PLANNING FOR INNOVATION: UNDERSTANDING AND ANALYZING THE APPLICATION OF FISCAL, REGIONAL, AND LAND USE PLANNING IN THE DEVELOPMENT OF INNOVATION CLUSTERS

by

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Abstract

Innovation clusters are becoming a common practice for municipalities and governments looking to increase research and development while also improving economic output and product commercialization. Although there are many existing fiscal, regional, and land use tools to leverage; there is limited multi-tier and cross-sector strategies being implemented. Observing these tools and mapping Canada's multi-tier innovation incentivization ecosystem enables the research to understand the strengths and disconnects that currently exist within the system. Further observation of foreign programming strategies and tools also work to present opportunities for program improvements and growth. The work presented in this research looks to provide a roadmap for how municipalities can implement the innovation clustering goals presented by regional and federal governments while also empowering urban planners with the tools to catalyze economic growth and develop a sustainable ecosystem for research and development.

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Introduction

Innovation clusters present a valuable opportunity for municipalities looking to expand their urban economy and labor force. This development strategy is defined by Li, Webster, Cai, and Muller in their work Innovation Clusters Revisited: On Dimensions of Agglomeration, Institution, and Built-Environment:

> Clusters are not only the spatial concentrations of, but also the localized networks of, specialized organizations including firms (suppliers, customers, competitors), knowledge producing agents (universities, research and training centers), bridging organizations (brokers, consultants, financial organizations and banks), and government agencies[1].

These clusters rebuild municipalities by presenting an influx of new jobs and talent while enhancing the urban core. The Brookings Institute discusses the power of innovation clusters when they write "productivity, the most important determinant of the growth in living standards in the long run, has experienced a significant slowdown globally in recent years. Clusters have the potential to combat this slowdown"[2]. Boschma and Lambooy further build upon this notion of innovation-led economic development writing "the more successful regions in a knowledge-based economy have come to be seen as those with sufficient economic variety and institutional adaptability to support ongoing innovation and adjustment to changing market conditions"[3]. Governmental investment in innovation can respond to the slow degradation of living standards by utilizing land use planning and finance tools to incentivize innovative industries to cluster within the municipality. The following paper will explore the fiscal tools governments use to incentivize innovation clustering within a targeted region.

[1] 1 Li, J., Webster, D., Cai, J, Muller, L., "Innovation Clusters Revisited: On Dimensions of Agglomeration, Institution, And Built-Environment. Sustainability", 2019.
[2] M. Neil Bailey, N. Montalbano, "Clusters and Innovation Districts: Lessons from the United States Experience", 2018
[3] Boschma, R. A. and Lambooy, J. G., "Evolutionary Economics and Economic Geography", Journal of Evolutionary Economics, 1999

Investing in innovation clusters has historically resulted in rapid economic growth within the regions in which they exist. Wonglimpiyarat demonstrates this relationship through her case study of Silicon Valley. In this study she writes "Silicon Valley has added more than 200,000 jobs since 1992 and created over 29,000 new companies in the 1990s"[4]. The Silicon Valley Competitiveness and Innovation Project reports further gains within the last two decades writing "Between 1995 and 2015, output in Silicon Valley's innovation industries grew by 147 percent, while the rest of the economy expanded by 39 percent"[5]. Silicon Valley's innovation sector has outperformed more traditional economic segments consistently since 1992, thus further propelling and uplifting the regional economy.

In her work, Wonglimpiyarat cites the success of Silicon Valley "to create and strengthen regional clusters of industries that become hubs of innovation in producing high-value products and services"[6]. This connection between innovation districts and economic growth is further supported by the Global Institute on Innovation Districts whose 2014 report titled The Rise of Innovation Districts explains that;" Innovation districts can generate revenues through increased economic activity, rising housing values and increased demand for goods and services"[7].

[4] Wonglimpiyarat, J., "The Dynamic Economic Engine at Silicon Valley and US Government Programmes In Financing Innovations", 2006
[5] Silicon Valley Competitiveness and Innovation project, 2019
[6] Wonglimpiyarat, J., "The Dynamic Economic Engine at Silicon Valley and US Government Programmes In Financing Innovations", Technovation, 26(9), 2006
[7] B. Katz, J. Wagner, "Rise of the Innovation Districts", 2014

Municipal-level adoption of innovation clustering strategies that are aligned with higher-level governmental initiatives can yield strong direct and indirect economic returns. It can be instrumental in urban revitalization, economic growth, and municipal budgeting and servicing through its ability to rapidly improve a city's economic performance. It is through an observation of fiscal incentivization tools, regional clustering strategies, and strategic land use guidelines that one can develop an understanding of how to foster the incubation and growth of these innovation clusters.

Municipalities can leverage this research to help provide a roadmap for how they may approach the development of a cohesive innovation-clustering strategy. Each of these elements work together to provide an environment that attracts private-sector investment, aligns with the tools and strategies of higher-level governments, and incentivizes knowledge-exchange. It is the belief of this paper that municipalities are the forefront of this strategy and need to be further engaged in its implementation in order for these projects to find true success.

This paper analyzes these innovation incentivization tools with both a domestic and international lens. It then further develops an understanding of how they work together to establish an ecosystem that is conducive to innovation clustering. The report also provides a recommended evaluation methodology that will not only ensure economic feasibility and social wellbeing but also align the initiative to higher-level governmental programs. It is through this holistic perspective of innovation clustering strategy that this work hopes to present a roadmap for municipalities wanting to engage with the regional supercluster initiative, the smart city challenge, and large innovative organizations.

This observation presents examples of tools that municipalities and governments can leverage while also acknowledging the disconnects that currently exist within the system. Canada has engaged in many exciting programs and initiatives for its innovation clustering strategy but can work to further optimize these programs and initiatives through improving program alignment and evaluating their economic and social capabilities.

Methodology

This paper takes a qualitative approach through its literature review to obtain a global and domestic perspective on the multi-disciplinary nature of these strategies while also observing how differing levels of government engage in innovation clustering. The work then presents a visual analysis of the multi-tiered Canadian clustering ecosystem and analyses the disconnects that exist.

The global and domestic perspective enables the work to not only evaluate the existing Canadian context but look outside to other opportunities for potential program improvement. An example of this methodology is seen through the evaluation of Technology Innovation Centres (TICs). Looking toward TIC programming examples in Germany, the UK, and the US enables this paper to observe a potential opportunity point that can further enhance the existing regional super cluster initiative currently being practiced domestically in Canada. The wider scope ensures that the work not only evaluates and analyzes the existing Canadian context, but also acknowledges the opportunities that are exemplified in foreign programs.

Literature from a spectrum of disciplines is utilized throughout the paper to understand the economic, societal, political, and geographic attributes of this economic development strategy. The development of innovation clusters requires a collaborative process that looks across sectors to engage a focused private-sector industry to invest and move into a particular municipality or proposed development area. It is through this approach that the research stresses the multi-disciplinary nature of innovation clustering initiatives.

The literature included an array of academic and professional sources. The work observed planning documents and presentations, business strategy reports, professional program presentations, private sector and academic reports, along with policy documents. Engaging in these sources allows the work to gain the multidisciplinary perspective from the stakeholders involved. An example of this methodology can be seen through the land use planning literature review. This section utilizes academic literature from Maria P. Roche to define the connection that exists between site design and innovation. The application of the concept is then demonstrated through a review of Microsoft's planning application documents and again through the RFP documents for the False Creek Flats. The observation of these cross-sector resources presents both the theory and practice of this methodology.

The literature is further analyzed through a visualization of the Canadian ecosystem and an analysis of the current disconnects that exist. This visual tool focused on the hierarchy of programs and initiatives across the varying governmental tiers. Visualizing the programs in this way presents a clear indicator of how each level of government is successfully or unsuccessfully engaging in these systems or programs.

The recommended evaluation methodology highlights existing evaluation programs from both the economic and planning sectors. This recommended evaluation strategy engages the Porter Competitiveness Model, The Global Institute on Innovation Districts model, a site design model, and a planning rationale model. This evaluation methodology presents a holistic approach that aligns with the multidisciplinary and complex nature of these strategies.

It is through a qualitative and literature-focused approach that this research works to address the stakeholders engaged in these processes. The research evaluates the multi-tiered governmental system while also acknowledging the role that the private and public sector play in incentivizing and developing these clusters. The selected literature paints a picture of the existing Canadian system and observes global examples of how this system can further be improved. It is through this research methodology that the paper works to achieve its goal of highlighting the network that exists to support these clusters and acknowledging the cross-collaboration that is required to make innovation clusters successful within the Canadian context.

Literature Review

In creating an Innovation-focused cluster it is crucial to recognize the tools needed to incentivize development and optimize knowledge exchange through a collaborative environment. Observing the application of fiscal, regional, and land use enables there to be an evaluation of the tools and programs that can be leveraged on all levels of government. Each tool will present a global example of its use while also presenting the existing programs and organizations that exist within the current Canadian context. This evaluation strategy presents the opportunity to know what is currently available as well as taking a global perspective on innovation clusters.

Each of these tools are leveraged by different levels of government. For instance, the R&D tax incentive is a tool utilized by both the federal and provincial governments to attract more foreign investment and channel it into specific provinces. While the land-use design guidelines of the Guelph Innovation District is a secondary plan strategy utilized on a municipal level to attract Agri-innovation industry to its municipality.

It is the hope of this analysis that government organizations and companies will be able to effectively collaborate and coordinate their innovation clustering strategies to align with all tiers of government. Through this coordination municipalities, provinces, and regions can generate stronger and more cohesive industry development strategies.

Fiscal Incentivization of Innovation Clusters

Price Waterhouse Cooper discusses tax incentivization in their 2010 *Innovation* report "innovation that addresses customer priorities has become a more important driver of economic growth for all countries, emerging and mature. Because these trends show no sign of reversing, governments are likely to continue pursuing tax policies that foster innovation"[8]. Tax incentivization is further highlighted by Wonglimpiyarat as a Cluster-based policy for developing regional networks for entrepreneurs. In her work she cites tax incentives as a cluster indicator of Porter's competitive Diamond Model[9]. Here she defines this indicator as "Favorable tax policies, e.g. tax-exempt capital gains and pension funds as investment incentives to facilitate the development of VC market"[10]. This indicator, listed under the context for firm strategy and rivalry portion of Porter's model, is a key pillar to establishing an effective innovation ecosystem that will continue to improve regional economic growth.

Porter further outlines the utilization of these indicators writing "Above-average economic performance measures are not enough to ensure regional prosperity. Maintaining, much less increasing, a region's standard of living requires the steady growth of productivity, which in turn requires innovation"[11]. The high volume of employment growth in these tax incentivized innovation districts and clusters presents a strong performance in the overall economic indicators while the rapid increase of new companies indicates a high innovation

[8] Price Waterhouse Cooper, "Government's Many Roles in Fostering Innovation", 2010
[9] Porter's Competitive Diamond Model is visualized in Appendix A, Figure 1
[10] Wonglimpiyarat, J., "The Dynamic Economic Engine at Silicon Valley And US Government Programmes In Financing Innovations" Technovation, 26(9), 2006
[11] Porter, M. E., "Clusters of innovation: Regional foundations of US competitiveness", 2001

output. This competitiveness model further suggests the impact that municipal taxation strategy can have in fostering and revitalizing the urban economy.

Tax incentivization can be achieved in a variety of different ways. Price Waterhouse Cooper defines six specific strategies in their 2010 report. These include R&D tax incentives, tax holidays, venture capital incentives, intellectual property tax relief, and indirect taxation. Each of these tax incentivization tools can be applied to an innovation district strategy to further entice innovative industries to locate to the municipality.

Observing the suite of global and domestic innovation financing models presents a crucial opportunity to understand the different ways that governments can engage with the private sector to develop powerful innovation clusters. The following section will observe some of the financing structures that fostered the development of innovation powerhouses in Germany, the United Kingdom, the United States, and Canada.

Tax Incentives and Government Grants in the United States

The United States has adopted a variety of different strategies to concentrate innovative industry into targeted regions. The White House defines this strategy writing that"Regional innovation clusters are based on a simple but critical idea: if we foster coordination between the private sector and the public sector to build on the unique strengths of different regions - while creating the incentives for them to do so"[12]. Through tax incentivization methodology,

[12] White House, "New Obama Administration Jobs and Innovation Initiative to Spur Regional Economic Growth", 2011

government financing programs, and TIC development these regional innovation clusters have become fruitful.

