. I denominate this customized version the *Business Disruption Impact Assessment* or BDIA to place emphasis on the consequences that a technology disruption would have in the business.

The Business Disruption Impact Assessment methodology relies on data from two primary dimensions – a Critical Business Functions (CBFs) dimension, and a Critical Applications and Technology (CAT) dimension. These two assessment dimensions were correlated during this exercise through various resilience and business impact attributes. In addition to these two dimensions, an analysis of THVC's users' needs was added to the BDIA as a means to obtain first hand qualitative data (opinions) from key stakeholders at THVC regarding their most pressing IS+T requirements.

3.3.2 Critical Business Function Assessment

The Critical Business Function dimension is meant to capture the list of critical business functions at THVC. Teck's Mining Business Model was used to collect a list of all level one, level two, and level three business functions. This list was used to guide the analysis and ensure all business functions were considered. For the purpose of the Business Disruption Impact Assessment, the focus was only on the level two functions deemed "critical" to the business as

indicated by the THVC stakeholders participating in this assessment. (Note that level three functions were used to help stakeholders understand what was meant by the level 2 functions).

Next, THVC's stakeholders were asked to assess the functions identified according to the following attributes.

- Recovery Time Objective (RTO): How long can your business "live" without each CBF?
    - Associated score and dimensions: 5 - <1hr, 4 - <1day, 3 - < Week, 2 - < Month, 1 - > Month
- Recovery Point Objective (RPO): How much work or data can each CBF afford to lose or recreate?
    - Associated score and dimensions: 5 - <1hr, 4 - <1day, 3 - < Week, 2 - < Month, 1 - > Month
- Overall Business Impact: What are the impacts if a particular CBF is disrupted?
    - Associated score and dimensions: 1 - Negligible Impact or No Business Loss, 2 - Low Impact or Manageable Business Loss, 3 - Detectable Impact or Material Business Loss, 4 - Major Impact or Major Business Loss, 5 - Significant Impact or Business Survival Threatened
- Disruption Frequency: What is the current disruption frequency for each CBF?
    - Associated score and dimensions: 5 - Once per week or more, 4 - Once per month or more, 3 - Once per year or more, 2 - Once per decade or more, 1 - Almost never
- Cost Impact: What is the impact relationship of this CBF to Costs?
    - Associated score and dimensions: 3 - Direct, 2 - Indirect, and 1 - Remote impact
- Revenue Impact: What is the impact relationship of this CBF to Revenue?
    - Associated score and dimensions: 3 - Direct, 2 - Indirect, and 1 - Remote impact

These questions were aimed at assessing the criticality and impact that each of the business functions has on the business which, in turn, allows for rationalization of IS+T efforts

and resources. Understanding what is critical for THVC created the basis for a technology roadmap and helped determine where Enterprise IS+T would add most value to THVC.

Each of these attributes was assigned a score (e.g., 1 to 5, or 1 to 3), depending on their significance to the business. The product of the scores provided by the workshop participants on each of the CBF's attributes served to create a ranking of CBFs where those with higher scores ranked higher in the criticality scale. (Note: If two or more CBFs received the same score, the ranking was based on the logical order in which the CBFs occurred in the end to end process, with CBFs occurring earlier in the process receiving a higher ranking placement.)

As it will be explained in the later sections, the information obtained from the Critical Business Function Assessment was combined with the results from the Application and Technology Impact Assessment, User Application Assessment, and User Needs Assessment to understand where Enterprise IS+T should be placing its focus on.

3.3.3 Application and Technology Impact Assessment

The second step in our analysis was the Application and Technology Impact Assessment. The purpose of this assessment was to obtain a list of the Critical Applications and Technologies (CATs) supporting each of the Critical Business Functions identified earlier. That is, instead of assessing the requirements and impacts of technologies and applications directly, one defining feature of this methodology was the assessment of THVC's dependency on Critical Applications and Technology from a Critical Business Process and Functions perspective. This allowed for an analysis focused on those applications that most matter to THVC's business.

This Application and Technology Impact Assessment consisted of a few steps. First, an inventory of all applications and technologies used at THVC was produced as a basis for discussion with THVC's stakeholders. Second, THVC's stakeholders from each operational area were asked the question "What are the top three critical applications for your business functions?" to obtain a collection of THVC's Critical Applications and Technologies (i.e., those that, if disrupted, would have negative consequences for the business). Next, the workshop participants were asked "How do particular technology disruptions impact your Critical Business Functions?" in order to obtain a measure of the degree of impact of the critical application and technology on the business functions already identified. The degree of impact and associated score was categorized as follows:

- 1- Negligible: No business or operational impact, no business loss
- 2 - Low: Manageable and low business or operational impacts, manageable business losses
- 3 - Medium: Detectable business or operational impacts, material business losses
- 4 - High: Major business or operational impacts, major business losses
- 5 - Significant: Significant or most severe business or operational impacts, personnel, business or asset survival threatened

In addition, two other variables were added to the analysis of Critical Applications and Technologies:

- Application FTE Rank: Refers to the number of employees directly impacted or affected by a disruption in the application. (Applications with larger number of users affected ranked higher.)
- Application User Rank: Refers to the assessment that Enterprise IS+T makes of the impact of the application in the Critical Business Functions. (This analysis is similar to the disruption analysis explained above but from an Enterprise IS+T perspective.)

The ranking of CATs was developed using the product of two vectors: The scores of CBFs on each of their attributes and the CATs assessment. This composite product was used to establish another numeric ordinal. This ordinal represented the prioritization or ranking of the CATs for THVC. Similar to the CBF rankings, this ranking of the CATs was also relative. The utilization of a linear distribution representation of the CATs ordinal values provided further insight into the relative importance and business criticality of the CATs, similar to the situation in the CBF prioritization.

3.3.4 Application User Assessment

The Application User Assessment was used as another attribute of THVC's Critical Applications to determine which of these applications require improvement, enhancements, or no further action from Enterprise IS+T. For this portion of the analysis, stakeholders were asked for their input on each of the applications identified as critical, specifically, around the following attributes related to their experience using the application:

- Functionality: Functional fit for business requirements
    - Associated score and dimensions: 1 - Bare minimum current or None future functions, 2 - Partial current or None future functions, 3 - Full current or Few future functions, 4 - Full current or Partial future functions, 5 - Full current or Full future functions
- Usability: Ease of use from a user perspective
    - Associated score and dimensions: 1 - Usability not acceptable, 2 - Usability barely acceptable, 3 - Usability acceptable, 4 - Easy to use, 5 - Totally transparent usability
- Adaptability: Ease of adapting to business changes
    - Associated score and dimensions: 1 - Not flexible to operational & business changes, 2 - Difficult to change, 3 - Standard change cycles, 4 - Easy to change, 5 - Instant adaptability to changes
- Availability: Availability & stability from a user perspective
    - Associated score and dimensions: 1 – Unacceptable, 2 - Unscheduled outages & degradations, 3 - Regularly scheduled outages only, 4 - Special scheduled outages only, 5 - Totally transparent availability
- Recoverability: Recovery from data, process, technology problems
    - Associated score and dimensions: 1 - No system, data, process recoverability, 2 - Manual best effort recoverability, 3 - Standard recoverability, 4 - Robust recoverability, 5 - Transparent recoverability
- Accessibility: Access from different location, platform and users
    - Associated score and dimensions: 1 - Inflexible access - location, platform, user, 2 - Manageable accessibility, 3 - Acceptable accessibility, 4 - Flexible accessibility, 5 - Fully current & future proof accessibility
- Performance: Performance, responsiveness & capacity
    - Associated score and dimensions: 1 - Unacceptable performance & insufficient capacity, 2 - Manageable performance & capacity, 3 - Acceptable performance & capacity, 4 - Flexible performance & capacity, 5 - Totally transparent performance & capacity

- Manageability: Ease of application management
    - Associated score and dimensions: 1 - Difficult to manage, 2 - Minimum manageability, 3 - Standard manageability, 4 - Easy to manage, 5 - Totally transparent manageability
- Security: Robust & flexible security controls of data, user, etc.
    - Associated score and dimensions: 1 - No security - data, user, platform, location, 2 - Minimum security management, 3 - Manual security management, 4 - Flexible security management, 5 - Transparent security management
- Administration and Operability: Ease & flexibility of administration & operational cycles
    - Associated score and dimensions: 1 - Difficult to administer and operate, 2 - Heavy manual admin & operation cycles, 3 - Standard legacy admin & operation cycles, 4 - Flexible admin & operation cycles, 5 - Fully transparent admin & operation cycles

Once again, the product of the scores assigned by users on each of these attributes was used to create a ranking of the Users' Assessments on these CATs. Critical Applications and Technologies that ranked with a value of greater than three were considered "Acceptable" (i.e., meeting the users' needs and expectations) and those ranked with a value lower than three as "Not acceptable" and requiring an investment in enhancements from Enterprise IS+T.

