



INDUSTRIAL CLUSTERS AND THE COLUMBIA BASIN – BOUNDARY REGION

A MINING AND METALLURGY SECTOR CASE STUDY

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The Columbia Basin Rural Development Institute, at Selkirk College, is a regional research centre with a mandate to support informed decision-making by Columbia Basin-Boundary communities through the provision of information, applied research and related outreach and extension support. Visit www.cbrdi.ca for more information.

EXECUTIVE SUMMARY

Interest in industrial “clusters” has grown under the realization that productivity and innovation seem to blossom in an environment where multiple interests operating within the same sector are arranged in a geographically condensed area. Promotion of industrial clustering has resulted in productivity booms and general improvements in economic conditions for the hosts. Prominent examples of strong clusters include: California’s Silicon Valley, the Swiss banking system, and the Japanese electronics cluster.

Starting with an understanding that productivity improvements are the driving force of economic development, the main drivers of productivity gains are: the quantity and quality of human resources, the quantity and quality of capital, and innovation and technological advance. Clusters, unsurprisingly given the clear linkage between Porter’s Diamond conditions and labour/capital/technology, are linked to high levels of innovation, productivity growth and profit. For these reasons, clusters have been identified as enviable engines of general economic growth for the host regions.

Canada leads mining investments in North and Central America, and receives 16% of global mining investments. Estimates of BC investment in exploration and mine development show \$2.2B being spent in the 2012/13 fiscal year. It is not surprising that British Columbia is home to the world’s highest concentration of exploration and mining companies. Both Toronto and Vancouver have developed financial expertise specific to the mining industry, and, Sudbury has become known as the mining superstore. Mining and mineral processing are alive and thriving in Canada.

The Basin-Boundary region has been recognized as a “cluster” by the Mining Association of Canada. The Basin-Boundary region’s Mining and Metallurgical sector constitutes a high concentration of activity and a significant component of the region’s economy. The “Diamond Conditions” affecting the Mining and Metallurgical sector in the Basin-Boundary region are weakly favourable. It is recommended that the regional interests pursue policies to strengthen these conditions and leverage the region’s advantages where possible.

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INTRODUCTION

The Twentieth Century provided the world with fascinating insights into economic development and growth patterns. Productivity improvements have long been identified as the principle source of economic growth, improvements in standard of living and increased wages (Smith 1776, Lucas 1988, Romer 1986, 1990, Nelson 1981). Post-war North America saw an unprecedented economic boom. The WWII industrial investment efforts translated to a position of economic dominance. As most nations rebuilt shattered infrastructure and capital stocks, North America enjoyed the productivity boom created by their investments in the absence of the monumental destruction experienced in Europe and Asia. As the rest of the world has rebuilt its capital stock and infrastructure around a new technology-driven industrial paradigm, the dominance of the western economic performance has steadily eroded (Monroy 2000). Lagging North American productivity is often attributed to under-investment in our capital stock and insufficient innovation.

Canadian productivity has been found to lag behind many of our Organization for Economic Cooperation and Development (OECD) counterparts. From 2001 to 2009, Canadian productivity grew at 0.7% compared to 1.9% in the US and over 4% in Korea (OECD 2010, OECD StatExtracts, Labour Productivity Growth). Within Canada, British Columbia lags behind the Canadian average (Deloitte 2010). In fact, British Columbia ranks 7th of the 10 Canadian provinces in productivity growth.

Interest in industrial “clusters” has grown under the realization that productivity and innovation seem to blossom in an environment where multiple interests operating within the same sector are arranged in a geographically condensed area. Promotion of industrial clustering has resulted in productivity booms and general improvements in economic conditions for the hosts. Prominent examples of strong clusters include: California’s Silicon Valley, the Swiss banking system, and the Japanese electronics cluster (Porter, 1990).

The Columbia Basin Rural Development Institute (RDI), together with the Lower Columbia Community Development Team Society (LCCDTS) Metallurgical Committee¹ commissioned this literature review / case study. The purpose of this paper is to summarize the pertinent industrial cluster literature and to consider the “cluster” conditions as they apply to the Mining and Metallurgy sector in the Columbia Basin-Boundary region.

The remainder of this paper includes: an overview of economic and management literature focused on industrial clustering, a snapshot of the Canadian, British Columbia and Basin-Boundary Mining and Metals sectors, an analysis of the “cluster conditions” impacting the sector, and concludes with recommendations and considerations for future work.

¹ LCCDTS Metallurgical Committee membership currently includes: Teck Trail Operations, Retrieve Technologies, Valhalla Technologies, Columbia Basin Trust, the National Research Council of Canada (NRC), Community Futures Central Kootenay (CFCK), the Kootenay Association for Science and Technology (KAST), the RDI and Selkirk College

CLUSTER THEORY OVERVIEW

The word “cluster”, in economic and management discussions, commonly refers to a geographic concentration of related businesses. The term was propelled into business discussions in the early 1990s, by Michael Porter. Porter’s influential book, *The Competitive Advantage of Nations* (1998), offers a framework to explain some of the forces that drive industrial concentration, and to understand the source of advantage.

ECONOMIC THEORY

Adam Smith introduced the world to economics, with the *Wealth of Nations* (1776). In his seminal tome, Smith discusses specialization and the concept of comparative advantage. Two parties can gain by trading if each specializes in the production of the good or service that they are relatively better at producing. This idea applies, equally, to individuals and to nations. These writings began to shed light on international trade patterns that could be observed in the world.

David Ricardo elaborated on the concept of specialization and wrote on the *Law of Competitive Advantage* as an extension of Smith’s treatment of international trade patterns (1817). Alfred Marshall, in the *Principles of Economics* (1920), introduced observations on the elevated productivity growth in industrial districts. In 1933, the Heckscher-Ohlin model introduced resource (labour/capital) endowments to explain differences in costs of production and hence patterns of trade specialization and concentration. While the earlier theories explained that trade patterns would emerge, the Heckscher-Ohlin model made the first contribution to understanding the determinants of locating certain industries.

New Trade Theory began to explain intra-industry trade through the works of Paul Krugman (1986). Krugman, using economic models that allowed flexibility of the competitive structure², introduced economies of scale, and the dynamics of their development, to this body of theory. Allowing imperfect competition, or oligopoly market concentration, allowed Krugman to explain the existence of firm dominance and the emergence of economies of scale. Economies of scale were used to account for non-resource endowment factors in explaining trade patterns. However, these explanations still offer little insight into the factors that lead to the *location* of those economies of scale.