The Price Waterhouse Cooper's *Innovation* report highlights R&D, sub-federal policies, and customs duty relief as the three main taxation incentivization strategies utilized by the US government. The report further highlights the role of the R&D tax credit writing that" the greatest period of growth in R&D was from 1994 to 2000, when R&D expenditures rose from $169.2 billion to $264.4 billion, and the United States was the world's top producer of high-technology products"[13]. This US R&D tax credit and sub-federal policy strategy works to channel venture capital and institutional investment into specific regions. Richard Florida and Donald Smith discuss the value of this investment in their work *Venture Capital, Innovation, and Economic Development*. They support the notion of concentrated high-technology economic development and based on their work they draw the following conclusion:

> venture capital supply is highly concentrated at the regional, state, and metropolitan levels. The Northeast and Pacific regions together account for an incredible 78% of venture capital supply. Just three states – California in the Pacific region and New York and Massachusetts in the Northeast – are home to 70% of venture capital supply. Furthermore, just three metropolitan areas- San Francisco, New York City, and Boston – account for approximately 60% of the supply of venture capital.[14]

These three clusters of innovation have experienced strong economic growth through their concerted effort to attract R&D and VC investment. These three metropolitan areas have demonstrated strong returns from this governmental investment. In 2017 these three states have

[13] Price Waterhouse Cooper, "Government's Many Roles in Fostering Innovation", 2010

[14] Florida, R., & Smith Jr, D. F., "Venture Capital, Innovation, And Economic Development", Economic Development Quarterly, 4(4), 345-360, 1990

initiated 327 start-ups and GDP output of $4,137,135 Million[15]. Further observing Boston will provide valuable insight into the ways that these sub-federal policies shape the capabilities and growth of innovation clusters and municipal economies.

R&D Innovation in Boston

The Boston region has become home to one of the largest biotech hubs in the world. In her work Heidi Ledford writes "The [Kendall Square] neighbourhood squeezes 120 biomedical firms within a 1.5-kilometre radius"[16]. The Innovation Institute further supports this notion by citing that Massachusetts was the highest performing LTS, Leading Technology State, in 2018[17]. The growth of this innovation cluster can be attributed to more than the high volume of Ivy league institutions or through the role of both R&D tax credits and sub-federal taxation policies. Massachusetts has engaged in a variety of different sub-federal taxation programs that promote the development of a more innovation-centered economy.

This taxation program includes an R&D tax credit system for foreign and domestic corporations, a training grant program, a sales tax exemption for R&D purchases, a manufacturing property tax exemption, and local level incentives; for instance, infrastructure grants, property tax abatements, and local wage reimbursements[18]. This advanced tax incentive program has yielded strong economic returns for the state through its ability to attract institutional R&D grants and venture capital investment.

[15] The Innovation Institute, "The Annual Index of the Massachusetts Innovation Economy", 2017
[16] Ledford H., "Start-ups fight for a place in Boston's biotech hub. Nature", 2015
[17] The Innovation Institute, "The Annual Index of the Massachusetts Innovation Economy", 2017
[18] Price Waterhouse Cooper, "Government's Many Roles in Fostering Innovation", 2010

Federal grant programs have also contributed to the strong economic performance of the innovation cluster. The Innovation Institute reports that the federal government invested more than $3.2 Billion in academic and health R&D in 2016. Furthermore, the report highlights that "11 research organizations received more than $100 Million in NIH [National Institute of Health] funding in 2017"[19]. These federal grant programs, when channeled into the municipal-level cluster, present large economic boosts to the economy.

The Innovation Institute reports a VC investment growth of $3.38 Billion since 2007. At $6.94 Billion, this state has the third highest volume of VC investment in the country, trailing only behind California at $35 Billion and New York at $11 Billion. This high volume of venture capital investment and government grants has resulted in an influx of employment and talent.

The Innovation Institute highlights that 61.1% of migrants into Massachusetts possessed a bachelor's degree in 2017. This new pool of highly skilled workers uplifts the market by increasing consumer demand and competition. It is through the new demand and limited market supply that certain necessities, for instance housing, become less obtainable. 46.5% of residents in Massachusetts reported spending more than 30% of their income on rent in 2017. This number has increased rapidly since 2012 when it was 31.3%[20]. This presents a key drawback to this rapid economic growth. Further policy frame working is required to help curb the market and provide more affordable options for residents in the region.

[19] The Innovation Institute, "The Annual Index of the Massachusetts Innovation Economy", 2017

[20] The Innovation Institute, "The Annual Index of the Massachusetts Innovation Economy", 2017

Through these policies and grants Massachusetts has seen rapid institutional and economic growth throughout its region. Although the region has gained greatly from the large influx in economic development, it is impacted by its lack of supply of affordable housing.

Tax Incentives in Canada

Canada has recently become a major player in the global innovation ecosystem due to its ability to commercialize disruptive technology. KPMG connects these capabilities to the fintech innovation ecosystem writing "in the financial services sector, for example, significant investments in fintech start-ups across the country are helping established players leverage emerging technologies into their business and operating models"[21].

Toronto has made a push to achieve this distinctive role as a leading fintech innovation region. The conference board of Canada reported that "The financial services sector is one of Toronto's major clusters. It directly employed 274,525 people in 2017"[22]. A key to the success of Toronto's Fintech innovation ecosystem is the collaborative public-private partnership that it shares with the government. Toronto Finance International's visualization of the core Fintech Ecosystem[23.] clearly defines the government and regulators as key pillars in achieving a system of innovation and economic development[24].

[21] KPMG, "The Changing Landscape of Disruptive Technology", 2017

[22] Edenhoffer, K., "Toronto on the Global Stage: 2018 Report Card on Canada and Toronto's Financial Services Sector", 2018

[23] Visualization of the Fintech Ecosystem in available in Appendix B, Figure 3

[24] Toronto Finance International, "Seizing the Opportunity: Building the Toronto Region Into A Global Fintech Leader", 2019

Canada has historically deployed and explored a variety of different fiscal programs to incentivize innovation. In 1999 Canada discussed the impact of R&D tax incentive programs in each Province within their report titled *Measuring the Attractiveness of R&D Tax Incentives: Canada and Major Industrial Countries.* R&D tax incentives are tax credits, tax deferrals and allowances that private firms can utilize to offset the cost to research and development. Price Waterhouse Cooper reports the utilization of these incentives in their 2010 *Innovation* report "Tax incentives reduce the marginal cost of R&D and thus stimulate more of it. They are usually available for a wide range of firms, and the firms themselves decide what kind of R&D to pursue"[25].

These research and development incentive programs are commonly used as an initial steppingstone for incubating an innovation cluster. In Ontario this strategy comes in the form of an "R&D Super Allowance" and an "Ontario Innovation Tax Credit"[26]. Both systems utilize the tax incentive strategy in two very distinct ways. While the super allowance allows companies to expense R&D for further tax relief the innovation, tax credit allows an 8% - 12% credit on scientific research and experimental development. Both programs have worked to provide private organizations the flexibility they need to take on more fiscally ambitious innovation projects.

[25] Price Waterhouse Cooper, "Government's Many Roles in Fostering Innovation", 2010
[26] Government of Canada, "Measuring the Attractiveness of R&D Tax Incentives: Canada and Major Industrial Countries", 1999

IMIT Property Tax Incentive in Toronto

In 2008 the City of Toronto established a municipal-level property tax incentive program called the Imagination, Manufacturing, Innovation, and Technology (IMIT) program. This program has provided recipients "60% of the increase in the municipal taxes attributed to the eligible development over a 10-year period"[27]. This municipal-level program is formulated under the TIEG (Tax Increment Equivalent Grant) framework[28].The city of Toronto defines this framework within their 2015 briefing note as:

> TIEG grants are generally based on some proportion of the full tax increment, such that annual grant payments are based on a declining percentage of the full tax increment in each successive year of the TIEG program. As the amount of the grant payment decreases in each successive year, the proportion of the full property tax increment retained by the City increases.[29]

The IMIT program works to establish innovation clusters by incentivizing developers to engage in projects that target specific industries, are in designated areas, and meet a specific employment requirement. These contingencies enable the city to have more control around where innovation development occurs and how it will intensify or alter the urban fabric.

The eligible industry sectors for this program include biomedical operations, creative industries, financial services, information and communications technology, manufacturing, and tourism attractions. This focused group of eligible industries highlights the type of innovation clusters that the city is working to develop. Both the biomedical operations and financial services industries are already apparent within the municipality. Toronto has been recognized as a major

[27] City of Toronto, "Imagination, Manufacturing, Innovation, and Technology (IMIT) Program", 2019
[28] City of Toronto's IMIT TIEG visualization is available in Appendix B, Figure 4
[29] Rossini. R., "2015 Operating Budget Briefing Note", 2015

hub for financial services and biomedical operations through the clusters in both the financial district and the MaRS Discovery District. Through this program the city hopes to continue to grow these clusters while expanding its reach in tourism, information and communications technology, and manufacturing.

The IMIT's site selection enables the city to channel its innovation clustering into specific communities. These areas include existing community improvement areas, East Bayfront, West Don Lands, the Port Lands, and the area south of Eastern District. These sites represent areas that tend to appear disconnected to the urban framework, for instance the Port Lands which is an industrialized brownfield that has limited modal access to the urban core. Through this process the city hopes to expand the urban framework and intensify areas that either require more remediation assistance or seem disjointed.

The employment attributes of the IMIT program present a focus on generating more opportunities for local talent. In defining the point system, the IMIT writes "the City will provide IMIT recipients with a menu of options for local employment and training activities from which to build their Local Employment Plan, which is a requirement for every IMIT grant recipient"[30]. This point system ensures that these projects develop the municipal economy throughout both the construction and operation lifecycles[31]. This strategy ensures that developers are engaged in the employment and skill development of local trade workers and the program ensures more equity through the engagement of a diverse set of industries.

[30] City of Toronto, "IMIT Local Employment Requirement Points-Based System", 2008
[31] Examples of these point calculations are available in Appendix B, Figure 5

The IMIT program has resulted in a few key developments, including the Globe and Mail Centre on King Street. This development is part of the Eastern District and has become a pinnacle attribute of the neighbourhood and a landmark for the information and communications industry. The development not only serves as the headquarters of the National news organization but serves as a space for commercial retail and event hosting. The site won the 2018 "Office of the Year" award from the Annual NAIOP Greater Toronto Real Estate Excellence Awards[32] and has also been certified with the LEED Gold-Certification.

The IMIT program presents an example of how a municipality can leverage fiscal programs, like the TIEG program, to both enhance its innovation network while uplifting its trade sector as well. The focused contingencies provide the municipality with a valuable opportunity to channel development and attract a targeted group of industries and organizations.

Innovation Development Through Regional Clustering Focuses

Technology Innovation Centers in the UK, Germany, and the US

The Technology Innovation Center model (TIC) exemplifies how partnerships between education institutions and industry can further enhance regional economic development. Bramwell, Hepburn, and Wolfe's analysis of TICs describes the economic and social impact of this strategy:

> Anticipated benefits of developing Canadian TICs to encourage engagement between world-class researchers and specific companies include the more effective use of tax expenditures to directly support innovation; job creation by providing the private sector access to talent, equipment and infrastructure that

[32] First Gulf, "The Globe and Mail Centre Reaches New Heights with "Office Development of the Year" Award", 2018

> they could not otherwise afford; mitigating risks involved in developing commercially unproven technologies; and establishing anchors for community economic development[33]

TICs have previously been practiced in the United Kingdom, Germany and the US and the methodology comes in different models: Germany's Fraunhofer- Gesellschaft financing model, the UK's Catapult Centre model, and the US's NNMI (National Network for Manufacturing Innovation) model. All three of these have worked to enhance regional economic development through public-private partnerships, tax financing mechanisms, and R&D investment.

The Catapult, Fraunhofer-Gesellschaft, and NNMI models utilize the R&D capabilities of universities and private sector resources to foster an environment that is conducive to innovation and product development. David Wolfe and Nicola Hepburn explain this relationship in his study of TICs:

> Partnerships between research and innovation actors that are strengthened and sustained by TICs support efforts at technological specialization and help to build up a jurisdiction's absorptive capacity as well as the financial and human capital necessary for generating cutting-edge ideas and bringing them to market [34]

This governmental strategy to concentrate innovation in these Technology Innovation Centres has resulted in rapid economic growth within its regional focuses. These highly collaborative innovation centers demonstrate the value of an industry-focused headquarters that connects regional private and public sector organizations for rapid economic and scientific development. A further exploration of these programs will present an opportunity to understand how this

[33] Bramwell, A., Hepburn, N., Wolfe, D., "Growing Innovation Ecosystems: University-Industry Knowledge Transfer and Regional Economic Development in Canada", 2012
[34]Hepburn, N., Wolfe. D., "Technology and Innovation Centres: Lessons from Germany, the UK and the USA", 2019

focused strategy can be applied to the Canadian Supercluster initiative to further enhance the existing regional superclusters.