3.3.5 User IS+T Needs and Expectations Assessment

To complement the analysis of THVC's CBFs and CATs, an analysis of THVC Users' perceived IS+T needs was carried out. For this purpose, THVC's stakeholders were asked the following questions:

- What are your top three needs from Enterprise IS+T?
- Who in the business should be the point of contact to continue refining this need?
- What's the desired timeframe to address the need?
- What's the deferral impact (i.e., the impact of not addressing the need by the desired timeframe)?

- Associated score and dimensions: 3 - Major Impact or Major Business Loss, 2 - Detectable Impact or Material Business Loss, 1 - Low Impact or Manageable Business Loss

These questions allowed us to compile data on 1) the actual IS+T business needs and the drivers for those needs, 2) the business "owner" or point of contact to further discuss the need, 3) the urgency to resolve those needs, and 4) the needs' deferral impact level or the cost of deferring the need.

The ranking of the identified needs was based on a number of attributes. First, they received a score on the "strategic" and "operational" attributes, which was calculated using a weighted value in each of the following parameters: 1) the need contributes to "keeping the lights on," 2) the need contributes to staff efficiency, 3) the need contributes to process optimization and quality improvement, 4) the need has a direct cost impact, 5) the need has a direct output impact, and 6) the need represents a strategic improvement.

Second, the identified needs were correlated with information on the CBFs and CATs associated with the need. In order to focus the analysis on the quick wins, a higher level in the ranking of needs was assigned to those needs with a smaller number of CBFs and CATs associated to them. The assumption here was that business needs that do not have too many CBFs associated to them would be easier to address because these needs would impact fewer areas of the business and, therefore, would be simpler from a business engagement point of view. Needs associated with less number of CATs would be more simple to resolve.

Finally, as part of our post-interview validation session, we reviewed the ranking of identified needs with key stakeholders at THVC and Enterprise IS+T: THVC's General Manager, THVC's Continuous Improvement Strategic Planning Team, and THVC's Administration team. Teck's CIO was also involved and asked for his input on the list of focus areas. Involving these groups was essential to narrow down the needs to those aligned with THVC's strategic objectives and to obtain the necessary buy in to proceed to the next phase (i.e., solution implementation).

3.4 Summary of the Business Disruption Impact Assessment

The goal of the Business Disruption Impact Assessment was to understand there areas where Enterprise IS+T could be of most value to THVC. The ultimate goal was to improve the level of service provided to this site and ensure that THVC would obtain the most value from their IS+T investment.

To reach this goal, the information obtained from each of the analyses explained before was consolidated to create a logical and comprehensive "picture" of the actual IS+T disruption impacts and needs at THVC. The information obtain from the different analysis was correlated to establish an objective prioritization of IS+T efforts. Associating the IS+T User Needs with critical CBFs was useful to understand the areas of the business and stakeholders that would be impacted by implementing a solution to those needs and properly engaging those stakeholders to realize the expected value. Associating the IS+T User Needs with CATs was useful to refine the scope and to understand the technology expertise required to address those needs.

4: Results and Conclusions

4.1 Critical Business Functions

Identifying the top CBFs allow us to focus on those business areas with the highest resilience gaps at THVC, including resilience issues or opportunities in processes, technology, and people. These, in turn, constitute the areas where Enterprise IS+T must focus on and could deliver most value.

A total of 145 departmental CBFs were uncovered during the analysis. (For a complete ranking of the CBFs identified, see Appendix B.) In the analysis of the top twelve CBFs (Table 8) the Mine and Mill Operations related functions ranked the highest, while supporting business functions ranked lower. These results are in line with the fact that Mine and Mill Operations functions have the highest impact on cost and revenue for THVC.

In particular, business functions such as Mining Preparation, Loading, Hauling, and Mining Support Services (ranked one to four) are related to Mine Operations and require more attention from Enterprise IS+T as this business area has higher levels of disruptions. Business functions ranked from five to nine, related to Mill Operations, are also essential in Copper production and, although this area does not suffer from frequent disruptions, as is the case with Mine Operations, it requires Enterprise IS+T support in order to close the gaps related to process automation. Business functions ranked ten to twelve are also related to Mine Operations and see challenges similar to those functions ranked one to four.

It is worth noting that, without this analysis, the focus of our Enterprise IS+T efforts would have continued to be, primarily, in the areas of Mill Operations and Maintenance as these are the areas directly related to Copper production and traditionally seen as most critical. This analysis helped uncover other areas (less obvious to Enterprise IS+T) which are seen as critical by THVC's stakeholders and where Enterprise IS+T efforts should be focused. These include business functions in the areas of Mine Engineering, Continuous Improvement, Strategic Planning and Tailing & Water Management.

Table 8 THVC Critical Business Functions Ranking

Critical Business Functions	BDIA Overall Rank
MINO MI.2 Mining Preparation	1
MINO MI.5 Loading	2
MINO MI.6 Hauling	3
MINO MI.7 Mining Support Services	4
MILO CP.4 Crushing & Conveying	5
MILO CP.5 Grinding & Flotation (Concentrator)	6
MILO CP.6 De-watering	7
MILO CP.7 Process Infrastructure (except Tailings)	8
MILO CP.3 Plant Run Planning	9
MINO MI.3 Drilling	10
MINO MI.4 Blasting	11
MINO MI.8 Mine Production Control	12

4.2 Critical Applications and Technologies

The Application and Technology Impact Assessment allowed us to produce an objective ranking of the critical technology solutions in use today at THVC (supporting Critical Business Functions) and can be used to determine which of those solutions require most attention from Enterprise IS+T in order to close technology gaps.

Table 9 illustrates the top twelve ranked Critical Applications and Technologies (CATs) based on their impact to THVC's business. As expected, technology infrastructure (Radios, Business Network, Open Pit Network, MS Exchange, Email and File Share) and the enterprise resource planning application (JD Edwards) ranked the highest amongst the 29 CATs identified during the Business Disruption Impact Assessment. The full list of THVC CATs can be found in Appendix C.

Table 9 THVC Critical Applications and Technologies Ranking and User Assessment Score

Critical Applications and Technologies	Overall BIA Rank	User Application Assessment Score
Radios	1	2.19
Business Network	2	4.10
Open Pit Network	3	2.60
MS Exchange / Email	4	4.60
File Share	5	2.88
JD Edwards	6	2.50
Historian	7	3.53
Process & Electrical PLC	8	2.60
Ultipro Human Resources & Payroll	9	3.03
Computer Aided Earthmoving System	10	3.27
GeoExplorer	11	3.80
Ultipro Time & Attendance	12	2.60

The CATs ranked from one to five and eighth correspond to key technology infrastructure and services required to ensure that users can communicate, control and monitor copper production, share information and access applications hosted at site or at the data centers.

