Economic Impacts **of Canada's Digital Technology Supercluster**

By Mansfield Consulting Inc.

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EXECUTIVE SUMMARY

Study Purpose

Canada's Digital Technology Supercluster (the "Supercluster") is a cross-industry collaboration of diverse organizations, including many of Canada's leaders in healthcare, communications, natural resources, technology, and transportation. To help quantify its effects on the Canadian economy the Supercluster engaged Mansfield Consulting Inc. ("MCI") to carry out an economic impact study (the "Study") of the Supercluster's operations and supported projects.

Study Scope

The Study examined both near-term and long-term economic impacts. The near-term impacts were defined as being those created through Supercluster operations and supported projects from the time of the Supercluster's incorporation in May 2018 to the anticipated end of its mandate in March 2023. The near-term impacts were first estimated to July 2020 (as that was the most recent date for which complete data were available at the time of the Study), and then extended to March 2023 using anticipated operations spending and project investments.

The long-term impacts were defined as being the projected impacts created over the ten years from the time of the Supercluster's incorporation in May 2018 to April 2028. The long-term impacts consisted of the estimated near-term impacts to March 2023, plus future economic impacts to April 2028.

The Supercluster Creates Economic Impacts Through Pathways that Differ from Those of a Traditional Business

A traditional business creates economic impacts as it earns revenue and spends money on staff, supplies, and other items. A traditional business tends to focus its activities in a particular industry and carries out its activities in a specific year. As a result, it is comparatively straightforward to estimate its economic impacts.

The Supercluster, however, has a different mandate and functions differently from a traditional business. As a result, it creates economic impacts through pathways that differ from those of a traditional business. In particular:

- Leveraging Effect of Partner Co-Investment. The funds invested by the Supercluster are accompanied by additional funds that are contributed by its partners. As a result, because of the leveraging effect of partner co-investment, the impacts created per dollar of Supercluster investment are much higher than what would be realized by a traditional business that has only its own funds to invest.

- Investments in Many Different Industries. The projects in which the Supercluster invests span a wide variety of industries rather than a single industry.

- Attraction of Subsequent Investment from Other Sources. Because of Supercluster investments, some projects are able to attract additional investment from other sources, thereby providing additional leverage from Supercluster investment.

- Investments in Commercialization and Problem-Solving Projects. Supercluster investments are targeted at commercialization and problem-solving projects that are intended to produce long-term effects, such as innovative new products, platforms and processes, productivity gains for Canadian industries, enhanced competitiveness for Canadian businesses, and advances in the delivery of health care services. These long-term effects are, in turn, expected to result in sustained economic impacts.

The pathways through which the Supercluster creates economic impacts are illustrated in Figure A.