Fraunhofer-Gesellschaft Model in Germany

The Fraunhofer-Gesellschaft Model is a series of seventy-two research organizations located throughout Germany with the mission to" perform contract research for German industry, particularly small and medium enterprises (SMEs), which translate basic research from universities and non-university research organizations into commercial products and industrial processes"[35]. Each of these institutes are designated a specific industry focus and work within the innovation ecosystem to bridge the gap between technological R&D and innovative companies[36]. As of 2018 the program has employed 25,327 staff and has obtained €2.3 billion[37] of contractual research financing from the German government, infrastructure and defense research, and publicly financed research.

Each of these Technology Innovation Centers becomes central points for R&D development in the region. The TICs collaborate with universities and international centers of excellence to connect them with high-tech and R&D intensive companies for rapid commercialization and expansion.

This innovation ecosystem model has resulted in the development of many highly influential technologies and economic catalysts. Some of these inventions include mp3

[35] National Research Council. 21st Century manufacturing: the role of the manufacturing extension partnership program. National Academies Press, 2013.
[36] Visual of the German Innovation Ecosystem is available in Appendix C, Figure 6
[37] Visual of financing and employment is available in Appendix C, Figure 7

technology, high speed wireless internet, and multi-junction solar cells. The mp3 generated €300 million of revenue per year and more than 9,000 jobs[38].

Through the application of this program Germany has been able to effectively focus industry and economic development within its research-focused regions. The proximity of the institutions and organizations to the centers enable a high volume of knowledge-exchange and collaboration that results in effective product development and commercialization.

Catapult Centers in the United Kingdom

The Catapult centers in the United Kingdom are developed with the vision to "create a transforming innovation resource, enabling the UK to address market needs in key areas and compete in the global markets of tomorrow – generating growth and wealth for the UK"[39]. The 2010 program has focused £200 million across six centers between 2011 and 2015.

One crucial aspect of the program is the strategic placement of the centers. Rather than use the centers to establish a specific industry-focused innovation cluster, like the German Fraunhofer-Gesellschaft Model, this model works to place the centers within already existing clusters of innovation that have yet to be formally established[40]. The implementation report highlights the existing innovation cluster network stating that "Across the UK there are many examples of different geographical groupings and physical clusters of companies and research

[38] Fraunhofer, "Working Together for Success", 2011
[39] Technology Strategy Board, "Technology and innovation centres: Closing the gap between concept and commercialization", 2011
[40] Visualization of the TIC development selection timeline is available in Appendix D, Figure 8

bodies which have an important role to play in innovation"[41]. The Catapult Technology Innovation Centers seek to formalize these clusters and further collaboration through the development of localized cluster headquarters.

Today the program has grown to include thirteen new localized innovation centers for a total of nineteen across the country[42]. The program has also expanded the scope of the project and included regional centers that complement the existing local technology innovation centers. This strategy has resulted in the operation of £850 million of world class facilities, 636 academic collaborators, 2,473 industry collaborations, the support of £1 billion in company valuations. This program not only enhances the existing academic network within the United Kingdom but has successfully formalized the relationships within existing clusters of institutions and private-sector organizations.

NNMI in the United States

The National Network for Manufacturing Innovation (NNMI) program was established in 2016 through the collaboration of seven national departments and agencies. These included the department of Commerce, Defense, Energy, Education, Agriculture, the National Science Foundation, and the National Aeronautics and Space Administration. The vision of the program was to make the US a leader in advanced manufacturing with a mission of "connecting people, ideas, and technology to solve industry-relevant advanced manufacturing challenges thereby

[41] Technology Strategy Board, "Technology and innovation centres: Closing the gap between concept and commercialization", 2011
[42] Map of the UK TIC centers is available in Appendix D, Figure 9

enhancing industrial competitiveness and economic growth and strengthening [our] national security"[43].

The program is focused on three specific goals; to facilitate technological transition, to accelerate the manufacturing workforce, and to ensure stable and sustainable infrastructure. The NNMI hopes to achieve these goals through the development of a series of manufacturing innovation institutes that focus on creating more collaborative research and development that also supports the education, training, and workforce development programs. These programs work on both an institute-level and a network-level[44].

The institute level focuses on the local partnerships between research institutions, private organizations, and governments while the network works to establish a nation-wide collaborative environment that shares best practices, technological limitations, and common interests. This two-tiered system enables not only cross-sector collaboration, but a cross-industry collaboration that expands the innovative ecosystem past that of the industry and regional silos.

The NNMI enables the Unites States to focus its development into specific regions while establishing itself as a global leader in manufacturing commercialization. The project has funded seven institutes with specific industry focuses and private sector partnerships. Through this engagement the local economies will see improvements in both their economic performance and workforce talent pool.

[43] Executive Office of the President National Science and Technology Council Advanced Manufacturing National Program Office, "National Network For Manufacturing Innovation Program Strategic Plan", 2016
[44] A map of the 2016 NNMI network is available in Appendix E, Figure 10

The Canadian Supercluster Initiative

The Canadian Super Cluster initiative is a federal-level program that engages both the public and private sector in industry-focused regional development. The program is administered through ISED (Innovation, Science and Economic Development) Canada. The program is split up into five regional "superclusters"[45] that share a federal investment of $950 million that is matched by private-sector partners. Each of the superclusters was developed through a two-step process with an industry-led consortium[46] delivering the funding through a four-pillared strategic plan. These pillars are defined as follows[47]:

1. Build a shared competitive advantage for their cluster that attracts cutting-edge research, investment and talent by addressing gaps, aligning strengths, enhancing attributes, and positioning it as a world-leading innovation hotbed;
2. Increase business expenditures on research and development (R&D) and advance a range of business-led innovation and technology leadership activities that will address important industrial challenges, boost productivity, performance and competitiveness for Canada's sectors of economic strength;
3. Generate new companies, and commercialize new products, processes and services that position firms to scale, connect to global supply chains, transition to high-value activities and become global market leaders; and
4. Foster a critical mass of growth-oriented firms, and strengthen collaborations between private, academic and public sector organizations pursuing private-sector led innovation and commercial opportunities to enhance the cluster's pool of resources, capabilities and knowledge.

This program shares similar attributes to the Technology Innovation Centers mentioned previously through its cross-sector partnerships and investments. The 2017 program aims to catalyze economic development in these regions through strategic programming, large-scale

[45] Map of Canadian Regional superclusters is available in Appendix F, Figure 11

[46] The Federal Definition of Industry-Led-Consortium is: The group of firms (i.e. large, small and medium-sized enterprises) and other organizations (e.g., post-secondary and research institutions, not-for-profits, non-federal Crown corporations, etc.). To apply to the ISI, the consortium must include a minimum number of Partner Applicants and be represented by a Lead Applicant

[47] Government of Canada, "Program Information", 2018

industry partnerships, municipal-level industry clusters, and targeted grant programs. Analyzing each of these superclusters presents an opportunity to explore how each regional cluster works to develop its innovative economy and catalyze the economic development of each region.

Digital Technology Supercluster

The Digital Technology supercluster is focused on the pacific coast with the vision "To position Canada as a global leader in digital technology through a supercluster that unlocks the potential of data in the era of the intelligent enterprise"[48]. The supercluster lists the creation of critical mass, productivity, the development and scale of start-up organizations, and the development of British Columbia as a hub for digital technology innovation as the key mission focuses for the cluster.

The strategy projects an incremental GDP growth of $5 billion, an increase of 13,500 jobs, the development of 200 industrial partnerships, the attraction of $200 million in investments, and the engagement of 500 organizations over the next ten years of this initiative. Furthermore, the strategy lists skill development, SME market exposure, ecosystem building, and a movement from research to commercial as key benefits of the program.

The program has focused its approach around expediting the commercialization of its products, platforms and technologies as well as alleviating the existing challenges of its current digital technology ecosystem. The program cites the solutions to the existing challenges as:

1. Leverage the existing investments into research and innovation capabilities of the region

[48] Canada's Digital Technology Supercluster. "Canada's Digital Technology Supercluster Business Plan 2018-2023", 2018

2. Accelerate the commercialization and growth of BC's small businesses by connecting them to customers, partners, investors and market opportunities
3. Maximize the potential for spillover benefits between traditionally siloed organizations and industries
4. Protect, expand and create role and job opportunities for Canadians
5. Uncover the unique challenges and gaps in the ecosystem that, if solved, could have multiplicative and multifactor benefits across organizations and industry sectors[49]

The supercluster aims to achieve this approach through "delivering strong interconnected regional innovation ecosystems; strong R&D partnerships; excellent digital technology platforms and projects; a high-quality technology portfolio; and, digitally skilled talent for entrepreneurship and scaling companies"[50]. Governmental oversight over the ecosystem along with strong institutional partnerships are required in order to successfully accomplish the approach being presented by the Digital Technology supercluster. Further developments in the physical clustering of organizations to enhance the occurrence of knowledge exchange, for example, locating high volumes of commercial organizations around institutions, will ensure optimization in the collaborative capabilities and commercialization of R&D technologies.

Protein Industries Supercluster

The Protein Industry supercluster is located in Canada's prairie provinces with a vision of positioning "Canada as a leading global source of sustainable, high-quality plant protein and plant-based co-products, while substantially contributing to Canada's economic growth and international trade"[51]. The supercluster is focused on Agri-innovation and looking toward regulation practices, access to talent, research capacity, access to capital, intellectual property

[49] Canada's Digital Technology Supercluster. "Canada's Digital Technology Supercluster Business Plan 2018-2023", 2018
[50] Canada's Digital Technology Supercluster. "Canada's Digital Technology Supercluster Business Plan 2018-2023", 2018
[51] Canada's Protein Industries Supercluster, "Protein Industries Canada Five-Year Supercluster Strategy", 2018

value, and data management as key factors to be addressed during the five-year development plan.

The plan projects a GDP impact of $4.5 billion and an increase of 4,500 jobs due to the supercluster initiative. The Pea and Canola oil processing project[52] exemplifies the application of this program on a provincial and municipal level. This $19.1 million project was created to commercialize the development of plant-based protein technology. The project gathered funding from a consortium investment of $9.5 million and a supercluster government investment of $9.6 million. The investment will assist in increasing Merit Functional Foods 'capacity from 20,000 metric tonnes per quarter to 100,000 metric tonnes per quarter, thus increasing the volume of produce being purchased from neighboring farmers in the Province.

Targeted regional investments in Agri-innovation technology not only uplifts the company directly, but also works to further develop and invest in the regional network of farmers and distributers. Through these strategic investments this supercluster is working to engage the prairie provinces in the development of their Agri-innovation industries. Further development in the zoning, land use guidelines, and land use planning of Agri-innovation clusters will help to further support the growth of this supercluster and the innovative industry within the region.

[52] Protein Industries Canada, "Protein Supercluster Invests into Novel Pea and Canola Processing", 2020

Next Generation Manufacturing Supercluster

The Canadian Next Generation Manufacturing supercluster in Ontario and Quebec is designed with the vision to "leverage Canada's technology and industrial strengths to accelerate the development, adoption, and scale-up of world-leading capabilities in Canadian manufacturing"[53]. This supercluster region is focused around the strong automotive and manufacturing industry in southern Ontario.

The Next Gen Manufacturing cites collaboration and institutional engagement as two existing limitations in the regional manufacturing ecosystem. The report writes," Current institutional and funding structures also make it difficult for companies to undertake collaborative innovation projects that are meaningful for their business, carried out on industry terms and timelines and that allow them to draw on the researchers and resources they need from across the ecosystem"[54]. The supercluster hopes to establish stronger connections across organizations in the region through an investment in manufacturing research and development along with an online capabilities database.

Although an online database is valuable to the cross-collaboration of companies, further development of satellite campuses closer to the manufacturing sites would allow more optimized engagement with institutions. This strategy would further the knowledge exchange across the industry and allow more research and development capabilities.

[53] Next Generation Manufacturing Canada, "Next Generation Manufacturing Canada Advanced Manufacturing Supercluster Five-Year Strategy", 2018
[54] Next Generation Manufacturing Canada, "Next Generation Manufacturing Canada Advanced Manufacturing Supercluster Five-Year Strategy", 2018

Scale AI Supercluster

The Scale AI supercluster is located in Quebec and the Quebec-Windsor corridor with the vision of "building the next-generation supply chain and boosting industry performance by leveraging AI technologies"[55]. The supercluster notes that the location was decided due to the volume of technology hubs that already exist in the region. It is through this work that the supercluster hopes to leverage large-scale players and their nation-wide presence while also creating dense national operation networks of supply chain players and developing a nationwide network of AI and supply chain researchers. This supercluster is expected to introduce $16.5 billion into the GDP and create more than 16,000 jobs over the next ten years.