The Radios (ranked in first place) are an essential communication tool in most operations (i.e., employees use the Radios to report safety incidents, plant controllers use it to communicate with employees on the concentrator plant, tailing personnel to communicate their status, truck drivers to communicate with dispatchers, and so on). In the case of a disruption of the Radios some of the Tailings & Water Management and Mill Operations' CBF will be significantly impacted including Tailings, Main Tailings Storage Facility (TSF) Construction, Remote Dam Inspections, Dam Monitoring & Instrumentation, Emergency Response Activities, and Dam Management. In addition, the Crushing & Conveying business function will suffer a major impact (major business loss). This disruption would have a direct impact on 533 employees. If the disruption is longer than two days, for safety and operations reasons, the site would delay or stop production.

The Business Network and Open Pit Network (second and third in the ranking of CATs, respectively) serve as the basic requirements to run all the technology capabilities required in THVC's business such as Wenco, data transport, E-mail, Control and Monitoring Systems, and

much more. In the case of a disruption in the Open Pit Network some of the Main Maintenance's CBFs will be significantly impacted including Maintenance Dispatch, Provide Site Services, and Equipment Monitoring. In addition, Perform Maintenance and Maintenance Testing & Analysis CBFs will suffer a major impact. This disruption will have a direct impact on 485 employees. If the disruption is longer than two days, for safety and operations reasons, the site will delay or stop production.

MS Exchange and Email (ranked fourth) is an essential vehicle for communication and File Share (ranked fifth) is another application used to share key performance and operational data at THVC.

Process and electrical PLCs (Programmable Logic Controllers) ranked eighth and are used for process control and monitoring of the copper production. This technology deserves attention as it contributes to increase plant availability. A disruption in the Process and Electrical PLCs would represent a significant impact in the areas of Mill Operations (Crushing & Conveying, Grinding & Flotation, De-watering, Process Infrastructure, and Tailings CBFs) and Mill Maintenance (Provide Site Services and Equipment Monitoring CBFs). Such a disruption would also have a major impact in the Plant Statistics & Reporting and Processing Performance Management CBFs of Mill Operations directly impacting twenty four employees. If the disruption is longer than seven days, the site will delay or stop production.

JD Edwards (ranked sixth)—an enterprise resource planning system—is used for the maintenance and procurement of Mine and Mill Operations as well as financial reporting. A disruption in JD Edwards would have a significant impact at THVC, affecting departments such as Administration (Cost accounting, Purchasing, Purchase Monitoring & Expediting, Receiving and Warehouse Operations CBFs), Supply (Material Analysis & Inventory Control CBFs), Mill Maintenance (Preventive Maintenance Planning and Perform Maintenance CBFs), Mine Maintenance (Work Order Planning and Perform Maintenance CBFs) and Site Engineering (Construction CBF). Such a disruption would have a direct impact on 453 employees.

Ultipro Human Resources & Payroll and Ultipro Time & Attendance (ranked ninth and twelfth, respectively) can have a detectable impact (i.e., material loss) in the Payroll, Cost Accounting and GL Accounting CBFs. Ultipro Human Resources & Payroll is used to manage employees and their salaries while Ultipro Time & Attendance is used to track employee time and

attendance. Disruptions in any of these two applications would, therefore, be noticed by more than a thousand employees and would impact Enterprise IS+T's credibility as a service provider.

The following three software applications play a key role in the value chain of Copper production and are related to the Mine and Mill Critical Business Functions. Historian (ranked seventh) is a database software application used to record trends and historical information related to the copper production process. Any information distributed in any part of the process is stored in real time in Historian and can be accessed to control, monitor, and troubleshoot the process. Without the Human Machine Interface or HMI (a component of Historian) the plant could not be operated. In the case of a disruption in Historian, a significant impact will affect Supply Chain (Purchasing and Purchase Monitoring & Expediting CBFs) and Mill Operations (Grinding & Flotation (Concentrator), De-watering, Process Infrastructure and Tailings CBFs). Such disruption would also impact the following Mill Operations' CBFs: Crushing & Conveying, Plant Statistics & Reporting and Processing Performance Management affecting 24 employees. If the disruption is longer than seven days, the site will delay or stop production.

The Computer Aided Earthmoving System or CAES (ranked tenth) is the software application that THVC uses to know where to locate the shovel to cut and extract material in the most efficient manner. A disruption in CAES would have a significant impact on the Mine Operations department (Loading, Mine Production Control and Mine Production Statistics & Reporting CBFs), a major impact on the areas of Mine Engineering (Engineering Standards, Short Range Plan & Schedule, Manage Quality and Flow and Drilling & Blasting Planning CBFs), and Mine Operations (Mine Operations Management and Mining Preparation CBFs). Such a disruption would directly impact on fifty two employees.

GeoExplorer (ranked eleventh) is used for slope monitoring. A disruption in this technology would affect the Mine Engineering department, specifically the Mining Performance Assessment CBF and would represent a major impact on Engineering Standards, Short Range Plan & Schedule and Manage Quality and Flow. Such a disruption would have a direct impact on fifty employees. If the disruption is longer than three days, the site will delay or stop production.

There are other applications and technologies that were not included in the top twelve and are also worth noting. JKMet and other applications used for the Metallurgical Accounting process (ranked seventeenth) are used to sample, analyse, and account for the copper throughout the metallurgical circuit at THVC's plant. A disruption in JKMet would have a major impact on

Mill Operations' Lab and Plant Statistics & Reporting CBFs directly impacting twenty four employees.

The InfoCentre (ranked twenty first) is THVC's intranet platform and hosts the links to most critical applications used at the site. InfoCentre is also the basis for most workflows supporting multiple processes such as the annual planning cycle, purchase approvals, etc. A disruption in InfoCentre would have a major impact on Mill Operations' Lab CBF and the rest of THVC. Such a disruption would have a direct impact on 300 employees.

Wenco (ranked twenty second) is a dispatch management system used at THVC to control and monitor mobile equipment during mine production. A disruption in Wenco would have a major impact on Mine Engineering (Short Range Plan & Schedule, Manage Quality and Flow and Mining Performance Assessment CBFs), Mine Maintenance (Maintenance Dispatch CBF) and Mine Operations (Mine Operations Management, Mining Preparation, Mine Production Control and Mine Production Statistics & Reporting CBFs). Such a disruption would directly affect 135 employees.

4.3 Applications User Assessments

Table 9 also illustrates the CATs User Assessment scores which represent the current health, business fit, and user satisfaction of the Critical Applications and Technologies through inputs on the attributes described earlier (i.e., Functionality and Usability, Adaptability, etc.). The CATs user assessment ranking provides another prioritization attribute for addressing future needs at THVC. The reader may recall from Section 3.3.4 that those CATs that ranked with a value of greater than three in the Applications User Assessment were considered "Acceptable" (i.e., meeting the users' needs and expectations) while applications that ranked lower than three were deemed as "Not acceptable" and requiring an investment in enhancements from Enterprise IS+T.

Radios received a low value in the application assessment score due to several gaps such as (1) adapting to the growth and extension of THVC, (2) responding to the new requirements for functionality at the site, (3) recovering the system after technology problems and (4) issues with Radio access in several locations at THVC. The challenges with the Radios are exacerbated by issues in administration, availability, stability of the platform, performance, and usability. The departments most affected for these challenges are Mill Operations and Tailings & Water

Management. These issues are due to the fact that the Radio hardware is based on analogue technology.

Currently, the Open Pit Network has a mix of frequencies, bandwidths, and protocols. This lack of standardization presents major challenges in its ease of use and THVC's ability to bring more applications that are required to operate the pit more efficiently and to improve the availability of the mobile equipment in the pit. As a result, THVC sees issues around adaptability, availability and coverage of the network, stability, performance, and sustainment of the network. The Maintenance department is the area of THVC that is most affected by the issues in the Open Pit Network. Improving the Open Pit Network will allow THVC to close the technological gap in the Radios and migrate them from an analogue to a digital technology.

The File Share infrastructure and service has challenges around quota and access management, availability of the service, performance, recoverability and security. These issues have negatively impacted the usability of the service. The areas most impacted by the technology, process and people gaps are Mill Operations, Maintenance, Supply, Accounting and Geology.