The early contributions established a framework to explain trade specialization and inter-industry trade patterns (Canada exporting softwood lumber, or France exporting wine), based on differences in opportunity cost, but did not offer any predictions concerning the location of specialization for intra-industry trade (Indian phone centres servicing parent companies in North America, or Canada and the US trading auto parts back and forth). New trade theory offered a framework that explained the emergence of industrial leaders, intra-industry trade and economies of scale. However, the framework fails to explain the external conditions that permit economies of scale to emerge.

² Trade theorists had typically adopted an assumption of perfectly competitive markets. This is a simplifying assumption that allows economists to build coherent models, but fails to take into consideration alternative (and more typical) market structures.

BUSINESS / MANAGEMENT THEORY (THE COMPETITIVE ENVIRONMENT)

While these developments in economic theory make strides toward understanding general patterns of trade, they offer little insight on the dynamics of cluster formation. Economic theory attributed the location of industrial concentration, or clustering, to chance or government intervention.

In *The Competitive Advantage of Nations*, Porter (1998) established a framework for better understanding both the microeconomic conditions that promote economies of scale, scope and industrial networks, and how these factors contribute to extraordinary growth rates for cluster members. Porter observed that “clusters” demonstrate high levels of innovation and productivity growth, resulting from constant investment in human resources, capital, and innovative technologies. His book elaborates on both the source of these advantages and the nature of the benefits.

Productivity is typically measured as the value of production per unit of input. Regions³ that focus their economic activities on value-added, technologically innovative activities typically realize productivity growth. It is this productivity growth that will improve wages and the living standards of its citizens, while those regions that import sophisticated activities while focusing on low-skill, low-value activities, will experience a long-term erosion of economic prosperity (Porter 1998).

Starting with an understanding that productivity improvements are the driving force of economic development, the main drivers of productivity gains are: the quantity and quality of human resources, the quantity and quality of capital, and innovation and technological advance. Clusters, unsurprisingly given the clear linkage between Diamond conditions and labour/capital/technology, are linked to high levels of innovation, productivity growth and profit. For these reasons, clusters have been identified as enviable engines of general economic growth for the host regions (Porter 2000).

THE DIAMOND MODEL

The Diamond derives its name from the four general corners (the points of the diamond) that create the dynamic microeconomic conditions under which “clusters” will or will not form. The four corners are: 1) Factor Conditions, 2) Demand Conditions, 3) Related and Supporting Industries, and 4) Firm Strategy, Structure & Rivalry. This list has been appended with: 5) Government, and 6) Chance, in as far as both government regulation and chance factor into the dynamic development of the other four conditions. The four points, which represent sources of competitive advantage, are location specific.

Factor Input Conditions

What is it?

Factor inputs refer to: natural resources, human resources, capital resources, physical infrastructure, administrative infrastructure, information infrastructure, and scientific and technological infrastructure.

³ “Regions” can be defined as: countries, provinces, states etc. The concept of a region is conceptually constrained by an area with similar activities and conditions, not necessarily by borders.

Despite the high degree of labour and capital mobility today, in reality highly specialized resources may not be readily available in every location. Resources are sub-classified as *basic* (unskilled labour, raw materials and rudimentary equipment) and *advanced* (skilled labour, innovative equipment and systems). Advanced factor conditions generally require constant reinvestment and innovation. This is particularly true in labour markets, which are strongly linked to education infrastructure.

Why is it important?

Sources of competitive advantage may spring from the existence of plentiful basic resource endowments. For instance, Canada has abundant natural resources so accessing them is relatively inexpensive. Alternatively, competitive advantage may arise by developing advanced factor conditions. For example, the high (per capita) number of engineers and technically advanced science graduates in Japan gives Japan's high-tech sector ready access to innovative employees.

Readily available advanced resources, a large, skilled labour pool and easy access to cutting-edge equipment can improve the competitive position of a firm. These factor conditions improve the competitive position by, for instance, lowering search times to match specific skills/equipment with production needs, providing easy access to equipment service, or financial experts that understand the sector. Innovative products and services tend to provide customers with higher value attributes than those created through cheap basic factors.

Advantages stemming from advanced factor conditions tend to be sustainable and of greater significance. Advanced factor conditions require commitment and continual investment to maintain. This comes with greater uncertainty and a need for vision. Industries that take their advantage from cheap and abundant basic factors face greater difficulty maintaining those advantages. Development of advanced factors elsewhere can usually overshadow any advantage enjoyed from basic factors. Clearly, having solid basic and advanced conditions is optimal.

How is it promoted?

Government can reduce or eliminate regulatory barriers, improve infrastructure, or even offer incentives to firms that encourage investment. Wise policy encourages investment in both human and physical capital. Public support for education will also improve the labour market conditions.

Ultimately, firms must adopt a mindset that recognizes and values investment. These strategies are long-term in nature. Developing sophisticated planning capacity can help reduce investment risk.

Regarding the labour pool, there is a considerable (and growing) body of evidence that indicates that the social and environmental conditions under which labourers live play a significant role in promoting labour productivity (Porter 1990, Nelson 1981, Sabatini 2006). It is becoming impossible to separate social and environmental conditions from the factors that impact productivity growth. All stakeholders should recognize this and protect and enhance social and environmental conditions.

Demand Conditions

What is it?

Demand conditions refer to the Diamond conditions existing in client markets. Specifically, the demand conditions consider the level of sophistication, competition and proximity of clients as this pertains to the relationships enjoyed by members of the focus market.

Why is it important?

Transaction costs refer to any costs (transportation, translation, red-tape, negotiations etc.) incurred in the course of making a trade. Proximity of clients minimizes transportation costs. However, the other non-monetary costs (negotiations on terms of trade, search times, and performing non-core duties etc.) will also be lowered. Proximity allows for more frequent meeting and the development of less formal relationships, for instance. Informal working relationships with clients can speed up negotiations and search times and reduce administrative costs. Any reduction in transaction costs will improve the competitive position of a firm.

Conditions in a firm's local product market likewise influence their drive to innovate. Sophisticated and demanding local customers, those customers whose needs can be used to anticipate customer needs elsewhere, can provide an invaluable incentive to get ahead of the innovation curve. Ideally, extraordinarily sophisticated local demand in specialized segments of the market can be translated to global market trends. In other words, the local clients are setting the bar for innovation in their markets; thus, setting global trends and growing the client market for the cluster.