The supercluster initiative is organized around five streams[56]. These streams include AI-powered chain adoption, the commercialization of AI-powered chain solutions, SME AI scale up support, current and future workforce development, and collaboration development. The supercluster hopes to develop a more integrated innovation ecosystem that supports the existing network of institutions and organizations working to usher in the technologies of tomorrow through these five streams

This initiative also includes a sustainability focus. The supercluster business plan notes the value of the program to sustainability practices writing, " As the value chain shifts depending on factors such as cyclicality, seasonality and other environmental and economic value, dynamically optimized and modular supply chains will allow for the creation of new products

[55] Scale AI, "Strategic Plan", 2018
[56] Stream visualization is available in Appendix F, Figure 12

and services related to time-based and collaborative optimization"[57]. Canada will become a leader in sustainable practices like optimized transportation modalities, waste reduction, and improved material flows through the development of AI-powered supply chains.

One of the key municipalities engaged in this supercluster is Montreal. Montreal has been noted as a world-class AI hub through its $1 billion investment in university R&D, 11,000 university students engaged in AI and data-related programs, more than 20 corporate AI labs, 20 VC-backed startups, and its selection as the headquarters of the Scale AI Supercluster[58]. This supercluster has seen a $313 million investment from the Scale AI supercluster for talent development and an additional $329 million to accelerate the adoption of AI in Quebec. The high volume of investment along with the concentration of universities and corporate entities enables an environment that is conducive to successful and fluid knowledge exchange. This cluster will continue to see rapid economic and scientific growth through this concentrated focus and organizational proximity.

Ocean Supercluster

The Ocean supercluster is located in Atlantic Canada with the vision to "Realize the potential of Canada's ocean economy to establish and grow companies, achieve commercial outcomes, and engage in cross-sectoral collaboration"[59]. The region is hoping to introduce an influx of $14 billion into the GDP and more than 3,000 new jobs to the economy over the next ten years through this initiative. The supercluster notes that the region currently has 600 marine

[57] Scale AI, "Strategic Plan", 2018
[58] Visualization of the organizations is available in Appendix F, Figure 13
[59] Canada's Ocean Supercluster, "Canada's Ocean Supercluster Strategic Plan 2018-2023", 2018

and ocean tech firms, over 10,000 fishing enterprises, and more than 10 major research centers with a highly skilled workforce.

The supercluster strategy report lists indigenous communities as a crucial partner in the development of the regional cluster within its engagement and connectivity strategy[60]. Here the program highlights the indigenous community as a key stakeholder alongside research institutions, NPOs, and SMEs. The empowerment of the indigenous community as a participant in the ocean economy is thoroughly addressed within the innovation ecosystem report. Here they note that:

> Working with Indigenous organizations, the OSC will support: participation and collaboration in TLPs and IEAs through the Indigenous Engagement and Participation Activities (IEPAs), indigenous founders creating ocean tech companies, and indigenous entrants into oceans-related workforce and research opportunities[61]

The acknowledgement and inclusion of the indigenous community within the ecosystem enables more social equity within the current ocean innovation economy. This engagement ensures that the indigenous voice is included and empowered through the development of the regional cluster.

The high cost and risk of ocean innovation and the integration of the innovation ecosystem are the two key challenges in the regional cluster. Furthermore, the document explains that a lack of shared infrastructure, regional connectivity, scale of supply chains, and commercialization from post-secondary institutions are the major gaps in the industry. These gaps can be addressed through the development of a program headquarters where there is a high

[60] Canada's Ocean Supercluster, "Innovation Ecosystem Strategic Opportunities", 2018
[61] Canada's Ocean Supercluster, "Innovation Ecosystem Strategic Opportunities", 2018

concentration of programming, startup development, and shared laboratory space. This would enable there to be more connectivity and communication throughout the cluster, thus alleviating the disconnects that currently exist in the region.

Land Use Planning for Innovation Clusters

The design of space in relation to innovation development has been explored by Maria P. Roche whose 2019 study analyzed how the layout of cities affects innovation though the organization of knowledge exchange. In this work she highlights physical connectivity as one of the most important factors in this network:

> A more strongly physically connected environment creates greater potential for interpersonal encounters and enables a more efficient organization of interaction. This should positively affect the extent to which interpersonal knowledge exchange occurs since both the number of contacts and the amount of time spent with partners relative to the time spent traveling increase with higher physical connectivity.[62]

Roche further supports this notion through her quantitative analysis of both a micro-geographic lens assessing innovation outcomes and an analysis of how the physical features of a neighbourhood can affect innovation outcomes. Through these analyses she was able to find a causal relationship between physical space and innovation while also highlighting a "dense local infrastructure" as the most optimal design typology for innovation. Here she states, "in light of initiatives such as the 'Smart City 'the importance of spaces for social interaction and connectivity between people should be stressed. As such, street infrastructure can be viewed as

[62] Roche, Maria P., "Taking Innovation to the Streets: Microgeography, Physical Structure and Innovation.", Review of Economics and Statistics:1-47.15, 2019

an important input and source of competitive advantage for metropolitan areas and for firms located there" [63].

Both municipalities and private sector corporations have started to engage in these practices through design guidelines and corporate campus master plans. These entities can generate hubs where ideas and infrastructure is shared, thus generating aspirational places to work and live through these optimized spatial patterns.

Land Use Design & Smart City Technology in Corporate Technology Campuses

Today's technology campuses exemplify the future of innovation-focused urban design. Apple Park, Googleplex, Microsoft, and Amazon HQ2 all work to redefine their municipal economies while also reshaping the urban and regional frameworks of the cities in which they reside. Memoori, a smart building research organization, discusses key elements of these plans in their discussion of Microsoft's Redmond Campus:

> The modern workspaces throughout the campus will promote collaboration and productivity, providing areas that help generate creativity and allow for focused concentration, in line with the latest in workplace design theory. Employees will have an abundance of natural light across the campus through an almost ubiquitous glass exterior, and the "neighborhood and courtyard concept" encourages employees to transition from outdoor to indoor spaces more seamlessly[64]

These elements support the conclusions made by Roche in her research and further develop a framework around the types of land uses and design guidelines that can be implemented in municipal innovation clustering plans. Through a case study of Microsoft's Redmond Campus

[63] Roche, Maria P., "Taking Innovation to the Streets: Microgeography, Physical Structure and Innovation.", Review of Economics and Statistics:1-47.15, 2019
[64] Memoori, "New Campuses Big Tech Companies Offer a Glimpse into the Future", 2017

one can further explore the types of technologies and landscapes being deployed to generate the environment needed to foster collaboration and innovation.

Microsoft's Redmond Campus in the United States

Microsoft began constructing its Redmond campus in January 2019 with the focus of developing "a community plaza where employees can gather, learn, and play. Car-free zones and a cross-campus bridge just for pedestrians and bicyclists. Energy-optimized smart buildings; spaces to spark creativity with teammates; trees, trails, and transit close at hand" [65]. In breaking down this vision one can notice sustainability, physical connectivity, and smart building technology as the key elements to this project. Each of these elements is apparent throughout the planning documentation.

In defining its sustainability focus, Microsoft cites its corporate sustainability mission which is stated as a continuance "to place emphasis on resource management and conservation while driving innovation in the areas of energy, carbon, water, and ecosystems"[66]. The organization incorporates this focus in its masterplan design through its forest thread[67], commute reduction program, LEED certified buildings, and a zero-waste certification for the campus.

The design of the campus supports the physical connectivity attributes needed to create a successful network of knowledge exchange while also supporting the community in which it

[65] Velush, "The Workspace of the Future", 2019
[66] Microsoft, "Campus Fact Sheet", 2019
[67] Available in Appendix G, Figure 15

resides. The site's master plan renderings[68] supports a strong network of activated open space and pathways that connect the buildings[69]. The site also works within the existing community network through its connection to the office and residential zones[70] near the site as well as its multi-model access[71] that welcomes vehicle, pedestrian, public transit, and bike transportation.

Microsoft also engages in Smart City technology[72] to further enhance its campus environment. The company discusses the use of Azure for building monitoring and energy use optimization. This cloud computing service uses the Internet of Things platform to "model [your] physical space digitally and, importantly, to layer in the real time location of where people are in that physical space and what devices they are using"[73]. This type of technology enables building infrastructure optimization for such attributes as security, fire safety, access control, power generation, lighting, and wireless connections.

The Microsoft Redmond Campus demonstrates a multi-purposed approach towards innovation that engages sustainability, community connectivity, and smart city technology. This masterplan strategy presents an example of how municipalities may engage in an innovative cluster design strategy while also enhancing the environmental wellbeing of the communities in which it exists.

[68] Available in Appendix G, Figure 14
[69] Available in Appendix G, Figure 16
[70] Available in Appendix G, Figure 17
[71] Available in Appendix G, Figure 18
[72] Available in Appendix G, Figure 19
[73] Velush, "New Microsoft Smart Buildings Showcase Azure Digital Twins", 2018

Land Use Guidelines in the False Creek Flats in Canada

Vancouver has engaged in land use planning for innovation clustering through its False Creek Flats land leasing project. This project provides a 99-year land lease to a private sector developer with specific zoning, design guidelines, and contingencies that are targeted towards attracting creative innovation-focused organizations and industries. The city of Vancouver cites a focus on high density, mixed-use development with the incorporation of both a "centre of arts and cultural entrepreneurship" and "non-market industrial arts production space for the City of Vancouver". This project estimates the creation of 8,000 to 30,000 new jobs[74] along with the development of activated public spaces as some of the opportunity points of the project.

The False Creek Flats project engages in targeted innovation clustering throughout both the RFP and project area documents. The building guidelines in the project RFP specifically focus on the development typologies that are the most conducive to a creative arts and culture industry:

> These spaces would include high ground floor, some double-height spaces to allow for moving large works and stage sets in and out to support the theatre productions throughout Vancouver's downtown. Synergistic market uses will be encouraged to collocate with the industrial arts anchor to establish a world class centre of art production and cultural economy[75]

Applying a land leasing methodology with industry-specific building guidelines enables Vancouver to establish a targeted innovation cluster that also revitalizes a blighted section of the urban core. This focus is carried through the public space design guidelines.

[74] City of Vancouver, "False Creek Flats Plan", 2020

[75] Reinventing Cities, "Vancouver Innovation Hub, Main Street & Terminal Avenue, City of Vancouver, British Columbia, Canada", 2018

Within the False Creek Flats area plan the project notes a key focus of the public realm design as "Creating unique, vibrant, attractive, interesting and amenity rich environments that appeal to the increasingly mobile employees of the twenty-first century is essential for unlocking the potential of any economic district in today's cities"[76]. Such components as connectivity, activated open space, green space connections, and parkland are highlighted throughout the strategic directions. Furthermore, the directions highlight economic cluster connections in the public realm. It is in this direction that the city writes to "Establish a clear hierarchy of well-connected places to strengthen economic clusters within each character sub-area"[77].

These types of public design typologies demonstrate many similarities to the innovation design typologies listed by Maria P. Roche and practiced by the Microsoft Redmond Campus plan. A center point of the public realm design within this project is having activated open space that connects the community and encourages knowledge-exchange. This project hopes to tailor the False Creek Flats to the needs of an up-and-coming creative-innovations industry through the engagement of both the land use and design guidelines.