JD Edwards is a system in a critical situation. It presents gaps addressing business requirements (poor functionality and adaptability attributes). Additionally, from the user perspective, JD Edwards is not an easy system to use. JD Edwards' poor functionality, adaptability, and usability are coupled with technology gaps, due to the obsolescence of the platform and the lack of support from the vendor, in availability, stability, performance, capacity, recoverability and the operational administration. The areas being most impacted by JD Edwards' issues are Maintenance, Site Engineering, Supply Chain, and Accounting. MS Excel is being used at THVC as an alternative to fulfil the needs that JDE is not addressing which creates issues of duplication of data and lack of data consistency. If THVC had a solution to manage the knowledge currently in MS Excel, this site would avoid duplication of efforts and deliver more accurate data and value to their processes.

The main challenge with Historian, from the users' point of view, is the accessibility to its data. For this reason, users scored Historian's functionality, usability, adaptability and availability very low (e.g., barely acceptable usability, difficult to change). The areas most affected by the challenges in Historian are Continuous Improvement, Strategic Planning and Supply.

Process and Electrical PLCs present challenges around operability, adaptability, recoverability, usability, accessibility, security and management. These issues make the process of troubleshooting a PLC time consuming and difficult. Replacing a PLC can stop line production, which is not an acceptable outcome. PLCs are essential for process control and monitoring. Both Mill Operations and Maintenance are areas that are heavily affected by the issues in the PLC.

Ultipro Time & Attendance is used by the Accounting area. There are a number of pending business requirements that need attention and, if addressed, would alleviate the User Assessment score of this application, particularly regarding functionality.

File share has also received a non-acceptable rating in the user assessment score due to users experiencing problems assigning access to directories as well as file directory quota and storage's size and performance.

InfoCentre received lower ratings due to its obsolete technology which fails to meet the purpose of this intranet of improving productivity and business collaboration, easily integrating with other office tools, and so on. Metallurgical Accounting uses data repositories that are obsolete, difficult to maintain, access, and improve. Disperse data and obsolete technology makes this a cumbersome process that requires substantial time to execute.

4.4 User IS+T Needs

As discussed earlier, during the Business Disruption Impact Assessment discovery sessions each THVC department was solicited for their top three critical needs. These needs were correlated against the collected information regarding Critical Business Functions (CBTs) and Critical Applications and Technologies (CATs). Table 10 presents a sample of twelve out of forty three needs collected. These needs are presented with their top three associated CBFs and CATs. The full list of ranked needs can be found in Appendix D.

The first three needs that ranked highest in the Operation and Strategic values include: Pebble Crusher Circuit Issues, Chronic PLC issues, and Grinding Circuit Expert System. These needs are related to Mill Operations and are associated with some of the previously identified highest ranked business functions (e.g., Crushing and Conveying, Grinding and Flotation) and Applications and Technologies (e.g., Process & Electrical PLCs, Historian and JKMet).

Addressing these needs would represent automating processes that are essential to THVC and helping increase the resilience in the following business functions: Plant Run Planning, Crushing and Conveying, and Grinding & Flotation process. Addressing these needs would also reduce the gaps in technology and the need for employees on the ground and safety risks associated with production.

The next six needs (ranked four to nine) reflect how critical it is for THVC to improve the technology gaps in the Open Pit Network (identified as a Critical Application and Technology at THVC). These needs have a significant deferral impact and users suggested that a solution to address these needs should be implemented as soon as possible. The implementation of such solution would impact forty one CBFs related to Environment Health Safety & Communities, Geology, Mine Engineering, Maintenance, Mine Operations and Tailings & Water Management departments. These solutions have a high impact on "keeping the lights on," staff efficiency, operational optimization and quality improvement and are, therefore, catalogued as strategic improvements. The improvement of the Open Pit Network will enable THVC to realize more value from Wenco (fleet management), Radios (when they migrate to digital technology), voice communication, GeoExplorer (slope monitoring), instrumentation, monitoring, mine performance management, AcQuire (Geoscientific Information Management), ArcGIS (geographic information system) and Tailings & Water Management remote sensors integration.

Additionally, the improvement of the Open Pit Network will enable the implementation of the shovel weighting system (need gathered during the BDIA) which is critical for getting accurate readings from the weight of every load. This solution would help manage the fill factor on trucks. Without these readings THVC could be over or under while loading the trucks. The dilemma is damage versus not loading enough. This need is a strategic improvement that has a high deferral impact and high impact on operational optimization, cost reduction, and output volume increase.

The next three needs (ranked ten to twelve) are linked to the requirement to access data located in the Mine and Plant applications, essential for the personnel responsible for Mine Planning, Equipment Monitoring, Processing Performance Management, Mine Support Services, and Mine Operations Management. This data can be used to improve decision-making, performance management, reduce energy consumption in the milling process, and increase mineral recovery at the concentrator. Although the deferral impact of addressing these needs is medium, during the interviews the users suggested that a solution should be implemented as soon

as possible. The implementation of such a solution would have a direct impact on sixty three CBFs related to Mine Engineering, Administration, Continuous Improvement and Strategic Planning departments and would enable users to access data hosted in repositories such as Wenco, Computer Aided Earthmoving System, JD Edwards, JKMet, GeoExplorer, Ultipro Human Resources & Payroll, Ultipro Time & Attendance, Acquire, ArcGIS, and so on.

Table 10 THVC User IS+T Needs Assessment

Ranked Index	Dept	Client Observations	Critical Business Functions Impacted				Critical Applications Impacted				Assessment Score	
			Count	Top3			Count	Top3			Operational	Strategic
1	MILO.4	Pebble Crusher Circuitry Issues	23	MILO CP.4 Crushing & Conveying	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.3 Plant Run Planning	6	Process & Electrical PLC	ParcView / Historian + HMI	Telephones + IT Network	3.00	3.00
2	MILO.2	Chronic PLC Issues	9	MILO CP.4 Crushing & Conveying	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.7 Process Infrastructure (except Tailings)	3	Process & Electrical PLC	ParcView / Historian + HMI	Instrumentation, Monitoring & Fiberoptics	2.95	2.71
3	MILO.5	Grinding Circuit Expert System	19	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.3 Plant Run Planning	5	Process & Electrical PLC	ParcView / Historian + HMI	JKMet / MOCMS / Mill Data Central / SQL	2.95	2.71
4	EHSC.2	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
5	GEOL.2	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
6	MENG.1	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
7	MINM.2	Site Wifi Upgrade (Pit)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
8	MINM.3	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
9	MINO.3	Site Wifi Upgrade (Pit)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
10	MENG.5	Engineering Application Integration	11	MINO MI.3 Drilling	MINM MN.11 Equipment Monitoring	MILM MN.11 Equipment Monitoring	10	Wenco	CAES (Computer Aided Earthmoving System)	Leica Drill Nav Plus	2.43	2.14
11	CISP.1	BI Reporting Tool	17	MILO CP.10 Processing Performance Management	MINM MN.11 Equipment Monitoring	MILM MN.11 Equipment Monitoring	4	Telephones + IT Network	InfoCentre + Sharepoint	SiteLine	2.43	2.14
12	CISP.2	Datawarehouse	30	MILO CP.8 Lab	MINO MI.5 Loading	MINO MI.6 Hauling	16	Wenco	CAES (Computer Aided Earthmoving System)	Leica Drill Nav Plus	2.43	2.14

5: Recommendations

As the reader may recall, the key business challenge that this thesis looked to address was how to best meet THVC's IS+T needs with the services provided by Enterprise IS+T to deliver solutions that drive the most value. With this objective in mind, this section outlines practical recommendations to improve the antagonistic perceptions between Enterprise IS+T and THVC and the value obtained for Teck Resources Ltd. as a whole from its IS+T investments.