Strategic collaborations are also a possibility with clients. New product development, processing or joint production may stem from strong inter-industrial relationships. Collaboration is more likely within sophisticated firms, and between firms that enjoy strong informal network relationships.

How is it promoted?

Firms may choose to play an active role in their client markets. This may include: encouraging clients to break into new markets of their own, collaborating with clients on products, services or systems that help them develop, or encouraging new clients to relocate into their sphere of influence.

Governments may, again, examine policy with respect to the incentives and barriers facing those downstream industries.

Related & Supporting Industries

What is it?

Conceptually analogous to Demand Conditions, the conditions in the up-stream industries affect performance of the entire cluster. The presence of sophisticated, locally-based suppliers and of competitive related industries is of enormous importance to the health of a business through reducing transaction costs and facilitating technological innovation.

Why is it important?

The transaction cost argument (from Demand Conditions) is virtually identical for Related and Supporting Industries. The collaboration and innovation arguments are likewise similar.

Competitive market places are a breeding ground for innovation; innovation is a hallmark of competition. Cluster members may collaborate with suppliers on innovation (such as product design / customization, system or service improvements) or influence suppliers' innovative focus if strong working relationships exist. Higher quality, customized input products/services, produced by up-stream suppliers that strive for innovation, will contribute to lowering production costs and/or improving the quality of the final product for cluster members.

How is it promoted?

Firms may choose to play an active role in their supply markets. This may include: collaborating with suppliers on products, services or systems, or encouraging new suppliers to relocate into their sphere of influence. This may take the form of seeding spin-off companies or offering purchase agreements.

Governments may, again, examine policy with respect to the incentives and barriers facing those downstream industries.

Firm Strategy & Rivalry

What is it?

Firm strategy refers to the lens through which businesses view themselves and how that shapes their actions. Firms may see themselves as market leaders (or innovators) or as market followers. Firms may see themselves participating in the global economy or in a more localized market. Strategies and actions are derived through these lenses and will be quite different depending on the view firms take.

Rivalry refers to the level of competition in the firm's market. Many competitors, who have largely eliminated price competition, are hallmarks of a highly rivalrous market. Few competitors, who do not bother to price compete, are hallmarks of a non-competitive market.

Why is it important?

The level of competition, or rivalry, a firm faces greatly influences the firm's drive to innovate. The more competitive the marketplace, the greater the gains to be made from innovation in technology, products or processes (Lipsey & Ragan 2010, Porter 1990). Competition forces firms to perform at the top of their game. With little competition, there is little motivation to improve upon the status quo. Lack of competition allows firms to rest on their laurels. In this context, competition encourages appropriate forms of investment and sustained upgrading.

Highly competitive market places tend to work through price competition first and to force competitors to offer lowest possible prices. This means that there is usually little room left for price competition in highly competitive markets. Furthermore, all firms likely enjoy the same access to factor resources.

If profit margins eliminate the ability to price compete, a firm must develop a production technology that lowers costs, or develop new products/services where no competition exists. New technologies open the profit margin until competitors catch up. New product markets will allow firms to charge a premium until they are imitated. This is a well-established

characteristic of competitive marketplaces (Lipsey & Ragan, 2010). Competitive pressures breed innovation which, if successful, improves productivity.

Furthermore, the strategy of the firm plays an important role in generating benefits. Firms may operate with a regional or international frame of reference. The same firms may position themselves in different roles within the sectoral economy (market leader, market innovator, niche market service provider, etc.). Strategic positions can influence the existence of innovations (if the firm positions itself as a market leader) of the location of those innovations. If the firm is positioned in the global market, it may strategically move portions of its operations to take best advantage of local conditions. In other words, it may focus its R&D / innovation in one region that has solid advanced factor market conditions, and move its more mundane operations to a region with cheaper basic factors.

Finally, a concentrated local market may open opportunities for strategic alliances between cluster members. In rural communities, business clusters can be a powerful way to mitigate high costs associated with relative isolation (Porter 2004). Implicit transaction costs, such as search time or negotiations, can be reduced through participation in a less formal network. These networks develop more readily and rapidly amongst participants that are close.

How is it promoted?

Internally, firms may engage in strategic planning, skills training at the management and executive level. Outwardly, firms may encourage competitors to locate within their region, or encourage the development of spin-off companies. Ultimately, adoption of long-term strategies and a progressive mindset are required for sophisticated engagement and cluster development.

CRITICISMS OF THE DIAMOND MODEL

There have been a number of criticisms of Porter's model. Criticisms have focused on two principle themes: its validity as a workable quantitative model (mainly stemming from economists), and the interpretation and application of assumptions regarding jurisdictions and geographic regions (mainly stemming from the management and administration field).

Economists have criticized Porter's Diamond for a lack of supporting empirical research. Porter's treatment of the Diamond makes few distinctions between theories, facts and conjecture (Waverman 1995: 70). The model, as such, does not offer much in terms of predicative power and suffers from typical partial-equilibrium modelling issues⁴

Management theorists bristle at the limited scope of the model. Failing to consider the impacts of trading partners' diamond conditions is short-sighted given the level of international integration in

⁴ Economic theory typically engages in two types of market equilibrium analysis: partial equilibrium and general equilibrium. Partial equilibrium analysis is based on a restricted set of data (i.e. the price of a single product), while all other factors are assumed constant. General equilibrium analysis models interdependence between all factors. It is typical that results from partial equilibrium analytical models do not perfectly agree with general equilibrium analytical models (because they do not allow for adjustment in related markets), but they are still commonly used for their simplicity and ability to analyse specific phenomena.

today's global economy. It is unrealistic to believe that international conditions are of no consequence. However, Porter's Diamond model can be, and has been, modified to reflect evolving theories.

Modification of the Diamond Model

Rugman (1990) modified Porter's Diamond by considering the Diamond conditions in the major trading partner. While still relevant, international borders are playing a smaller and smaller role in locating production facilities. Business is commonly conducted between companies and overseas clients. Many companies operate facilities in more than one country while moving product from one to be used as an input in the other. This modern-day fact forces us to accept that the Diamond conditions in close trading partners have an impact on competitiveness.