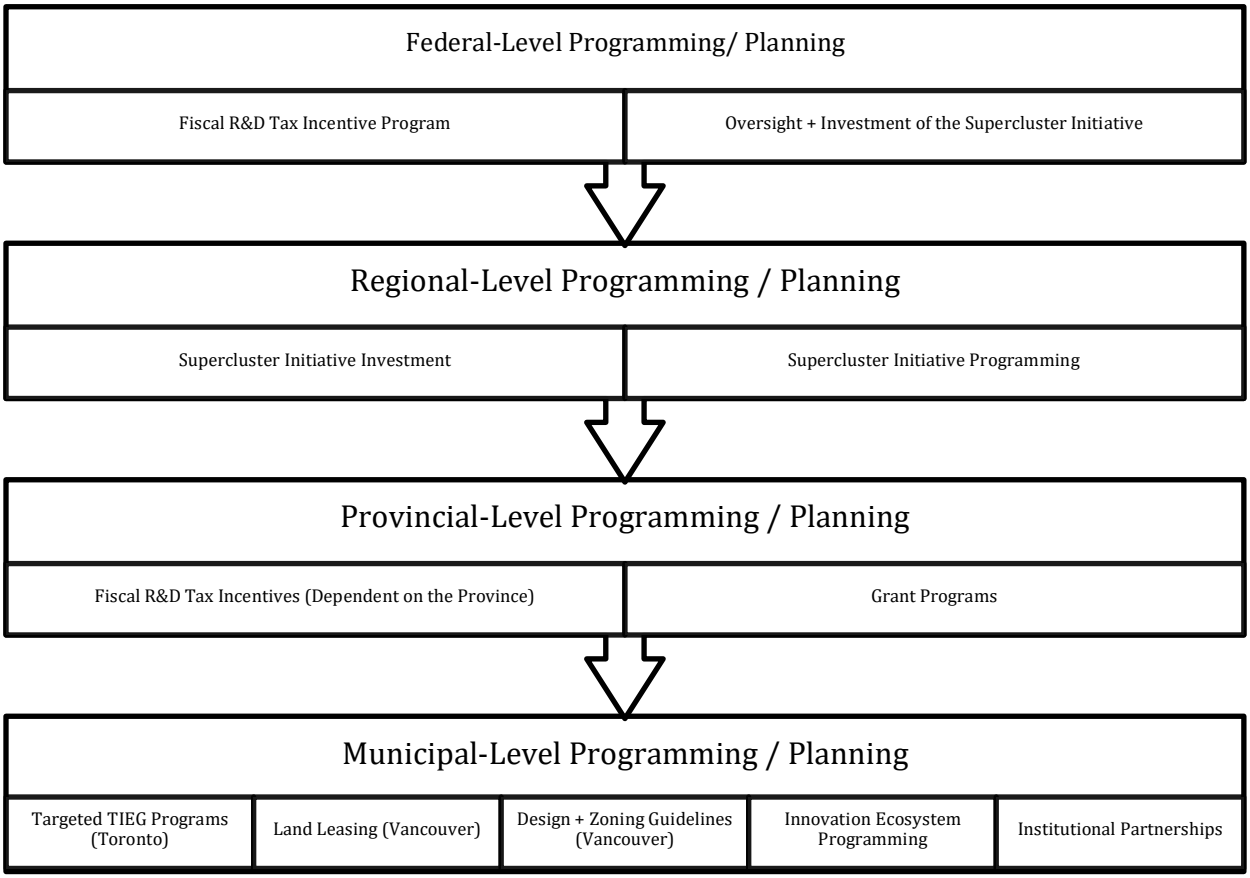
[76] City of Vancouver, "False Creek Flats Area Plan", 2017
[77] City of Vancouver, "False Creek Flats Area Plan", 2017

Analysis

The Canadian Innovation Cluster Ecosystem

The innovation cluster ecosystem is a complex structure that required both a cross-industry collaborative environment and multi-tiered governmental focus. These programs leverage land use, regional, and fiscal planning in different capacities to alleviate fiscal development limitations while also clustering innovative industry and generating a public realm that supports knowledge exchange.

An Innovation Ecosystem Map Across All Governmental Tiers



Cross-collaboration between stakeholders is an important element that must be developed more within the innovation ecosystem in Canada. Although each tier is effectively utilizing its tools to incentivize innovation clusters, it seems that the current system is disjointed. For instance, the creative-hub cluster in Vancouver does not align with the digital supercluster focus in British Columbia and the Agri-Innovation cluster in Guelph resides outside of the Protein Supercluster in the prairie provinces

Many regional super cluster initiatives are not translated into municipal-level innovation clustering programs and plans. This limits the capability of the super cluster program to successfully implement the strategic goals presented in each business plan while also losing a valuable opportunity to leverage the financial benefits of the almost $2 billion program.

Scale AI presents an example of successful cross-tier collaboration within the development of its supercluster. This program focused its initiative within Montreal and furthermore developed a supercluster headquarters within the city. This program is not only able to successful leverage the expertise, private-sector relationships, and financing from the supercluster, but also engages in the TIC model that helped to make the innovation network in Germany, the UK and the US more efficient.

These regional programs need to designate municipal headquarters or TICs within the regional super cluster and develop their municipal-level or regional-level initiatives around those headquarters. A simple system would designate a TIC within each municipal-level network, as seen in Germany and the United States, while a more complex program would also enact

regional TICs, like that of the United Kingdom, as well. It is through this network of innovation headquarters along with an aligned innovation clustering system that this program will reap the most benefits.

The design attributes of the municipal cluster must also be acknowledged within the planning process. The design practices must look toward activated open spaces, co working space, smart building technology, connectivity, and sustainability as foundations to the clustering project. Looking toward locations with physical proximity to institutions and creating connections to the existing residential network should also be included in the planning strategy. Through the application of these elements in the physical design of the project or plan these innovation clustering strategies would best support the development of collaboration and knowledge exchange.

As we look toward designing the future of Canadian cities in the world of innovation clusters, it is crucial that these key elements are included in the planning and development. There must be governmental alignment, a physical center of the program, and there must be a design that welcomes collaboration and communication. Canada can efficiently deploy its supercluster strategy and successfully develop a system that attracts organizations and talent from around the world to relocate to this country through these elements.

Evaluating Innovation Clusters

The success of municipal-level innovation clusters can be measured through an evaluation of its alignment to higher-tier programming, it's key design elements, Porter's Competitive Diamond Model[78], and the Global Institute on Innovation Districts 'Key Performance Indicators. These models evaluate the capabilities and growth of these clusters while preempting the impacts to the economy, the citizens, and the environment. Introducing these three evaluation standards will enable municipalities to intermittently analyze and track their innovation cluster strategy while highlighting the limitations and impacts of the projects.

Alignment to the higher-tier governmental priorities can be measured with the same methodology as a traditional planning rational. This evaluation will require planners of municipal-level innovation clusters to go through each governmental tier's innovation program and ensure that their project matches the goals, tools, and programs outlined within the business strategies and policies. For instance, an innovation cluster program in Toronto would align with the Federal R&D tax credit program, the Ontario R&D Super Allowance, the Ontario Innovation Tax Credit, and The Regional New Manufacturing Supercluster priorities. The municipality would efficiently leverage all the tools and capabilities of the higher tiers of government through this strategy.

[78] Porter's Competitive Diamond Model is visualized in Appendix Figure 2

The design evaluation ensures that the municipal-level cluster is effective in the development of knowledge-exchange and collaboration. This methodology should align with the factors outlined by Maria P. Roche and should also include shared features from today's top technology campuses. This evaluation will enable planners to design engaging spaces that welcome top talent and provide valuable shared resources for both institutions and private sector organization. Through this design strategy Canada will effectively engage top industry specialists while also accelerating the R&D life cycle.

A key element of the Porter Competitive Diamond model is the utilization of the four pillars (firm context, factor conditions, supported industries, and demand conditions) to analyze and observe the economic inputs and outputs for the region. It is through this model that one can organize their municipal innovation clustering strategy to ensure that all four pillars are sufficiently addressed. An example of this analysis can be seen through Wonglimpiyarat's analysis of Silicon Valley[79]. Each pillar is aligned with at least one factor of the Silicon Valley development strategy and works to understand the ways that each component impacts the success of the region. One can further establish how the region is developing over time and what elements are necessary to its strong performance through this breakdown. This fiscal evaluation will enable planners to map out the resource capabilities and economic outputs of the municipal-level innovation cluster.

[79] Wonglimpiyarat's Implementation of Porter's Diamond Model against the case study of Silicon Valley is available in Appendix A, Figure 2

The Global Institute on Innovation Districts model is defined as a "tool for public and private leaders to audit the assets that comprise their local innovation ecosystem"[80]. This tool is centered around five main elements that include critical mass, innovation capacity, diversity and inclusion, quality of place, and leadership. Municipalities can utilize this tool to gain further insight into the key elements and limitations of their project while also providing a framework that is conducive to a well-rounded and socially equitable innovation-cluster. This tool is critical in ensuring that innovation-clustering plans are not only economically feasible but provide a benefit to the wider community network as well.

These four evaluation tools work together to create a framework around how Canadian Municipalities should approach its innovation clustering strategy. Current municipal-level initiatives like the False Creek Flats in Vancouver and the Innovation District in Guelph can utilize this tool to further enhance their existing proposals. Future clustering strategies within expanding innovation-focused municipalities can also conceptualize their projects through the lens of these tools and evaluation methods. These methods ensure that fiscal, regional, and land use tools are being leveraged appropriately while also enabling social sustainability, economic feasibility, and R&D acceleration.

Next Steps

This paper has taken a literature-focused approach toward its analysis of the policy and planning programs that currently exist in the Canadian innovation ecosystem. Next steps for this research include a primary-focused qualitative analysis and a translation of this work into a

[80] Wagner.J, Vey.S, Hachadorian. J, Andes. S, Storring, "Addressing Your Innovation District: A How-to Guide", 2018

quantitative innovation clustering grading model. These next steps can work to gain further understanding on why these disconnects are happening within the Canadian innovation clustering system and how this can be alleviated through a model that will objectively evaluate current and future municipal-level initiatives.

The primary research should include interviews with stakeholders from each tier of the Canadian system to understand the processes that have influenced the fiscal, regional, and land use planning decisions of existing clustering strategies. The work should also look toward the private sector to understand their needs. Interviewing private-sector innovative organizations and startups will further exemplify the infrastructure and design attributes that must be present within the cluster. This qualitative work is crucial in developing an understanding of the reasoning behind the current system's limitations and capabilities.

The evaluation next step should work to address process limitations as well as the systemic tools and evaluation methods proposed within this paper. The evaluation should include key performance indicators and set success thresholds within each indicator. Further work would include an evaluation of existing and proposed innovation clusters against this model and an analysis of the strengths and limitations of each innovation clustering project.

These next two steps compliment the conclusions made throughout this research project. Further exploring how the municipal disconnects exist on a systemic level and how one can evaluate these innovation clustering programs will ensure that Canada can efficiently develop these clusters in a way that enhances the economy, ensures social wellbeing, efficiently utilizes

the innovation clustering tools, and has longevity. It is the hope of this work that Canada will be able to efficiently use its fiscal, regional, and land use tools to continue to attract new organizations and support the innovation network that currently exists in the country.

Conclusion

Canada has taken many valuable strides in developing its innovation clustering ecosystem. It has included tax incentivization programs, developed a regional supercluster network, and initiated various municipal-level projects and programs that have ushered in a high volume of innovation investment into the country. The collaborative cross-sector programs are showing strong potential within each governmental tier with some inklings of multi-tier programming as well.

Examples of these cross-tier and multi-sector innovation clustering initiatives are visible through projects like Montreal's Scale AI hub. This hub has engaged in not only the federal and provincial tax programs but has also leveraged the business consortium and programming from the Scale AI regional supercluster. It is through this strong multi-tier alignment, along with the physical development of the Scale AI headquarters in the city, that Montreal has been able to rapidly develop a municipal-level cluster that is supporting institutions, labs, and private sector entities while also engaging in the goals and tools presented by the higher-level governments.

Further alignment and engagement in these initiatives on a municipal level will result in the development of more innovative clusters and yield the rapid development of municipal economies. Applying attributes of other foreign programs can also provide further improvements, for instance applying a TIC strategy or a more targeted R&D grant program.

Exploration into how these disconnects occur, how Canada can absorb best practices from foreign innovation clustering initiatives, and the development of a quantitative grading model will further enhance this economic development methodology and create a more cohesive system.

Urban Planners can engage in this work through the adoption of cohesive master planning strategies that include fiscal, regional and land-use tools while also implementing evaluation methodologies from the Global Institute for Innovation Districts and the Porter Competitiveness model. A cohesive plan should include fiscal tools that incentivize private-sector investment, for example the IMIT TIEG program and targeted grant programs, along with an industry focus that aligns with the applicable regional super cluster business model and finally a land use planning methodology that is conducive to knowledge exchange. This focused approach presents municipalities with the capability to draft municipal plans that boost the municipal economy, further accelerate R&D, and limit disruption to the host municipality.

Canada has the potential to be a leader in the way that it approaches innovation and technology enhancement. It has a strong institutional and professional network. Further channeling this network with its private-sector capabilities across governmental tiers and with an evaluation of economic and social resiliency will ensure that Canada's innovation ecosystem benefits all stakeholders and can catalyze municipal economic growth across the country.

Appendices

Appendix A

Porter Competitive Model

Fig. 1 Porter's Competitive Diamond Model: determinants of regional productivity.