5.1 Establish a THVC IS+T Steering Committee

It is recommended to form a THVC IS+T Steering Committee with representation from THVC management, IS+T, Continuous Improvement, Strategic Planning as well as key users organized by domain areas (e.g., operational technology). The mandate of this committee would be to approve any new technology changes and develop an IS+T roadmap aligned with THVC's strategic objectives, the mandate and services of Enterprise IS+T, and the input from other relevant strategic enterprise support areas such as Operational Excellence, Human Resources, and so on.

The THVC IS+T Steering Committee would also establish budget boundaries amongst competing requests for technology and support the IS+T Business Unit Lead for Copper in representing THVC's requirements and priorities at the regular meeting of Teck's Information Systems Steering Team (ISST).

From the combined perspectives of Teck's Copper Business Unit, THVC, and IS+T, it is also recommended to identify the IS+T services that should be eliminated, reduced, created and/or increased. Analyzing what should be kept at the Enterprise level, site level, or to be outsourced is a key step towards an optimal Enterprise IS+T delivery model where minimization of the total cost of ownership and maximization of business value delivery can be guaranteed.

5.2 Recommendations from the Business Disruption Impact Assessment

Based on the findings from the Business Disruption Impact Assessment, the technology roadmap developed by the THVC IS+T Steering Committee may address the following technological gaps.

5.2.1 Radio System

The issues with the current analogue radio system make it imperative to focus efforts on building a business case to migrate this system to a Radio Over Internet Protocol (ROIP) system. This technology refresh would help reduce safety risks at the site (e.g., use the radio to call 911), extend the radio coverage, and would address the impact of not having Wenco available. Additionally, the new technology will enable extending the system to places at the site where there is no radio coverage but there is Wi-Fi coverage. Teck's Enterprise IS+T Operational Technology and Infrastructure services have the expertise to help in this regard. Previous experiences like this were undertaken in Teck Carmen de Andacollo and the Teck Coal Business Unit.

5.2.2 Open Pit Network

THVC cannot operate without the Open Pit Network for more than two days, therefore, this is a critical application for "keeping the lights on." The Open Pit Network improvement is currently underway. Once this solution is completed, the site will have a standard network, which will enable THVC to run more applications required on the trucks, loaders, shovels, drillers and geological equipment. Additionally, the improvement of the Open Pit Network will enable to build the telemetry that is required to collect data from the sensors located around the site to monitor tailings, water, and dust. Extending the coverage of the Open Pit Network will also ease the work in areas with potential Copper reserves around the pit. Enterprise IS+T Operational Technology and Infrastructure services are already contributing to this solution.

5.2.3 File Share

File Share is the infrastructure used to host various files, which, based on permissions, users can access for their day-to-day work. From our analysis, THVC cannot afford to lose more than one hour of the information contained in the File Share. Based on the considerable amount of users that rely on File Share, its disruption frequency, and the criticality of the business

functions that it supports, File Share requires attention from Enterprise IS+T. The present technology gap demands an increase of the performance, storage size, and to improve the quota and access management. Enterprise IS+T's Infrastructure Services have the expertise and resources to support THVC with the solution required. Once the solution is implemented, IS+T Help Desk Services would be the appropriate group to provide the ongoing support (e.g. assign quotas, granting user access, managing user space). This is the kind of service that THVC could leverage from Enterprise IS+T in order to focus their Local IT Support Group in matters that are more essential to the site.

5.2.4 Process and Electrical PLCs

Process and Electrical PLCs are used for process control and monitoring of the copper production and contribute to increase plant availability. The main challenge with the PLCs, as communicated by the Mill Technical group during the BDIA and reflected in the User Needs Analysis, is the length of time that is dedicated to troubleshooting them. This is the reason why the Process and Electrical PLCs scored low in the recoverability attribute. In order to improve the speed and ease the process to recover PLCs, it is recommended to evaluate the feasibility of implementing the same solution that Enterprise IS+T developed for Teck Carmen de Andacollo. This solution consisted of implementing a Process Control Laboratory that is used to program, test, and troubleshoot the PLCs without the need to stop the plant. A solution to the issues with the PLCs would address the user needs ranked one and three.

5.2.5 JD Edwards

JD Edwards is the enterprise resource planning (ERP) software used at THVC to support finance, procurement, and maintenance processes. This system is obsolete and is currently not being supported by the vendor. To reduce the negative impact of JD Edwards in operational optimization and staff efficiency, it is recommended to draft a business case to determine the most suitable solution that may include upgrading the current ERP, replacing it altogether, or separating the Maintenance and Procurement modules from JD Edwards. Enterprise IS+T would be a key partner of THVC in this process and Technology Standards & Design as well as Application services would be leveraged.

5.2.6 Historian

Accessibility, functionality, usability and adaptability are the main challenges with Historian. This system functions very well in monitoring and controlling the mineral production process, however, it presents challenges related to the accessibility to its data. Replacing the current Historian is not a recommended action due to the high cost and complexity of such an initiative. However, an alternative—after a proper business case is conducted—would be to place a layer of application on top of Historian that would facilitate data consumption. Enterprise IS+T Operational Technology, Technology Standards & Design, and Infrastructure services could be leveraged here.

5.2.7 Wenco

Even though Wenco only ranked twenty second in the Critical Application and Technology Assessment, this application has a tremendous value for mine operation optimization. Wenco's major challenges are around performance, usability, operability and adaptability. These challenges could be lessened significantly by implementing a test environment where all new functionalities, upgrades, or developments could be tested before moving them into production. Enterprise IS+T Operational Technology and Technology Standards & Design could be leveraged here.

5.2.8 Metallurgical Accounting

Metallurgical Accounting is a key process in evaluating the results of mineral production. This process uses data from obsolete repositories such as JKMet. It is recommended to migrate all the data used in the Metallurgical Accounting process to other, more reliable, data repositories (e.g., MS SQL Server). Next a business case to evaluate alternatives to automatize the entire Metallurgical accounting process would be recommended. Enterprise IS+T Operational Technology, Application Services, and Technology Standards & Design could be leveraged here.

Improving Historian, Wenco, and Metallurgical Accounting would also address User Needs ranked tenth to twelfth.

5.2.9 Ultipro Human Resources & Payroll and Ultipro Time and Attendance

Ultipro Human Resources & Payroll and Ultipro Time & Attendance are used by Human Resources and the Accounting departments. Both systems have room for further value realization and could be integrated with other Human Resources and Administration systems.

5.2.10 InfoCentre

InfoCentre is THVC's intranet, which is built using an obsolete technology. Given the expertise available at the IS+T Enterprise group, replacing it with a more modern technology could be considered. Enterprise IS+T Application and Technology Standards & Design services could be leveraged to address the issues with these CATs.

5.3 Increase Collaboration with Service Provider Alternatives to Enterprise IS+T

As described in section 2.3 of this thesis, there are a number of alternative service providers to Enterprise IS+T. This collection of service providers (e.g., External Vendors, Enterprise Support Groups, On-site IT Support Groups) currently act as "competitors" to Enterprise IS+T in the delivery of services to fulfil THVC's User requirements. By working in close collaboration with these groups, instead of "competing" with them, Enterprise IS+T can harness vendor economies of scale and cost advantages. Such collaboration would also increase the likelihood of successful delivery of the IS+T services described in the IS+T Service Catalogue (see Section 2.1). For this to occur, open and frequent communication is essential for each group to be aware of the capabilities that each other brings to the service delivery process.

5.4 Awareness Campaign and Organizational Change Management

In addition to the recommendation aimed at improving the existing Critical Applications and Technologies at THVC and addressing User Needs, it is recommended to conduct an awareness campaign to better communicate the IS+T services offered by Enterprise at THVC. In other words, Enterprise IS+T needs to improve at articulating its mandate, along with specific focus areas where it can partner with THVC to deliver target business value to Teck Resources Ltd.

Improved awareness would bring visibility to pre-existing Enterprise IS+T solutions that today are not being fully utilized and could be leveraged by THVC and promote efficiencies, synergies, and opportunities for standardization. On the other hand, the Enterprise IS+T team must align with the Site's needs, priorities, timing, and sense of urgency. In this regard, Enterprise IS+T must be conscious of the Site stakeholders' priorities as described in Figure 1.