BENEFITS GENERATED BY CLUSTERS (AND STRONG DIAMOND CONDITIONS)

Starting with an understanding that productivity improvements are the driving force of economic development, the main drivers of productivity gains are: the quantity and quality of human resources, the quantity and quality of capital, and innovation and technological advance. Clusters, unsurprisingly given the clear linkage between Diamond conditions and labour/capital/technology, are linked to high levels of innovation, productivity growth and profit. For these reasons, clusters have been identified as enviable engines of general economic growth for the host regions (Porter 2000).

Specifically, clusters tend to generate tight networks. These networks are evident between firms (both competitors and trading partners) and between employees. Firms, through collaboration, information sharing, resource sharing and mapping, and collectively attracting a pool of highly-qualified labour, enjoy accelerated productivity improvements. Their transaction costs are lowered, allowing for increased focus on core activities and innovation. And, these networks of communication likewise accelerate the innovative process by increasing the number of creative and innovative participants sharing ideas.

Employee networks are equally important, if often less formal. Increasing the concentration and sheer numbers of people with like education, training, and experiences naturally leads to the establishment of informal networks of communication. This support network transmits information on job opportunities, for those searching, and discussions of interesting technical issues, for those innovating. In both cases, firms benefit from the strength of their employees' networks, with results leading to greater innovation and productivity gains.

Development of collaborative partnerships is another characteristic of clusters and of industrial concentrations. Collaborations may also be seen as an extension of solid networks. Collaborations may lead to new products, processes, or systems or they may lead to the development of new markets, or even to joint production (innovation in management structure). In some instances, collaboration has led to the development of formal research centres.

THE IMPORTANCE OF RESEARCH AND DEVELOPMENT

The role of innovation in improving productivity is the most difficult to understand. Research and development (R&D) is undertaken to develop new products, new capital, new processes and new techniques. In a rural context, innovation may also be focused on gaining economies of scale. While there is widespread agreement that R&D is critical to technological improvement (Solow 1957, Griliches 1979), attributing a direct result or quantifying the impacts on productivity is difficult to accomplish for a number of reasons.

Returns from R&D are uncertain. There is no acknowledged guarantee that engaging in R&D will create financial returns for the firm. The options that are open to a researcher are vague by nature. Knowing, or feeling remotely certain, that the choices made will turn out to be the correct one is virtually impossible. Coupled with the risk that a competitor will make "the discovery" first, the concrete benefits of engaging in R&D are highly uncertain.

Innovation and R&D contribute spillover effects to other stakeholders as well. New processes and new products become publicly observable once developed (Griliches 1979). So, the profits, while

accruing principally to the innovators, are quickly sought by imitators. The extent of spillover effects will depend on the concentration of competitors and the publicity generated around the innovation. Because these spillover effects originate outside of the control of the affected firm, it is virtually impossible to quantify the relationship.

Collaboration, then, makes perfect sense. All of the beneficiaries of technology, and its spill-over, contribute to the R&D efforts. Risks associated with R&D efforts are shared. Collaboration also leverages the R&D budgets of stakeholders that might be individually too small to accomplish major breakthroughs. Many “clusters” are host to highly developed research centres; some are supported by post-secondary or government backing, others are entirely industry supported.

DEVELOPMENT OF A CLUSTER

Regional strengths develop over time. A region will have natural strengths and natural weaknesses. These natural strengths and weaknesses will evolve. Left to their own, they will develop in an unmanaged manner. While this may work out by good fortune, a region may greatly improve the chances of favourable conditions emerging by managing their development path.

Diamond conditions include basic factors (which tend to develop through natural endowments) and advanced factors (which tend to be encouraged, or built by design and conscious effort). Evidence suggests that the advanced Diamond conditions lead to higher growth rates and more sustained competitive advantage. Understanding the dynamics of the relationships between the Diamond conditions, and accepting that advanced conditions must be actively created, permits regional stakeholders to wrest some level of control over their development path.

GOVERNMENT / PUBLIC INFRASTRUCTURE

We can start by discussing the role of public investment in infrastructure. Infrastructure includes the education system to the transportation system, from stabilizing banking regulations to the government's administrative infrastructure. While these factors are outside of the control of a sub-region, such as the Basin-Boundary region, they do lay the foundation for all other Diamond conditions. Our interests, then, are well-served by encouraging our public service to continually invest, set high performance standards, and administer in as efficient a manner as possible.

STRONG FACTOR CONDITIONS

In developing strong, or advanced Factor Conditions, Firm Strategy & Rivalry creates strong incentives. An active and competitive market can trigger the development of post-secondary programs focused on the industry in question, either by sector investment or through institutional responses to market conditions. Observable competitive markets may attract increased public investment in training or research centres. If the industry is perceived as prestigious or important, interest in focused skills development and public spending will be more rapidly grown.

Industry, then, has a strong incentive to organize through formal or informal networks. The collective voices of a strong network are more likely to attract the attention of policy makers. Similarly, a motivated industrial cluster may invest hard funds, themselves, in the development of formal training programs serving their membership. Acting collectively may greatly defray these costs.

Conditions in the Related & Supporting Industries also influence the development of Factor Conditions. Strong Diamond conditions in Related and Supporting Industries stimulate Factor Conditions specific to their sector. There are usually transferrable skills developed between related industries. Understanding this, stakeholders (both industrial and policy-makers) may actively encourage both competitors and supporting industries to locate within the cluster.

Demand Conditions can also accelerate the development of advanced Factor Conditions. Sophisticated local demand will tend to draw both social and private investment into the development of advanced factor conditions. Advanced and specialized factors tend to gravitate naturally and quickly to observable local needs. Again, stakeholders should remain aware of these conditions and actively encourage development.

STRONG DEMAND CONDITIONS

Evidence suggests that competition for the business of local (or regional) buyers can hasten the sophistication of those local clients (Porter 1998). Aggressive pricing, in an effort to win local business, creates favourable input pricing conditions for the local Demand (downstream) market, thus building their overall performance. Likewise, the introduction of innovative products or new technologies that occur in the local market before showing up in foreign downstream markets can help the profits in the local downstream market.

Actions by cluster members can actually stimulate demand in the local downstream market, both in terms of quantity and in raising the level of sophistication in that client market. Fostering or facilitating these developments in the local downstream market may also attract business from that sector's international competitors.

Cluster members have a strong incentive to innovate to provide their clients with the greatest competitive advantage possible. Similarly, cluster members have a strong incentive to enter into innovative collaborations for the same reasons. Innovations (and for that matter, a vibrant labour pool of highly-qualified people) may also have spill-over effects, even when focused on the host cluster market.