Source: Porter (1990, 2001)

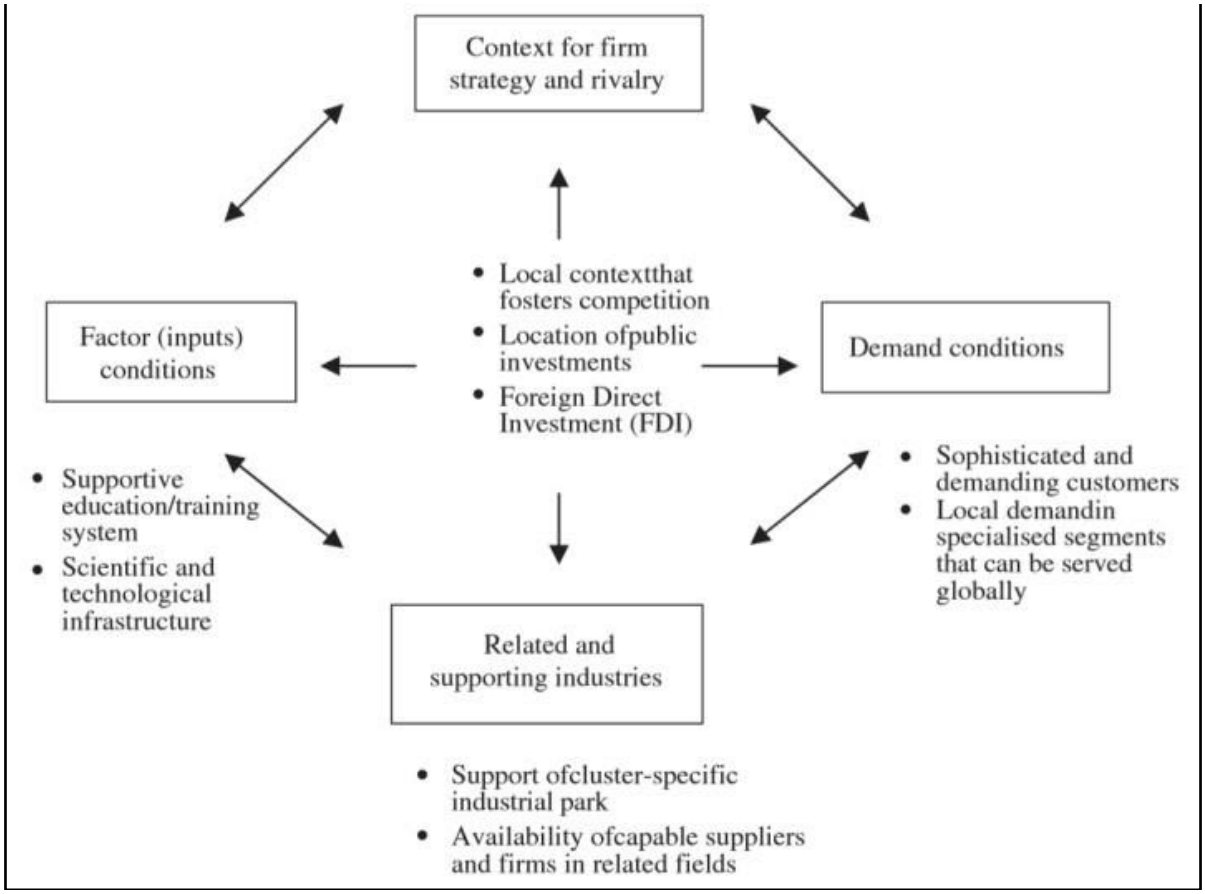


Fig. 2 Wonglimpiyarat's Implementation of Porter's Diamond Model against the case study of Silicon Valley

Source: (Wonglimpiyarat, 2006)

Silicon Valley characteristics according to the cluster indicators of Porter's competitive Diamond Model

Cluster indicators of the competitive Diamond Model	Cluster-specific model of Silicon Valley
1 Context for firm strategy and rivalry	• The culture of risk-taking California-style entrepreneurship • Favourable tax policies, e.g. tax-exempt capital gains and pension funds as investment incentives to facilitate the development of VC market
2 Factor (inputs) conditions	• Substantial degree of information sharing across competing entrepreneurial firms • Cooperation between high-technology firms, research institutions and universities in the cluster • Liquid stock market and angel capital network as the venture channels for investors in Silicon Valley
3 Related and supporting industries	• Government-supported R&D funding programmes (Major programmes shown in Table 2) • Support of cluster-specific industrial park, specialised research centres and education institutions, e.g. Stanford University, Stanford Research Institute, Stanford Industrial Park
4 Demand conditions	• Firms and entrepreneurs work with sophisticated local customers in the California electronics industry for the clusters' products and services, e.g. Intel's high capacity microprocessor, IBM's microcomputer and PC equipment • Collaboration is a major source of innovation as local demand helps focus on critical needs in the regional clusters (electronics-based agglomeration in Silicon Valley)

Appendix B

Fiscal Programs in Canada

Fig. 3 Toronto Finance International's Fintech Ecosystem

Source: (Toronto Finance International, 2019)

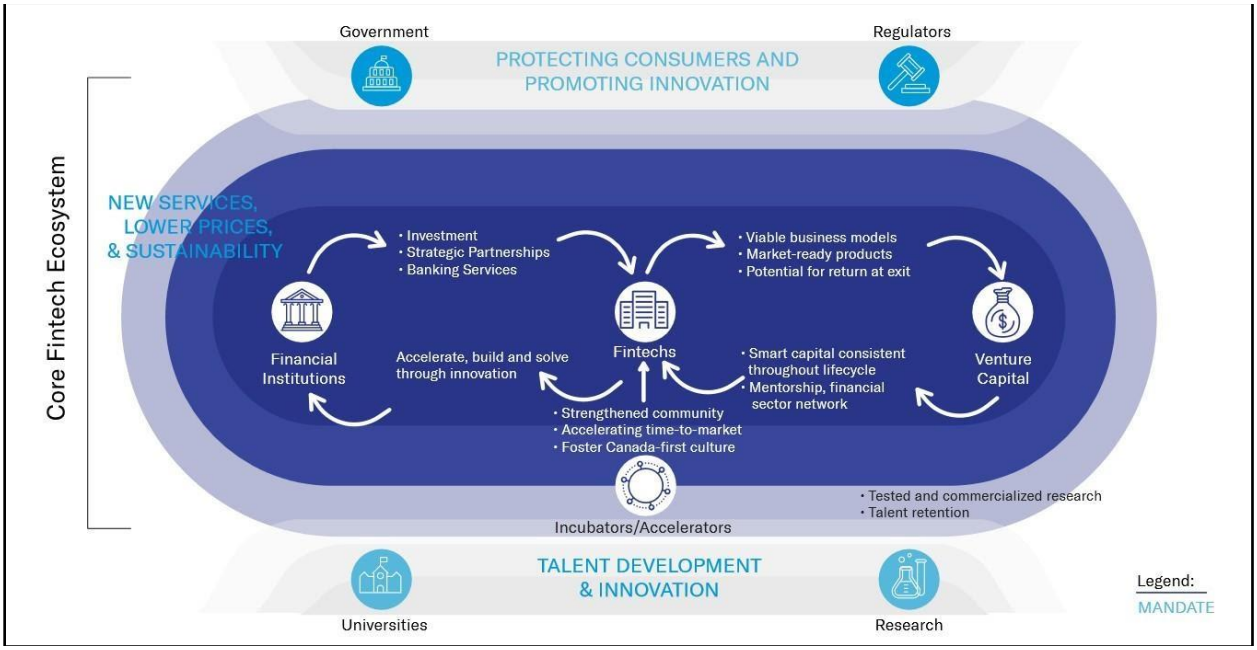


Fig. 4 City of Toronto's Visualization of the IMIT TIEG Grant Program

Source: City of Toronto (2015)

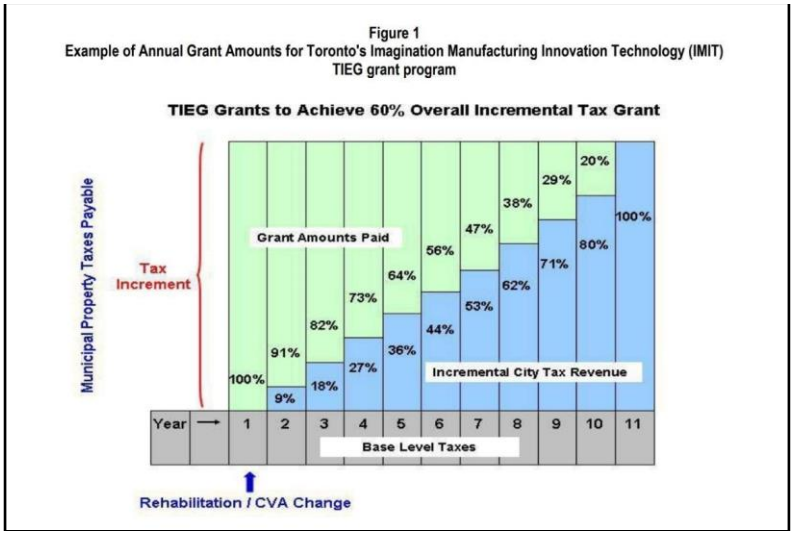


Fig. 5 Example Point Calculations from the IMIT TIEG Grant Program

Source: City of Toronto (2019)

Example 1- Expansion of existing manufacturing facility
28,000 sq. ft., $3 Million in construction value. Estimated total IMIT grant would be $239,400 over 10 years.
A total of 30 points over the 10 year incentive period or 3 points per year would be required.

Ex 1. Sample activities for a local employment plan over a 10-year period

Activity	Point value (per activity)	Activity Level/Unit	Total Points
Provide work placement for building maintenance certification program	3	1 placement	3
Participate in a City recruitment job fair	2	2 events	4
Interview candidates from City-endorsed programs	2	3 interviews	6
Hire individuals from City-endorsed from City-endorsed programs	10	2 hires	20
Total			**33**

Example 2-Data Centre (new construction)
218,000 sq. ft., $58 Million construction value. Estimated IMIT development grant total is $7 Million over 10 years.
580 points required over 10 year grant period or 58 points per year would be required.

Ex 2. Sample activities for a local employment plan over a 10-year period

Activity	Point value (per activity)	Activity Level/Unit	Total Points
Construction Connections Program plan development	30% of total	1 plan	174
Construction Connections - Hires	5	10 hires	50
Work placement building maintenance	3	10 placements	30
Interview candidates from City-endorsed programs	2	20 interviews	40

Appendix C

German Technology Innovation Centers

Fig. 6 The German Technology Innovation Center Role in the Innovation Ecosystem

Source: Fraunhofer (2018)

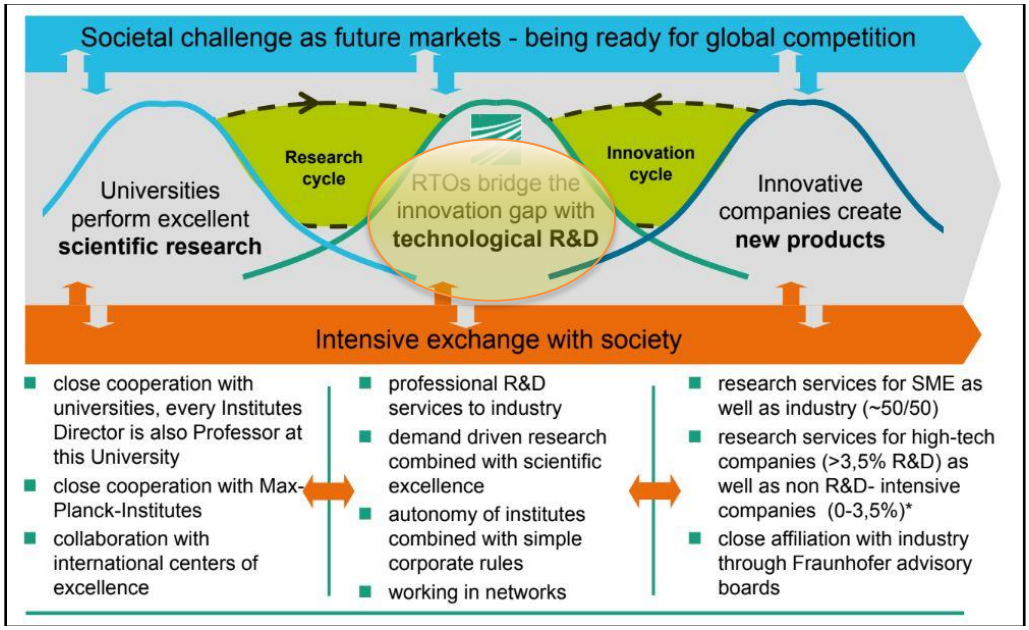
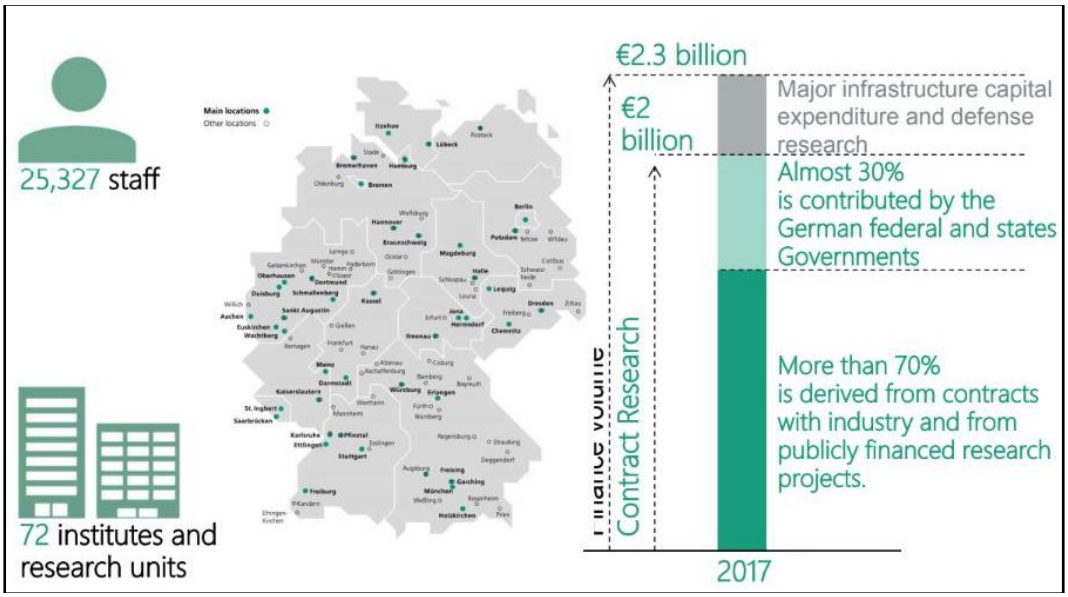