Also, it is recommended that Organizational Change Management is applied to every project or technology implementation to foster user buy-in and adoption. Change management can also increase trust, communication, and address the antagonistic perceptions described earlier in this thesis (Table 1). At the end of the day, value creation is dependent on people dynamics as there is little value in a technology that no one uses or a process that no one follows. People, however, is a variable that is difficult to manage and even more difficult to understand. Organizational Change Management can be defined as the "application of processes and tools to manage the 'people side' of change" and is an essential contributor to success (Hiatt & Creasey, 2003).

5.5 Reflexive and Deliberate Technology Implementation: Stop Rising Complexity

Traditionally, business gaps in process and people are addressed with the implementation of new technologies, sometimes without having conducted a proper assessment of how those technologies fit the needs of the Site. In this context, the question that is being asked is "What technology can we bring to fix this issue?" This results in the complex landscape (described in the Introduction) of solutions implemented by different groups to address immediate needs in detriment to long term solutions with tangible side-effects for Teck Resources Ltd.

For Enterprise IS+T to deliver value to the business as described by Ferber, Gurgul, and van Overdam, (2013), the introduction of new technology should be a *reflexive* and *deliberate* process driven by results, the people, and must be grounded on business processes. When looking at results, the question that should be considered is "What is the trade-off between addressing an immediate need and potentially sacrificing future value?" When examining the people, the questions should be "Is the company ready to adopt this technology and realize the value of the investment?" and "What is the impact of implementing this technology on people?" In other words, the technology implemented should fit the dynamics and behavior of the people that will be operating and benefiting from this technology. When addressing the business processes, the questions should be "Are the business processes mature enough to support this technology?" "Are there IS+T processes in place to maintain it?" "What is the impact of introducing the new technology in the current IS+T landscape and business processes?"

The reflexive and deliberate IS+T technology introduction will only be introduced once the issue has been clearly identified and there is a solid business case agreed upon by the Site's Management Team.

Note that it would be extremely costly to attempt to reduce the complexity in THVC's technology landscape. As such, the above recommendations are intended to mitigate the risk of additional complexity moving forward.

5.6 Business Disruption Impact Assessment Refresh

Going forward it is recommended that a refresh exercise for the BDIA be conducted on a regular basis to ensure continued alignment and optimization of THVC and Enterprise IS+T service delivery requirements and fulfillment.

6: Limitations

There are a few limitations to this study. First, the results and recommendations discussed here must be validated by THVC's Management Team. Their input is essential in ensuring the validity of this thesis' conclusions and ensuring some of the recommendations are put into practice. In addition, the recommendations of this thesis may only be realized upon budget availability. Second, although the results of the assessment presented here provide a roadmap for Enterprise IS+T to focus its efforts, these results will not be sufficient to resolve the relationship issues and antagonistic perceptions between Enterprise IS+T and THVC. As discussed earlier, change management should be applied to ensure relationships are productive and IS+T initiatives are properly adopted and business value is realized.

Appendices

Appendix A

INVITATION TO PARTICIPANTS OF THE VOICE OF THE CUSTOMER ASSESSMENT

From: THVC's General Manager
To: Workshop Participants

Text

Hello All,

Teck IS+T (Information Services & Technology) will be visiting Highland Valley Copper the week of December 8th, to meet with us to understand our operation's most critical IS+T needs and expectations, and work in collaboration with us to match your requirements to the services IS+T offers. To achieve this goal, IS+T would like to schedule 2-hour sessions with our operational teams (please see list below) to review each team's specific needs.

Actions Required

1) Please agree within your operational team on a 2-hour timeslot between Monday, December 8th to Wednesday, December 10th.
2) Then get one member from your team to email Miller Dussan, no later than December 2nd, with a suggested timeslot. Miller will follow up with a calendar invitation to each member of the team.

HVC's Operational Teams

- Administration: [Names were listed here]
- EHSC: [Names were listed here]
- Human Resources: [Names were listed here]
- Mill Maintenance: [Names were listed here]
- Mill Operation & Mill Technical Support: [Names were listed here]
- Mine Engineering: [Names were listed here]
- Mine Maintenance: [Names were listed here]
- Mine Operations: [Names were listed here]

Please let me know if you have any questions.

Thank you,

[Name]
General Manager
Teck Highland Valley Copper

Appendix B

RANKING OF CRITICAL BUSINESS FUNCTIONS

Critical Business Functions	BIA Overall Rank
MINO MI.2 Mining Preparation	1
MINO MI.5 Loading	2
MINO MI.6 Hauling	3
MINO MI.7 Mining Support Services	4
MILO CP.4 Crushing & Conveying	5
MILO CP.5 Grinding & Flotation (Concentrator)	6
MILO CP.6 De-watering	7
MILO CP.7 Process Infrastructure (except Tailings)	8
MILO CP.3 Plant Run Planning	9
MINO MI.3 Drilling	10
MINO MI.4 Blasting	11
MINO MI.8 Mine Production Control	12
MINM MN.4 Maintenance Dispatch	13
MINO MI.9 Mine Production Statistics & Reporting	14
SUPP SU.6 Receiving	15
MILM MN.4 Maintenance Dispatch	16
SUPP SU.7 Warehouse Operations	17
MINM MN.11 Equipment Monitoring	18
EHSC SH.3 Incidents/Emergency Response	19
SUPP SU.8 Traffic Administration	20
MENG MG.6 Manage Quality/ Flow	21
MILO CP.8 Lab	22
MINM MN.6 Perform Maintenance	23
MINM MN.7 Provide Site Services	24
SUPP SU.5 Purchase Monitoring & Expediting	25
TAWM TW.9 Emergency Response Activities	26
SUPP SU.4 Purchasing	27
MINO MI.1 Mine Operations Management	28
MILO CP.2 Process Engineering	29
MILO CP.10 Processing Performance Management	30

Critical Business Functions	BIA Overall Rank
MILO CP.9 Plant Statistics & Reporting	31
SENG SE.2 Technical Engineering Support	32
MILM MN.11 Equipment Monitoring	33
SUPP SU.11 Material Analysis & Inventory Control	34
MILO CP.1 Processing Planning	35
MENG MG.2 Maintain Geological Model & Reserves	36
SUPP SU.10 Procurement Administration	37
HRES HR.5 Salary & Pay Administration	38
MILO CP.11 Tailings	39
ACCT AC.5 Payroll	40
GEOL EX.3 Field Data Gathering	41
MINM MN.5 Work Order Planning	42
GEOL EX.4 Exploration Drilling	43
SUPP SU.1 Supply Planning	44
TAWM TW.3 Dam Monitoring & Instrumentation	45
EHSC SH.5 Security/Loss Prevention	46
MINM MN.10 Maintenance Testing & Analysis	47
TAWM TW.8 Dam Maintenance	48
MILM MN.6 Perform Maintenance	49
EHSC EV.7 Environmental Issue Resolution	50
EHSC EV.8 Environmental Reporting	51
SUPP SU.2 Supply Set Up	52
MENG MG.8 Mining Performance Assessment	53
MILM MN.7 Provide Site Services	54
MILM MN.10 Maintenance Testing & Analysis	55
MINM MN.3 PM Planning	56
MENG MG.5 Short Range Plan & Schedule	57
MENG MG.7 Drilling & Blasting Planning	58
SENG SE.1 Engineering Services	59
SUPP SU.3 Supply Agreements	60