Local firms can encourage the development of high-quality, highly specialized labour by working with post-secondary institutions (to build skills development), with municipal and regional governments (to leverage efficient local infrastructure) and directly with their suppliers.

STRONG RELATED & SUPPORTING INDUSTRY CONDITIONS

While there is little a firm can do to influence the location of their existing suppliers, they can be supportive of new providers in the region. There may be growing pains, but developing competent local suppliers of inputs and services could easily pay off many times over. And, businesses could help develop ties between their suppliers and other regional competitors. This may help build the regional importance to their suppliers.

Strong firm rivalry in the host-cluster market will, again (like the discussion for Strong Demand Conditions), stimulate the development of strong conditions in the upstream, or supporting and related industries. Strong competition will encourage sophistication, innovation and creativity in the upstream market. The potential to build business with a sophisticated group of competitors will stimulate innovation upstream.

STRONG FIRM STRATEGY & RIVALRY

Each of the other Diamond Conditions will have an impact on Firm Strategy & Rivalry. Encouraging competition, facilitating new entrants, and prompting technological advances, the other Diamond Conditions can stimulate development of both rivalry and sophisticated strategy.

Factor conditions may influence the development of Firm Strategy & Rivalry primarily by stimulating spin-offs. One of the hallmarks of strong Factor conditions is the existence of post-secondary or industry-funded research centres.

Cluster development opens the doors to complementary economies. Buying power is greater in numbers. There are opportunities for shared marketing campaigns, and customers enjoy a wider

range of complementary products that enhance their experience. There has been a strong correlation found between the strength of clusters and regional growth and development (Porter 2000). Clusters reduce the costs of finding specialized built capital and human capital. Clusters facilitate collaborative enterprise and innovation. Anything the business community can do to foster cluster development will be well worth the efforts.

NETWORK CONSIDERATIONS

Networks play a prominent role in clusters. Networks are a dynamic environment. Each network will develop its own hierarchical structure with a unique level of organization that is created by its membership. Each network will form its own level of commitment and cooperation according to the needs and abilities of its members. Cluster networks develop in two important directions: intra-industry (with competitors), and inter-industry (upstream and downstream stakeholders). Cluster networks tend to foster both strategic and technological collaborations in both inter and intra-industry arenas.

Strategic collaborations may take the form of pooling resources on contracts or projects that would be out of collaborators' individual capacities, supporting education programs or trade organizations, for instance. These types of collaborations could be formed between competitors or related industries. Regardless of who participates, the opportunities for collaboration are greatly increased by stronger networks.

Technological collaboration may focus on new product design, product improvement, new machinery or equipment development, or system redesign, for instance. One might expect inter-industry technological partnerships to be generally focused on improving capital or processes, and intra-industry partnerships to be focused on improving the quality of output (either from upstream producers, or to cluster clients).

The value of cluster networks is augmented by the concentration within the labour pool. A concentration of related firms draws skilled and specialized labour. Informal employee networks typically form through the shared interests of the individuals participating in that sector's labour pool. These informal labour networks expedite the formation of the more formal cluster networks through collegial discussions and the relationships that are formed. These relationships give otherwise independent workers a familiarity with the projects that are occurring within the region, thus creating a shared culture of innovation.

NETWORK MANAGEMENT

There are a number of perspectives that need to be considered with the successful management of a network. Networks are typically voluntary; the usual management hierarchies may need to be modified in order to maintain the health of the internal relationships. Networks require consideration of three principle facets of management: governance, network management, and 'within' network management.

Governance

The governance of a network lays out the incentives and values that will govern the nature of network relationships. Contracts and formal agreements will offer concrete incentives for participation and cooperation, whereas reliance on trust and shared values creates an overall

sense of shared purpose to guide actions. Elements of both types of governance tools will be required in any network to ensure appropriate participation from members. Notably, the governance element of management is the only aspect that is an external influence on the network, as governance is establishing the objective standards to be applied to the entire network. Governance arrangements may be set out in a network charter, systems of recognized roles, or quasi-mandatory roles etc.

Management of the Network

A network must be managed as an entity in itself. A network must have its boundaries and functions defined through the membership in order to set appropriate expectations for members. Network members must have a clear idea of how they may participate in the network and what benefits they may receive. A network should have clearly defined recruitment goals and tools. The functions and boundaries of the network should be well and clearly established. Defining these elements of management allow firm expectation setting and a more purposeful participation in the activities of the network.

Managing Within the Network

Networks should be managed from within to effectively execute their purpose. Roles of peer-members must be established and accepted. The reach, or directive power, of members must be established (as best one can) *ex-ante*. Systems for the establishment of shared approaches and strategies are easier to implement if well understood and agreed upon. Rules governing the sharing and implementation of innovations by network members should also be set as early as possible.

ROLES OF NETWORK PARTICIPANTS

The development of networks facilitates the flow of cluster benefits and vice versa. Better understanding of the roles played in networks may allow stakeholders to speed up the building of beneficial networks. Networks form around a number of central stakeholders. These stakeholders play specific roles in the network:

- **Broker Nodes** are those individuals that activate and mobilize networks
- **Charismatic Nodes** build network membership and enthusiasm
- **Legitimate Nodes** are stakeholders with legitimate license to make binding decisions
- **Bridge Nodes** are people that bridge otherwise unrelated network participants.

Cluster research also points to a special role for the central large firm in a cluster's network. A strong, dominant firm, committed to the cluster, can act as a catalyst. In terms of nodes, the large dominant firm has particular potential to perform as the **broker node** and the **legitimate node**. The big player is a more natural host for network activities and most likely to have broker type connections. They are also most likely source of spin-off projects. Finally, the dominant firm has the resources to make significant binding decisions.

GOALS OF A NETWORK

In the end, members are looking for a network which is:

- Centrally positioned within the range of interests of network members
- Subject to a well-defined mandate and governance structure

- Inclusive yet voluntary
- Of a manageable and effective size
- Cohesive, with clear strategies for maintaining that cohesion
- Not dominated by the interests of the strongest member
- Responsive to member needs.