Fig. 7 The German Technology Innovation Center Program at a Glance

Source: Fraunhofer (2018)



Appendix D

United Kingdom Technology Innovation Centers

Fig. 8 The United Kingdom Technology Innovation Center Development Selection Timeline

Source: Technology Strategy Board (2011)

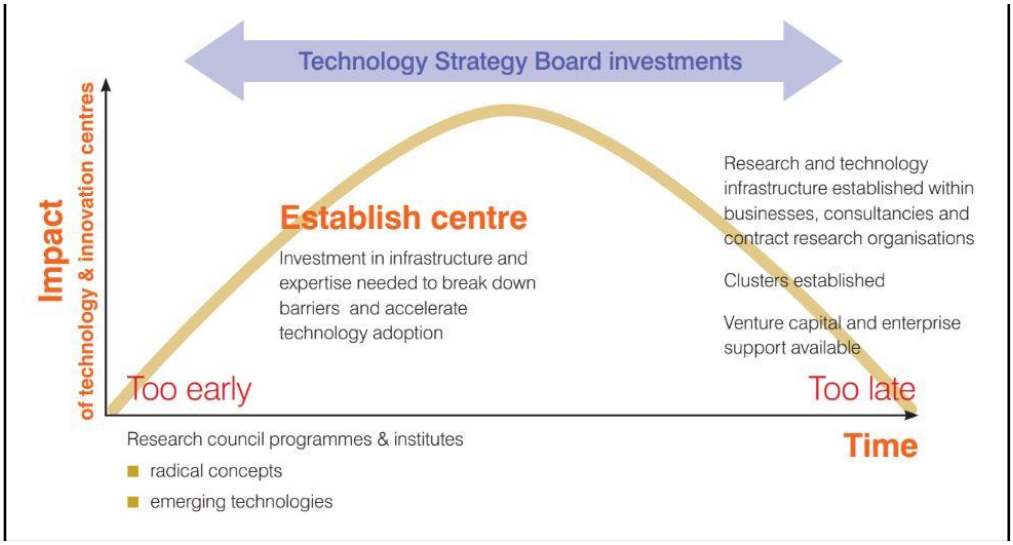
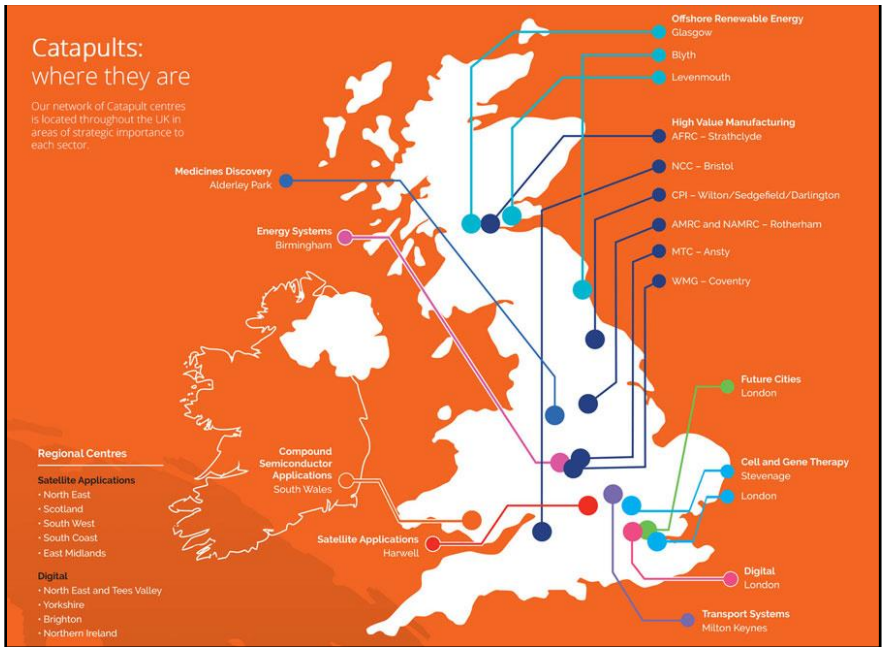


Fig. 9 Network Map of United Kingdom Technology Innovation Centres

Source: Catapult Network (2017)

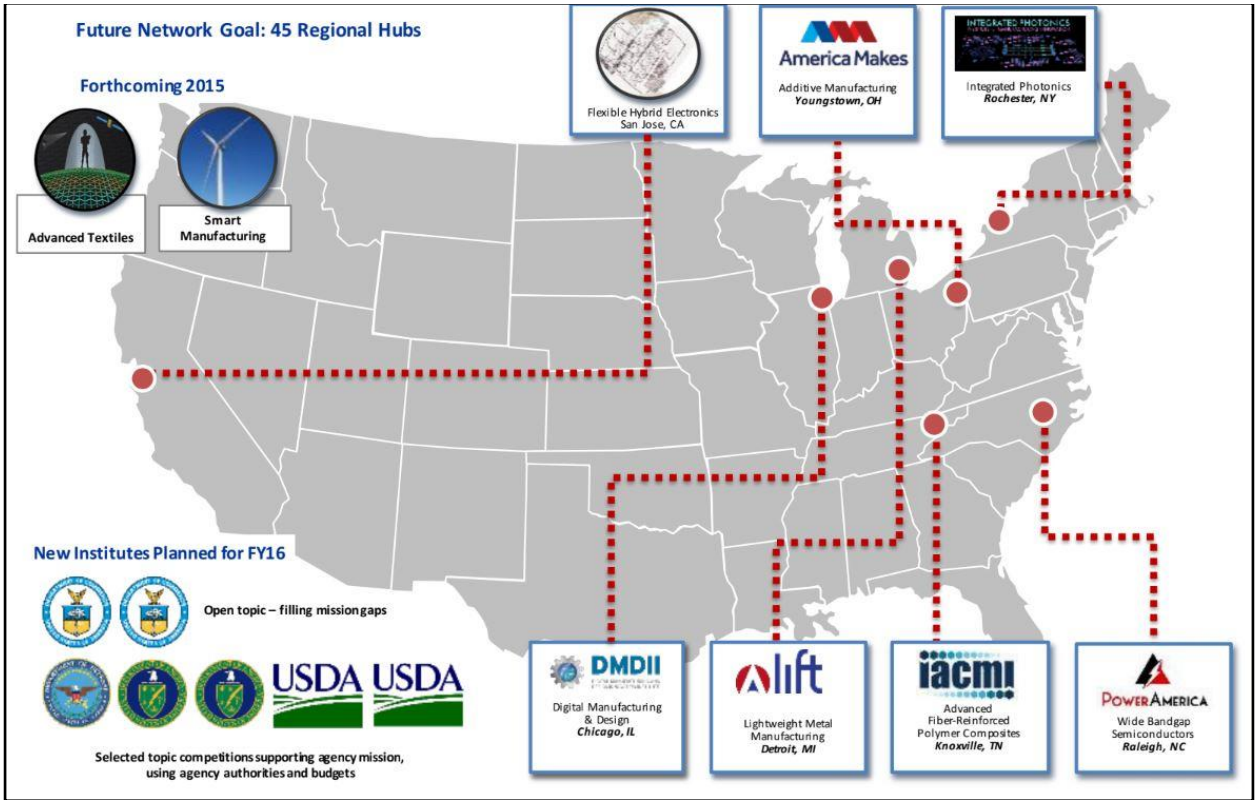


Appendix E

United States Technology Innovation Centers

Fig. 10 Map of United States Technology Innovation Centers

Source: Advanced Manufacturing National Program Office (2015)



Appendix F

Canadian Super Clusters

Fig. 11 Map of Canadian Superclusters

Source: Invest Canada (2020)

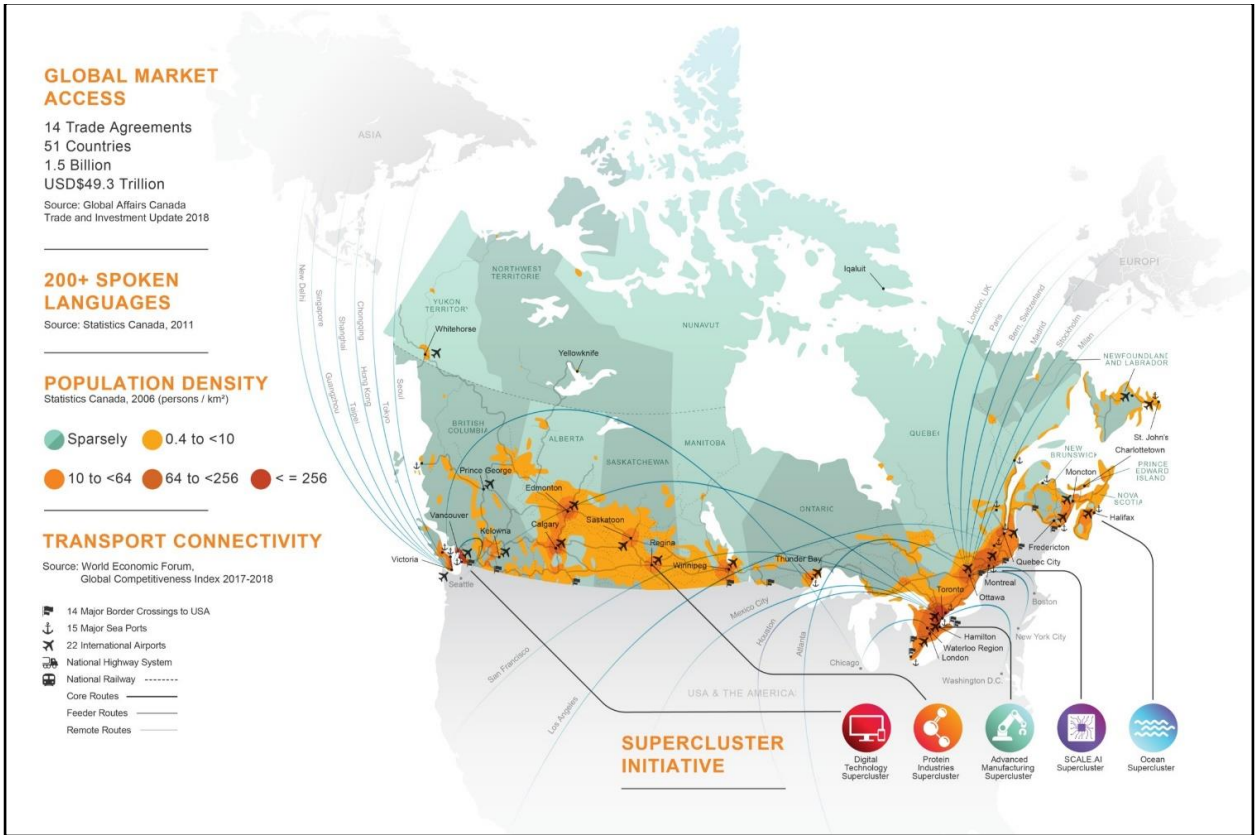


Fig. 12 Scale AI Streams

Source: Scale AI Canada (2018)