Critical Business Functions	BIA Overall Rank
ACCT AC.4 Accounts Payable	61
ACCT AC.12 GL Accounting	62
MILM MN.3 PM Planning	63
ACCT AC.11 Cost Accounting	64
MINM MN.15 Maintenance Records Management	65
TAWM TW.5 Water Management	66
TAWM TW.10 LL Dam Management	67
EHSC EV.3 Environmental Testing & Monitoring	68
EHSC SH.6 Incident Investigation	69
MILM MN.2 Equipment Records Management	70
MILM MN.8 Shops & Maintenance Services	71
MINM MN.8 Shops & Maintenance Services	72
GEOL EX.5 Collect & Analyze Samples	73
MILM MN.15 Maintenance Records Management	74
MILM MN.16 Maintenance Performance Management	75
MINM MN.1 Maintenance Management Planning	76
MINM MN.12 Administer Offsite/External Maintenance	77
EHSC SH.7 Safety Monitoring & Assessment	78
ACCT AC.7 Product Inventory Accounting	79
SUPP SU.12 Vendor Relationship Management	80
ACCT AC.1 Prepare Operating Budgets	81
ACCT AC.2 Prepare Capital Budgets	82
HRES HR.6 Benefit Programs	83
MILM MN.1 Maintenance Management Planning	84
MILM MN.5 Work Order Planning	85
MILM MN.9 General Maintenance	86
MILM MN.12 Administer Offsite/External Maintenance	87
MILM MN.13 Manage Maintenance Contracts	88
MINM MN.2 Equipment Records Management	89
EHSC EV.4 Environmental Permits & Approvals	90

Critical Business Functions	BIA Overall Rank
EHSC SH.4 Safety Programs	91
SUPP SU.9 Recycling & Surplus/Material Disposal	92
ACCT AC.6 Sales & Revenue Accounting	93
HRES HR.12 Employee Records Management	94
GEOL MG.2 Maintain Geological Model & Reserves	95
HRES HR.11 Employee Services	96
MINM MN.16 Maintenance Performance Management	97
SENG DV.4 Construction	98
ACCT AC.8 Project Accounting	99
ACCT AC.9 Capital Control	100
ACCT AC.13 Operating Reporting	101
EHSC EV.1 Environmental Compliance Planning	102
HRES HR.4 Recruiting & Placement	103
CISP DV.7 Infrastructure Improvement	104
TAWM TW.1 Main Tailings Storage Facility (TSF) Construction	105
HRES HR.7 Industrial Relations	106
EHSC EV.2 Environmental Impact Assessment	107
EHSC SH.2 Occupational Health Programs	108
MENG MG.4 Budget Plan & Schedule	109
ACCT AC.3 Accounts Receivable	110
ACCT AC.10 Depreciation & Depletion	111
HRES HR.1 HR Planning	112
GEOL EX.2 Exploration Program Management	113
HRES HR.2 HR Policies & Procedures	114
MILM MN.14 Manage Equipment Warranties	115
EHSC EV.5 Reclamation	116
EHSC EV.6 Environmental Research	117
EHSC SH.1 Safety Strategy & Planning	118
MENG MG.1 Engineering Standards	119
SENG DV.2 Conceptual Design	120

Critical Business Functions	BIA Overall Rank
SENG DV.3 Detail Design	121
HRES HR.10 Employee Appraisal & Performance Management	122
CISP DV.1 Development Management	123
CISP DV.3 Detail Design	124
CISP DV.5 Project Services	125
MENG MG.3 Long Range Planning	126
SENG DV.5 Project Services	127
GEOL EX.1 Exploration Planning	128
GEOL EX.6 Exploration Geology	129
HRES HR.3 Organizational Development	130
HRES HR.8 Training & Staff Development	131
MINM MN.9 General Maintenance	132
TAWM TW.2 Remote Dam Inspections	133
CISP DV.2 Conceptual Design	134
CISP DV.4 Construction	135
CISP DV.6 New Mining Area Pre-Production	136
HRES HR.9 Workers Compensation Administration	137
MINM MN.13 Manage Maintenance Contracts	138
MINM MN.14 Manage Equipment Warranties	139
TAWM TW.4 Regulatory & Compliance Management	140
TAWM TW.6 Tailings Project Management	141
TAWM TW.7 Water Management Project Management	142
SENG DV.1 Development Management	143
SENG DV.7 Infrastructure Improvement	144
SENG MG.1 Engineering Standards	145

Appendix C

RANKING OF CRITICAL APPLICATIONS AND TECHNOLOGIES

Critical Applications and Technologies	Overall BIA Rank	App Assessment Score
Radios	1	2.19
Business Network	2	4.10
Open Pit Network	3	2.60
MS Exchange / Email	4	4.60
File Share	5	2.88
JD Edwards	6	2.50
Historian	7	3.53
Process & Electrical PLC	8	2.60
Ultipro Human Resources & Payroll	9	3.03
Computer Aided Earthmoving System	10	3.27
GeoExplorer	11	3.80
Ultipro Time & Attendance	12	2.60
MS Excel	13	3.70
DIRA (Dam Inspection & Recommendations)	14	3.70
Acquire	15	3.30
Leica Drill Nav Plus	16	2.88
JKMet / MOCMS / Mill Data Central / SQL	17	1.50
Geovia/Gemcom	18	2.60
AutoCAD	19	3.61
ArcGIS	20	3.80
InfoCentre + SharePoint	21	2.81
Wenco	22	3.24
PA	23	3.60
WHMIS	24	2.80
Fax Application	25	1.90
Instrumentation, Monitoring & Fiberoptics	26	2.30
SiteLine	27	3.10
DrawDB	28	1.80
MS Project	29	3.40

Appendix D

RANKING OF USER NEEDS

Ranked Index	Dept	Client Observations	Critical Business Functions Impacted				Critical Applications Impacted				Assessment Score	
			Count	Top3			Count	Top3			Operational	Strategic
1	MILO.4	Pebble Crusher Circuitry Issues	23	MILO CP.4 Crushing & Conveying	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.3 Plant Run Planning	6	Process & Electrical PLC	ParcView / Historian + HMI	Telephones + IT Network	3.00	3.00
2	MILO.2	Chronic PLC Issues	9	MILO CP.4 Crushing & Conveying	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.7 Process Infrastructure (except Tailings)	3	Process & Electrical PLC	ParcView / Historian + HMI	Instrumentation, Monitoring & Fiberoptics	2.95	2.71
3	MILO.5	Grinding Circuit Expert System	19	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.3 Plant Run Planning	5	Process & Electrical PLC	ParcView / Historian + HMI	Metallurgical accounting (JKMet / Mill Data Central)	2.95	2.71
4	EHSC.2	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
5	GEOL.2	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
6	MENG.1	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
7	MINM.2	Site Wifi Upgrade (Pit)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
8	MINM.3	Site Wifi Upgrade (Accessibility)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
9	MINO.3	Site Wifi Upgrade (Pit)	41	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.8 Lab	MINO MI.5 Loading	8	Wenco	Telephones + IT Network	Radios / Satellite / Mobile Phones	2.71	2.29
10	MENG.5	Engineering Application Integration	11	MINO MI.3 Drilling	MINM MN.11 Equipment Monitoring	MILM MN.11 Equipment Monitoring	10	Wenco	CAES (Computer Aided Earthmoving System)	Leica Drill Nav Plus	2.43	2.14
11	CISP.1	BI Reporting Tool	17	MILO CP.10 Processing Performance Management	MINM MN.11 Equipment Monitoring	MILM MN.11 Equipment Monitoring	4	Telephones + IT Network	InfoCentre	SiteLine	2.43	2.14
12	CISP.2	Datawarehouse	30	MILO CP.8 Lab	MINO MI.5 Loading	MINO MI.6 Hauling	16	Wenco	CAES (Computer Aided Earthmoving System)	Leica Drill Nav Plus	2.43	2.14