MEASURING INNOVATION

Benchmarking is an important part of measuring project success or performance against an objective standard. Innovation and technological improvement are difficult to measure. Given the importance of productivity and innovation in defining the success of a “cluster”, benchmarking and tracking improvements in performance within the cluster should be undertaken by stakeholders, or by the network. The following are some suggestions for a number of proxies:

- Spending on R&D
- Measures of productivity (GDP / Worker)
- R&D intensity (R&D / GDP)
- Share of R&D personnel in workforce
- Capital spending
- Capital / worker
- Machinery & equipment / worker
- Average years education / worker

MINING AND METALS SECTOR OVERVIEW

Canada has a rich history of exploration. The Geological Survey of Canada was established in 1842, directed to explore, map and assess the resource base of Canada. The exploration culture has been and continues to be on the leading edge⁵. There has been a continued commitment to modern and advanced equipment and technology, with the GSC introducing the world to aerial mapping techniques and continuing to make advances in sub-oceanic surveying. The exploration culture is well-developed in Canada

Today, Canada is a world leader in mining. Mining and metals processing is active and important in the Canadian economy. According to the Mining Association of Canada (MAC), Canada is one of the top-ten global producers of 17 metals (Canadian Chamber of Commerce 2012). British Columbia (BC) is Canada's largest producer of copper and the largest exporter of metallurgical coal (Ministry of Energy, Mines, and Natural Gas 2013). According to the Coal Association of Canada, BC is the world's third largest metallurgical coal producer.

Canada leads mining investments in North and Central America, and receives 16% of global mining investments (Marshall 2013). Estimates of BC investment in exploration and mine development show \$2.2B being spent in the 2012/13 fiscal year. It is not surprising that British Columbia is home to the world's highest concentration of exploration and mining companies. Both Toronto and Vancouver have developed financial expertise specific to the mining industry, and, Sudbury has become known as the mining super-store. Mining and mineral processing are alive and thriving in Canada.

There are currently (approximately) 1670 mining companies listed on the Toronto Stock Exchange (TSX) and TSX Venture Exchange. Of these 962 are located in British Columbia. There are, of course, mining companies not listed on the exchange. Estimates indicate there are roughly 1200 exploration companies in BC (British Columbia Securities Commission 2012).

British Columbia mineral production was valued at \$8.6B in 2011, compared to \$10.7B in Ontario (Ontario Mining Association 2013). Mineral production represents roughly 4% of BC's 2011 GDP. Canadian Mining, Quarrying and Gas represented 3.4% of Canada's GDP. BC, by comparison, is a mining province even before considering oil and gas production.

In British Columbia, there are ten coal mines (representing over 40% of Canadian coal production), nine metal mines, 30 industrial mineral mines and more than 50 aggregate mines. Employment from these mines, alone, is roughly 12, 500 people. The current provincial government is expecting to approve the opening of an additional eight mines and the expansion of nine existing mines (Ministry of Energy Mines and Natural Gas, 2013).

According to a 2012 PriceWaterhouseCoopers report, maintenance of the skilled workforce is expected to be a defining challenge over the next decade. Fewer youth have been entering the field, and there is a large cohort expected to retire in the near term. Despite the jobs forecasts, new entrants are not seemingly attracted to the sector.

⁵ Canada's GSC received their first accolades at the 1855 Universal Exposition in Paris. Only two years later, Canada's Director of the GSC was knighted by the Queen for exceptional service.

MINING AND METALS CLUSTER CASE STUDIES

During the course of this research, a number of striking Mining and Metallurgical sector success stories were discovered. Sudbury is often cited as the Mining Superstore; a play on its burgeoning Mining Supply and Services sector. Toronto and Vancouver are heralded as mining finance centres. In addition, Australia has a number of regions that have built their fortunes on mining and metals.

SUDBURY

Ontario currently has over 40 mine sites operating across the province. Nickel, gold, copper, zinc and platinum are Ontario's main metals. Non-metallic minerals include: salt, gypsum, talc, calcium carbonate, and nepheline syenite amongst others. The value of Ontario's mineral production was \$10.7B in 2011, according to the Ontario Mining Association (OMA). Roughly \$4B was invested back in R&D, exploration, construction and equipment. Of this, nearly a quarter was spent on exploration.

Sudbury, ON, has become known as the **Mining Superstore**, and one of the world's "Four Great Mining Cities" (Robinson, 2004). This moniker is derived from the cutting-edge Mine Supply and Service sector that has emerged on the back of Sudbury's mining activities. The Mining Supply and Service sector produces over \$5B/yr in GDP, while employing over 20,000 people (OMA 2013). Sudbury is widely recognized as the centre of the strongest mining-centric cluster in Canada.

SUDBURY'S DIAMOND CONDITIONS

The following is a brief summary of the Diamond Conditions that exist in Sudbury.

Factor Conditions

- Over one-third of Ontario's mining employment is located in Sudbury
 - Over 14,000 jobs with 320 companies
 - Average weekly Ontario mining wage is 60% higher than the provincial average
- Enjoys the basic labour skills development provided by the Canadian publicly-funded education system
- Home to Laurentian University
 - Goodman School of Mines
 - Bharti School of Engineering
 - Over half of research dollars are directed to mining related research
- Home to Cambrian College, College Boreal and Canador College
 - Each with mining focused programming
- Home to the Mining Intelligence Centre
 - Sudbury and Area Mining Supply & Service Association (SAMSSA)
 - Privately funded research and innovation focused institutional membership includes:
 - Centre for Excellence in Mining Innovation (CEMI)
 - Mining Innovation Rehabilitation and Applied Research Corporation (MIRARCO)

Demand Conditions

- Almost two-thirds of the value of mineral commodities is exported
 - \$12B in Trade Surplus in 2011
- Almost 60% of the metals minerals are processed domestically
 - Domestic processors are also major importers of raw material from Australia and the United States

Supporting & Related Industry Conditions

- Mining Supply and Service Industry is equal in size to the mining industry in Sudbury, by employment
 - 25,000 jobs in Ontario with 1000 companies in Ontario
 - Sudbury's Supply and Service sector creates \$5.6B/yr in GDP
- Cutting edge mining equipment producers
- 90% of inputs to the mining sector are sourced domestically
 - Over 40% from a one-hour radius of mine-sites
- Mining and Mineral Exploration Financial expertise is relatively close, in Toronto

Firm Strategy & Rivalry Conditions

- Over 300 related companies
- Innovation in mining safety
 - Regarded as one of the safest industrial jurisdictions in the world
 - Reduced "Lost Injury Time" by 90% over 30 years
- Innovation in environmental stewardship
 - Over \$60M/yr on environmental related technologies (capital expenditure)
- Commitment to innovation and R&D demonstrated through industry support of SAMSSA and the "Mining Intelligence Centre"