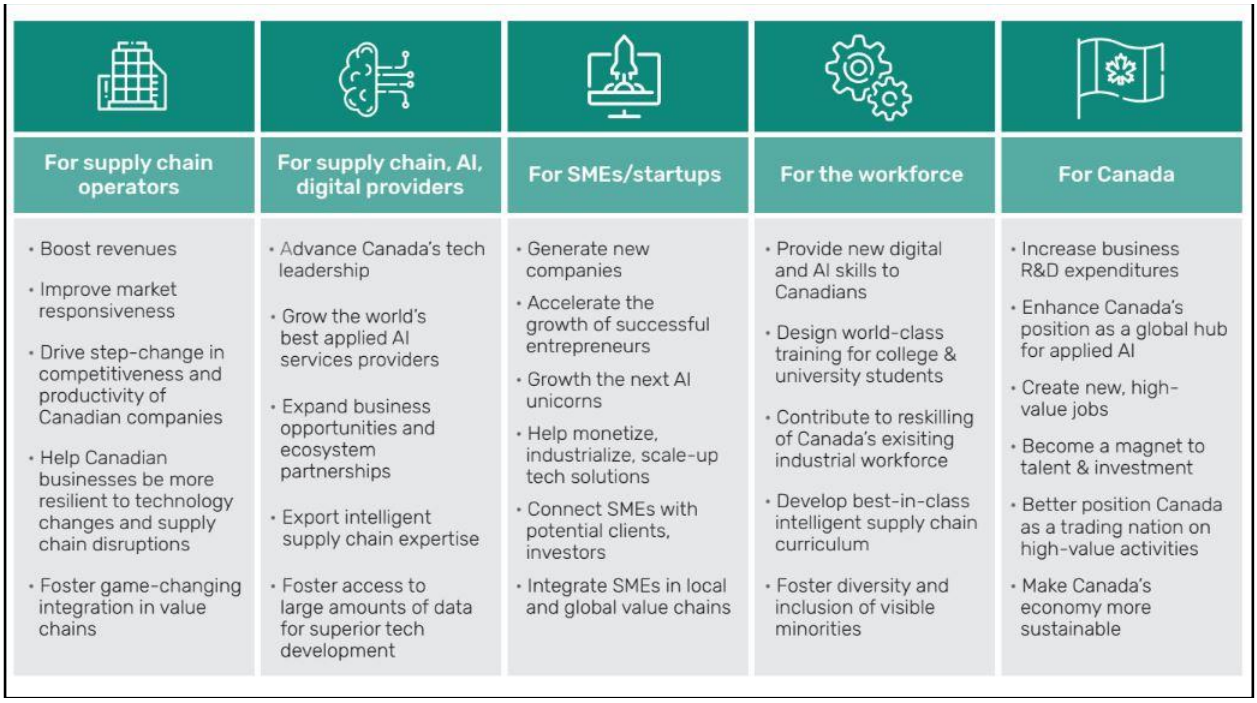


Fig. 13 Scale AI Organization Visual

Source: Montreal International (2020)

Appendix G

Microsoft Redmond Campus

Fig. 14 Redmond Campus Site Plan

Source: Microsoft (2019)

Fig. 15 Redmond Campus Forest Thread

Source: Microsoft (2019)

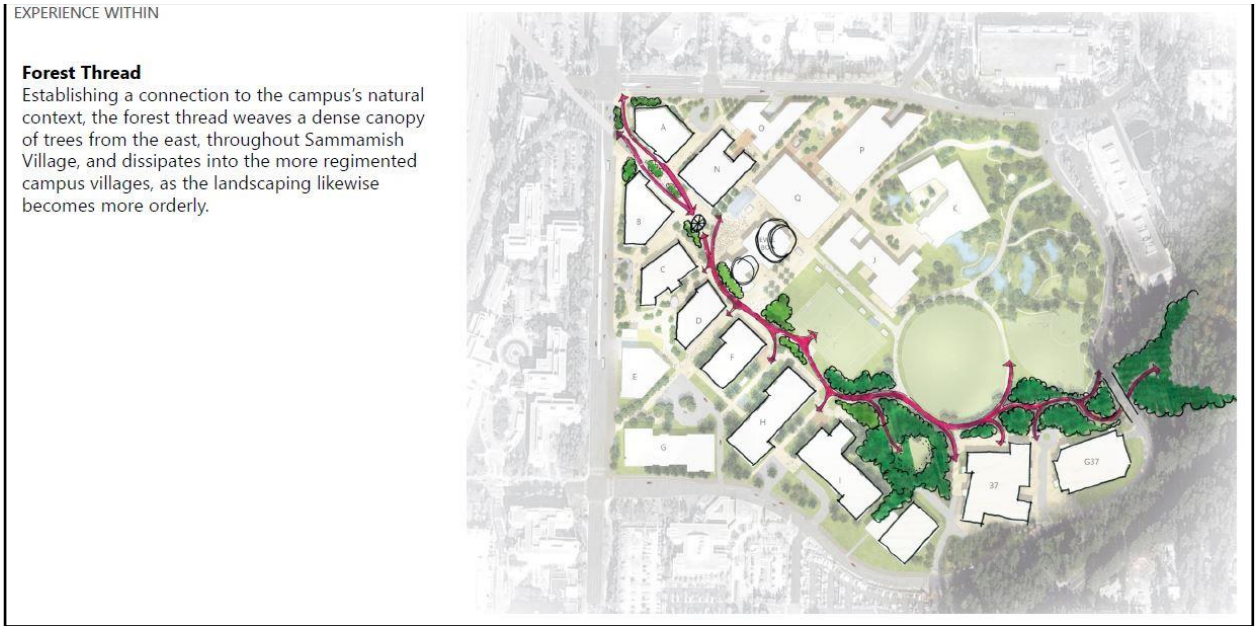


Fig. 16 Redmond Campus Open Space Elements

Source: Microsoft (2018)

Fig. 17 Redmond Campus Prioritizing Connections

Source: Microsoft (2019)

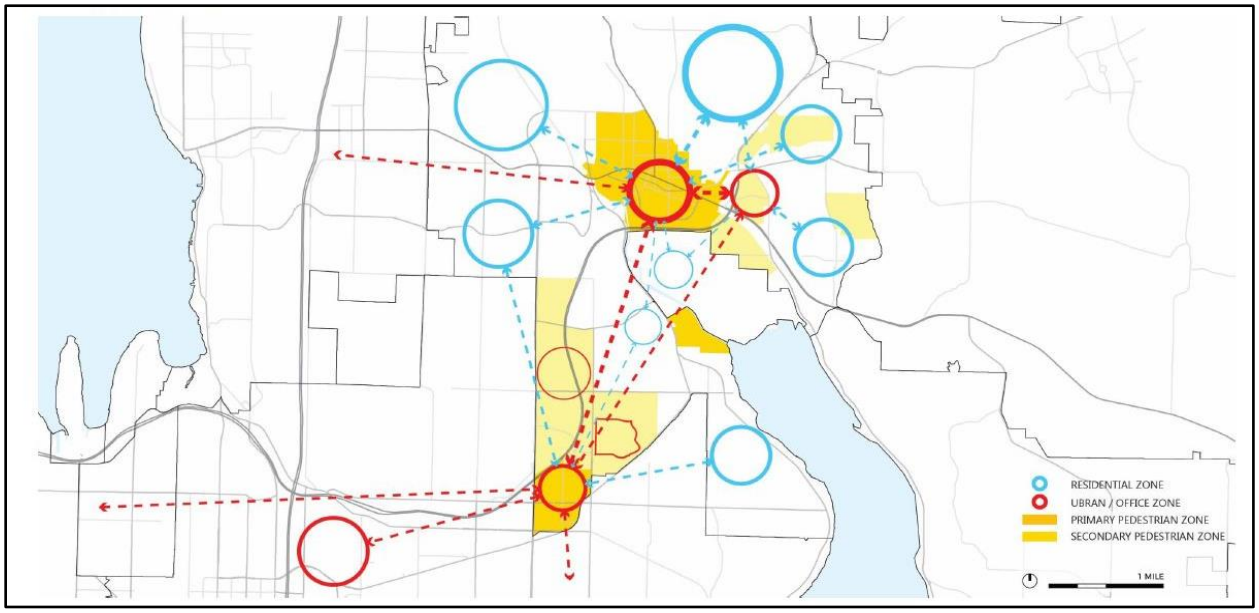


Fig. 18 Redmond Campus Multi-Modal Access

Source: Microsoft (2019)

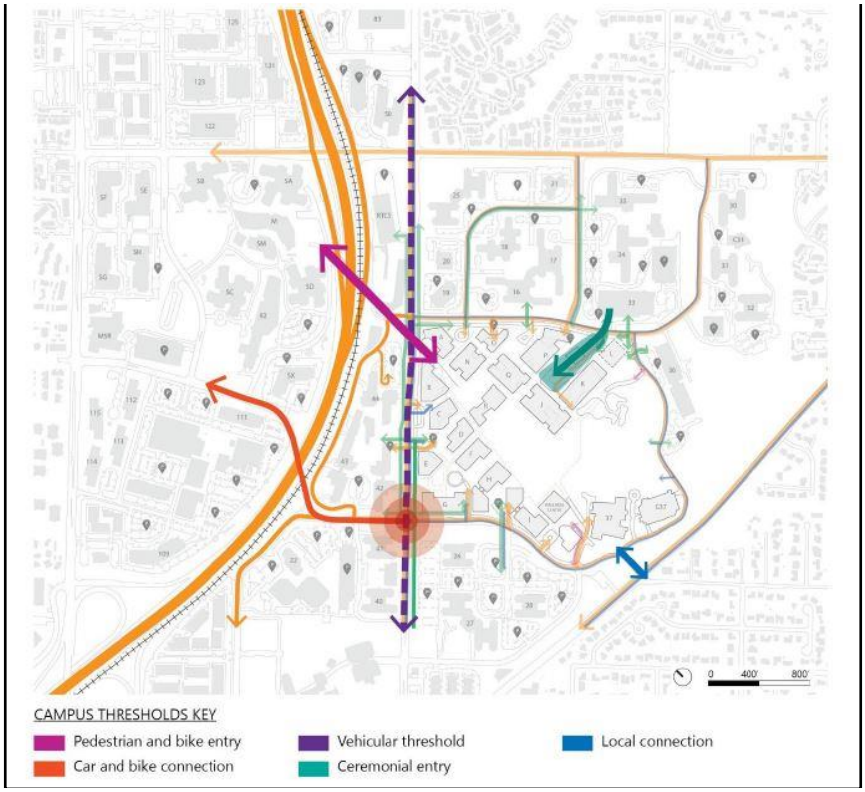
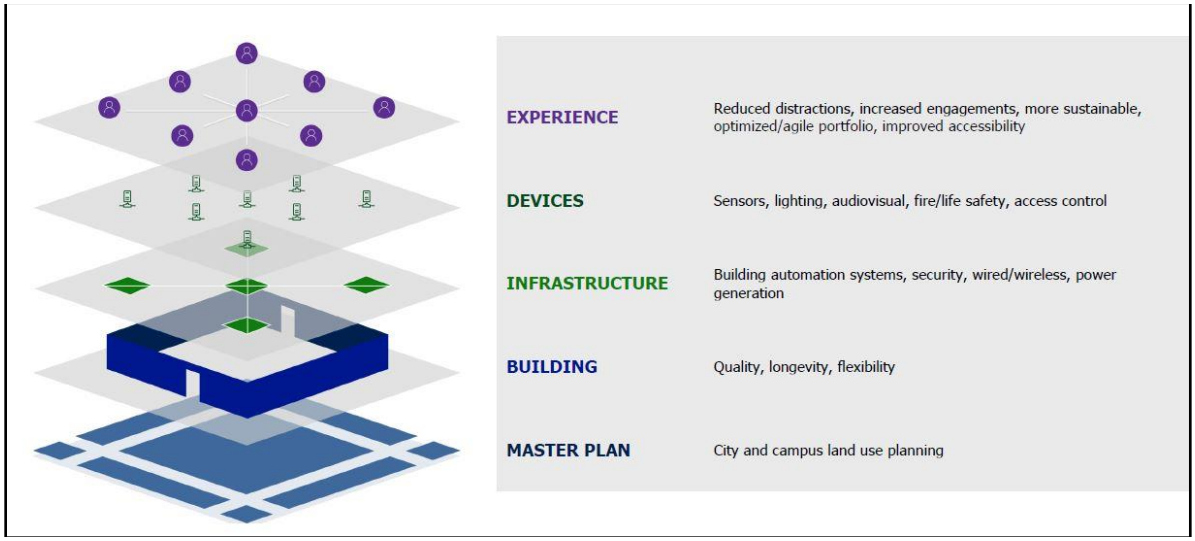


Fig. 19 Redmond Campus Physical & Digital Transformation

Source: Microsoft (2018)



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