Ranked Index	Dept	Client Observations	Critical Business Functions Impacted				Critical Applications Impacted				Assessment Score	
			Count	Top3			Count	Top3			Operational	Strategic
13	Admin.2	New BI Reporting System	63	MINO MI.5 Loading	MINO MI.6 Hauling	MINO MI.7 Mining Support Services	12	Wenco	InfoCentre	JDE	2.43	2.14
14	TAWM.3	Remote Sensor Integration	39	TAWM TW.9 Emergency Response Activities	MINO MI.2 Mining Preparation	MINO MI.1 Mine Operations Management	4	Telephones + IT Network	Site Network (Open Pit)	Instrumentation, Monitoring & Fiberoptics	2.33	2.00
15	CISP.3	Acquire DB Integration	24	MILO CP.8 Lab	MINO MI.5 Loading	MINO MI.6 Hauling	5	Leica Drill Nav Plus	Telephones + IT Network	Site Network (Open Pit)	2.24	1.76
16	TAWM.1	Voice Communications Upgrade	63	MILO CP.4 Crushing & Conveying	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.6 De-watering	2	Telephones + IT Network	Radios / Satellite / Mobile Phones		2.19	1.48
17	MINO.1	New Shovel Weight System	10	MINO MI.5 Loading	MINO MI.6 Hauling	MINO MI.9 Mine Production Statistics & Reporting	4	Wenco	Telephones + IT Network	Site Network (Open Pit)	2.05	2.62
18	MILO.3	Mine 2 Mill Stockpile Model	12	MILO CP.4 Crushing & Conveying	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.7 Process Infrastructure (except Tailings)	8	Wenco	Leica Drill Nav Plus	Process & Electrical PLC	2.05	2.62
19	MENG.3	HVC Wenco Test Environment	8	MINO MI.3 Drilling	MINO MI.8 Mine Production Control	MINO MI.1 Mine Operations Management	5	Wenco	Leica Drill Nav Plus	Telephones + IT Network	2.05	1.48
20	GEOL.1	Data Storage Expansion	41	MENG MG.6 Manage Quality/ Flow	EHSC SH.3 Incidents/Emergency Response	GEOL EX.3 Field Data Gathering	6	MS File Share	InfoCentre	GeoExplorer	2.00	1.67
21	MILO.1	Additional Citect Staff	5	MILO CP.4 Crushing & Conveying	MILO CP.7 Process Infrastructure (except Tailings)	MILO CP.2 Process Engineering	3	Process & Electrical PLC	ParcView / Historian + HMI	Instrumentation, Monitoring & Fiberoptics	2.00	1.43
22	TAWM.2	Fibreoptic Network / Alarms	42	MINM MN.4 Maintenance Dispatch	TAWM TW.9 Emergency Response Activities	MINO MI.1 Mine Operations Management	5	Telephones + IT Network	Radios / Satellite / Mobile Phones	Instrumentation, Monitoring & Fiberoptics	1.95	1.62
23	PROJ.3	ERP Integration	5	GEOL EX.4 Exploration Drilling	GEOL EX.2 Exploration Program Management	SENG DV.5 Project Services	5	JDE	AutoCAD	DrawDB	1.95	1.38
24	PROJ.1	Drawings DB Upgrade	58	MILO CP.7 Process Infrastructure (except Tailings)	TAWM TW.9 Emergency Response Activities	MINO MI.7 Mining Support Services	6	Telephones + IT Network	Site Network (Open Pit)	AutoCAD	1.95	1.38

Ranked Index	Dept	Client Observations	Critical Business Functions Impacted				Critical Applications Impacted				Assessment Score	
			Count	Top3			Count	Top3			Operational	Strategic
25	PROJ.2	Drawings Versioning/Archiving	59	MILO CP.7 Process Infrastructure (except Tailings)	TAWM TW.9 Emergency Response Activities	MINO MI.7 Mining Support Services	7	Telephones + IT Network	InfoCentre	Site Network (Open Pit)	1.95	1.38
26	EHSC.3	Data Storage Expansion	70	MINO MI.5 Loading	MINO MI.6 Hauling	TAWM TW.9 Emergency Response Activities	6	MS File Share	InfoCentre	GeoExplorer	1.95	1.38
27	MILM.1	JDE Maintelligence Integration	32	MILO CP.3 Plant Run Planning	MINM MN.4 Maintenance Dispatch	MILO CP.10 Processing Performance Management	2	Telephones + IT Network	JDE		1.90	1.57
28	MINM.1	JDE Support & Stability	31	MINO MI.1 Mine Operations Management	MINM MN.11 Equipment Monitoring	SUPP SU.6 Receiving	3	Wenco	Telephones + IT Network	JDE	1.90	1.33
29	MILM.2	JDE Training	43	MINM MN.4 Maintenance Dispatch	MILO CP.10 Processing Performance Management	MINM MN.6 Perform Maintenance	5	MS File Share	InfoCentre	JDE	1.90	1.33
30	Admin.4	JDE & Sharepoint Training	57	MILO CP.10 Processing Performance Management	MINM MN.6 Perform Maintenance	SUPP SU.6 Receiving	6	Wenco	MS File Share	InfoCentre	1.90	1.33
31	Admin.1	New ERP System	113	MILO CP.4 Crushing & Conveying	MILO CP.5 Grinding & Flotation (Concentrator)	MILO CP.6 De-watering	9	Wenco	Telephones + IT Network	InfoCentre	1.90	1.33
32	MENG.2	New SRSS Server	9	MINO MI.3 Drilling	MINO MI.8 Mine Production Control	MINO MI.1 Mine Operations Management	5	Wenco	Telephones + IT Network	MS File Share	1.71	1.29
33	MENG.4	Geotechnical Sharepoint Site	27	MINO MI.3 Drilling	MILO CP.2 Process Engineering	MILO CP.11 Tailings	3	InfoCentre	Acquire	ArcGIS	1.71	1.29
34	MINO.2	Application Exploitation	7	MINO MI.5 Loading	MINO MI.6 Hauling	MINO MI.3 Drilling	3	Wenco	CAES (Computer Aided Earthmoving System)	Leica Drill Nav Plus	1.67	1.48
35	EHSC.1	Unified Safety Reporting	42	TAWM TW.9 Emergency Response Activities	MINO MI.1 Mine Operations Management	MINM MN.6 Perform Maintenance	6	MS File Share	InfoCentre	SiteLine	1.67	1.24
36	MINO.4	Access Control Upgrade	3	EHSC SH.5 Security/Loss Prevention	EHSC SH.4 Safety Programs	EHSC SH.1 Safety Stategy & Planning	4	PA	Telephones + IT Network	Site Network (Open Pit)	1.57	1.29

Ranked Index	Dept	Client Observations	Critical Business Functions Impacted				Critical Applications Impacted				Assessment Score	
			Count	Top3			Count	Top3			Operational	Strategic
37	Admin.3	New Barcoding System	8	MILO CP.8 Lab	SUPP SU.6 Receiving	SUPP SU.7 Warehouse Operations	2	Telephones + IT Network	JDE		1.43	1.14
38	MILM.3	Scheduling & KPI Reporting	30	MILO CP.3 Plant Run Planning	MINM MN.4 Maintenance Dispatch	MINO MI.2 Mining Preparation	4	Telephones + IT Network	MS File Share	JDE	1.43	1.14
39	HR.1	Fix Ultipro Useability Issues	15	MILO CP.1 Processing Planning	HRES HR.5 Salary & Pay Administration	MINM MN.5 Work Order Planning	4	Telephones + IT Network	Ultipro	MS Excel	1.38	1.10
40	GEOL.3	Workstation Admin Rights	2	GEOL EX.2 Exploration Program Management	MENG MG.3 Long Range Planning		1	Geovia/Gemcom			1.19	1.05
41	Admin.5	Workstation Replacements	2	HRES HR.4 Recruiting & Placement	MENG MG.3 Long Range Planning		3	Metallurgical accounting (JKMet / Mill Data Central)	Ultipro	MS Excel	1.19	1.05
42	HR.2	Ultipro Integration	18	MINO MI.2 Mining Preparation	MINO MI.1 Mine Operations Management	MILO CP.1 Processing Planning	4	JDE	Ultipro	UTA	1.19	1.05
43	HR.3	Expand Ultipro Utilization	22	TAWM TW.9 Emergency Response Activities	MINO MI.2 Mining Preparation	MINO MI.1 Mine Operations Management	5	InfoCentre	SiteLine	Ultipro	1.19	1.05

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