Salient Features of Sudbury's Cluster

- Earned its place in the mining world through the development of mines, mills and refineries on the basis of nickel production. Favourable basic resource conditions permitted the establishment of the regional sector. The following demonstrate the subsequent commitment to innovation and sophisticated collaborative investment.
- Recognition of "cluster" network was only reached in the last ten years; despite the extraordinary importance of the cluster to the Sudbury region. Lack of recognition may have stemmed from the diversity of the cluster (it has membership from at least 17 separate industries, as defined by the North American Industry Classification System).
- Cluster members suggest the following have been critical success factors
 - Strong local demand provides a "sales anchor"
 - Strong Supplier & Related Industries
 - Highly skilled labour pool
 - Research institutions and training facilities

- Physical infrastructure
- Quality of knowledge in the community of workers
- Public Private Partnership in the creation of joint research facilities is a feature found in many innovative clusters
- Industrial partners, through industry associations, jointly branded and marketed their collective expertise in underground mining and associated equipment and services
- SAMSSA has worked to develop formal educational opportunities, training support and research institutions

TORONTO AND VANCOUVER

The following is a brief summary of the Diamond Conditions that exist in Toronto and Vancouver. Despite their geographic distance from one another, they are treated together because of the common capital financing theme. These two cities are the mining-centric finance centres in Canada.

Factor Conditions

- Both Toronto and Vancouver are home to several top-tier universities
 - University of Toronto, Ryerson University
 - University of British Columbia, Simon Fraser University
 - More within one-hour travel:
 - MacMaster University, University of Guelph, University of Victoria
 - Many colleges within these regions, too.
- Both Toronto and Vancouver are world-class financial centres
 - As home to Canada's Commodities and Exploration Securities exchanges, these cities have large and well educated labour pools
 - Highly specialized financial expertise has developed, in these labour pools, that is specific to the mining and mining exploration related industries
 - Understanding of specific risk profiles and typical business cycles
- Vancouver is home to one of the world's highest concentrations of:
 - Exploration experts
 - Geologists
 - Mine engineers
 - Project financing experts, and
 - Environmental specialists

Demand Conditions

- Over 1,200 exploration companies are based in BC, most of which are in Vancouver
- The Toronto Stock Exchange lists an impressive 57% of the *world's* publicly listed mining companies
 - Several dozen base their head-quarters in Toronto
 - Estimated combined equity valuation of these companies is over \$19B

Supporting & Related Industry Conditions

- Both Toronto and Vancouver have internationally recognized financial sectors
 - Expertise spills over and complements mining specific financial experts
- The industries supporting more generalized financial sectors have transferrable expertise and services

Firm Strategy & Rivalry Conditions

- The Financial Services sector is competitive, with many participants
- Firms look internationally for their strategy, as evidenced by the international market share enjoyed by our domestic service providers

Salient Features of Vancouver's and Toronto's Mining, Mineral Exploration Financing Cluster

- Listing 57% of the entire world's publicly listed mining companies

AUSTRALIA

Like Canada, Australia has a long diverse history of mining. Australia's industrial mining started, in earnest, in the 1840s. Like Canada, mining tradition and skills were imported from the UK, establishing a culture of mining and exploration (van Eenennaam 2011).

Mining is booming in Australia. The share of Gross Value Added (GVA) derived from the resource economy in Australia has more than doubled in the past decade. Directly, mining and processing contribute 11.5% of Australian GVA, while related sectors contribute 6.5%. These sectors employ roughly one in ten Australians.

Activity is concentrated in the Northern and Western regions of Australia. Western Australia, alone, produces over \$48B GDP from mining activities, employing over 70,000 workers. Iron Ore accounts for over half the value of mineral sales. Australia is also a significant gold and aluminum producer.

AUSTRALIA'S DIAMOND CONDITIONS

The following is a brief summary of the Diamond Conditions that exist in Australia's Mining Cluster.

Factor Conditions

- Insufficient local skills in the labour pool in some remote communities
 - Stakeholders often have to operate fly-in / fly-out operations
- High electricity / power costs
 - Spurred innovation in power efficiency technologies
- Labour force is aging with decreasing interest in mining sector

Demand Conditions

- Mineral exports are very important to the sector, with over a third going to China
 - Over 70% of iron ore is exported
 - 27% of alumina are exported
 - 45% of gold is exported

- Domestic demand is small compared to the export market

Supporting & Related Industry Conditions

- Mining equipment firms are establishing in Western Australia
 - High concentration of market power in upstream markets
 - Low levels of domestic competition
 - High input prices
 - Low levels of customization / sophistication
- Refining and processing facilities mostly located in ports
- Easy and cheap access to the ocean
 - Inexpensive transportation
- Other transportation intensive industries exist
 - In particular, agriculture
 - Combined volumes make ports more financially feasible
- Collaboration with Tourism sector
 - Promote infrastructure development
 - Promote region as labour destination/field

Firm Strategy & Rivalry Conditions

- Significant barriers to entry prevent high levels of competition in certain regions
 - The Pilbara region (the largest iron ore exporter) has high concentration of industrial power
 - Two companies privately own the rail lines
 - Form barriers to entry into region's productive economy
- Easy access to the ocean creates positive export conditions
 - Many firms position themselves in the international market
- Competition is not high
 - Firms view themselves as primary producers – commodity producers
 - World prices, little value-added
 - Firms do not compete on price, but on:
 - Environmental innovation
 - Access to labour markets
- Innovation in environmental stewardship and management
 - Function of inhospitable climate
 - Water extraction and management innovations
 - Renewable energy technology implemented
- Commitment to cutting edge capital technology
 - Over \$21B of investment in capital (2009)
 - 71% of all investment spending in Western Australia

Salient Features of Australia's Cluster

- Darwin's (one of Western Australia's mining cities) Mining Services Sector was initially developed because Darwin's remoteness made it expensive to import services.
- Heavy public investment in infrastructure
 - Services, roads, education
 - While not always located in mining communities, Australia's top-rate post-secondary school system is credited with creating a well-qualified (if not plentiful) labour pool.
- Mining focused vocational schools exist within the region
- Collaborative projects emerge where firms:
 - Form networks and a culture of cooperation
 - Cooperate in winning larger contracts than they could otherwise handle
 - Build capacity and certifications
 - Right-size contracts (large firms design contracts so smaller firms can bid)
- Access to post-secondary, mining focused research institutes has been helpful

BASIN-BOUNDARY MINING AND METALLURGY SECTOR DIAMOND CONDITIONS

The Basin-Boundary region has been recognized as a “cluster” by the Mining Association of Canada. The term cluster is often misused to mean any collection of similar firms in a geographic region. The meaning developed through the formal literature on the topic is more exclusive. While the Basin-Boundary region’s Mining and Metallurgical sector may not be a “cluster” in the strictest definition by Porter’s hierarchy (Porter 1998), it does constitute a high concentration of activity and a significant component of the region’s economy. In order to provide a useful benchmark for the region, the following provides an assessment of the “Diamond Conditions” affecting the Mining and Metallurgical sector in the Basin-Boundary region.

REGIONAL FACTOR INPUT CONDITIONS

BASIC RESOURCES

Labour: Canada provides an excellent public education system that provides basic skills development.

Natural Resources: Plentiful mineral resource reserves exist in the region.

Capital: Canada has reasonable access to financial capital through formal banking institutions. However, access to mining specific financial capital specialists does not exist in this region.

ADVANCED RESOURCES

Labour: Post-secondary education is heavily subsidized for Canadian residents. Canada has many mining-specific programs in post-secondary education and research institutions. However, those institutions are located prohibitively far from the Basin-Boundary region.

The Basin-Boundary region has consistently demonstrated post-secondary education levels roughly 10% below the provincial average. Matching skills with regional skilled-labour shortages has been a common problem in the Basin-Boundary Region.

Capital: The Basin-Boundary region does not have access to advanced capital resources. Bridge financing has been identified as a gap in the region’s economic infrastructure

PHYSICAL INFRASTRUCTURE

Canada has a reasonably well maintained public transportation infrastructure and rail system. However, transportation over a huge area is necessarily limited by resource constraints. Reliable access to air transportation is a common challenge in the western portion of the region.

ADMINISTRATIVE INFRASTRUCTURE

Canada’s federal, provincial and municipal governments all offer services to facilitate business development. By international standards, Canada does not hold a particular strength or a particular weakness in this respect.

INFORMATION INFRASTRUCTURE

Basic information infrastructure through the Basin-Boundary region is of high-quality. Broadband, fibre-optic service is only available in some locations.

SCIENTIFIC / TECHNOLOGICAL INFRASTRUCTURE

Canada's scientific and technological infrastructure is very well developed. However, most of those benefits are not evident in the Basin-Boundary region because of its relative level of isolation. Top-tier research institutions are a full day's drive away.

REGIONAL DEMAND CONDITIONS

MARKET SIZE

Teck Cominco has a large presence in the towns of Trail and Sparwood. These two branches of Teck represent the sectoral anchor for the region.

Additional market information was not readily available at the time of writing⁶. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

MARKET SOPHISTICATION

Market information was not readily available at the time of writing⁷. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

One consideration, in this respect, is in the interpretation of the general public as consumers of the industry's by-product; namely, pollution and environmental degradation. A number of case studies (including the Australian case study) contain story lines demonstrating cluster members tackling perceived weaknesses in an innovative manner, and turning those facets of the business into an advantage.

Given the vocal, and relatively well educated position of much of the region's population with respect to pollution, cluster members should consider whether potential exists to turn this into a source of advantage.

REGIONAL RELATED & SUPPORTING INDUSTRIES

UPSTREAM

Market information was not readily available at the time of writing⁸. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

⁶ There is an opportunity to explore this question and to determine, in a more defensible way, the extent of the regional market. Public data is not readily available for a detailed analysis of this kind. It is recommended for interested parties to apply a Business Retention & Expansion survey to the sector to develop regional data.

⁷ Ibid 4

⁸ Ibid 4

DOWNSTREAM

Market information was not readily available at the time of writing⁹. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

REGIONAL CONTEXT FOR FIRM STRATEGY & RIVALRY

COMPETITIVE ENVIRONMENT

Market information was not readily available at the time of writing¹⁰. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

STRATEGIC CONTEXT

Market information was not readily available at the time of writing¹¹. A limited treatment of the various sectoral stakeholders and related stakeholders is included in Appendix A.

9 Ibid 4

10 Ibid 4

11 Ibid 4

RECOMMENDATIONS

The Mining & Metals sector is the economic anchor in the areas immediately surrounding both Sparwood and Trail. The sector is a major employment driver for the region and has created a number of spin-off companies and support operations. As a focal point, this sector holds the potential to drive the region's economy.

The Lower Columbia Community Development Team Society (LCCDTS) Metallurgical Committee is poised to act as a quasi-industry association, lobby group, and sectoral promoter. The committee has defined its Vision Statement as:

Our region has a diverse community of innovative and prosperous SMEs in a metallurgical cluster supported by a comprehensive network of resources, infrastructure and highly qualified people.

The following are a suite of recommendations for the LCCDTS Metallurgical Committee and any other interested stakeholders.

1. Establish a Mining & Metals Sector network. Network goals could include: development of a regional trade association, communications and marketing strategies, facilitation of collaboration, sponsor further analysis of the sector's breadth of upstream and downstream related industries.
2. Inventory the "cluster". Perform a network analysis to determine the size and breadth of the Mining and Metallurgy Cluster. Include, in the questionnaire, a suite of questions designed to fill the data gaps on the region's Diamond Conditions.
 - a. Expand the concept of the "region" to include the entire Basin-Boundary
3. Perform a Value Chain Analysis and a Supply Chain Analysis to identify service and activity gaps that may be filled by regional stakeholders.
4. Explore education partnership between Selkirk/COTR and UBC and/or UofA and/or UofC. These partnerships should be pursued aggressively, but thoughtfully. As part of these efforts:
 - a. Build a comprehensive strategic plan to frame any education or skills development based efforts
 - i. Frame goals of efforts already underway
 - ii. Create long-term goals and vision
 - b. Foster existing efforts to bring senior students to the region
 - i. Prioritize by innovative potential
 - ii. Improve student retention
 - c. Continue working with regional colleges to establish focused curriculum goals
 - i. Consider sponsored / partnered certificate development
 - ii. Avenues with high potential for development of regional research capacity within colleges
5. Strengthen relationships between potential cluster members and local governments. The role of the local government is to remove barriers to the formation and development of the cluster. This is not limited to regulatory barriers, but includes the encouragement of

education and skill development specific to the growing cluster, and facilitation through infrastructure improvement. Cluster network members may consider an analysis of the regulatory regime as it pertains to the development of strong Diamond Conditions.

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APPENDIX A