Figure A. Creation of economic impacts by the Supercluster
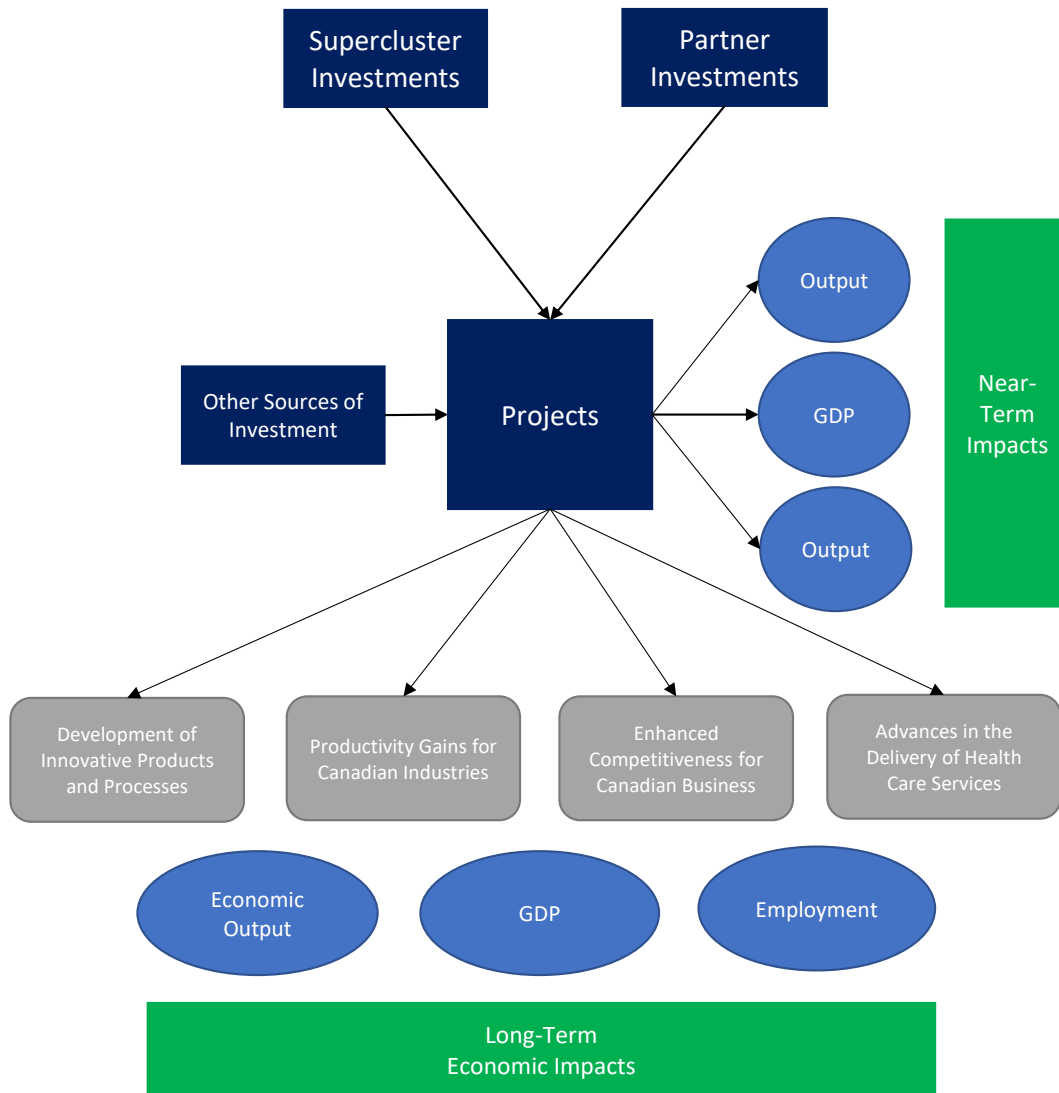
Economic Impacts

Economic impacts consist of well-established, quantitative measures of economic activity. The most common of these measures are output, GDP, employment income, employment, and government tax revenue:

- Output is the total gross value of goods and services produced by a given organization, industry, or project, measured by the price paid to the producer.

- Gross Domestic Product ("GDP"), or value added, refers to the additional value of a good or service over the cost of inputs used to produce it from the previous stage of production.

- Employment income is the total amount of wages and salaries paid to employees.

- Employment is the number of additional jobs created. Employment is measured in terms of full-time equivalents ("FTEs").[1]

- Government Tax Revenue is the total amount of tax revenues created for federal, provincial, and local government.[2]

Economic impacts may be estimated at the direct, indirect, and induced levels. Direct impacts are changes that occur in "front-end" businesses that would initially receive operating revenue and incur expenditures. Indirect impacts arise from changes in activity for suppliers of the "front-end" businesses. Induced impacts arise from spending on goods and services resulting from increases to the payroll of the directly and indirectly affected businesses.

Near-term Economic Impacts to July 2020[3]

From the time of its incorporation in May 2018 to July 2020, the Supercluster and its partners invested a total of $223.3 million in projects, with an additional $8.0 million occurring in operations spending. The estimated economic impacts created by project investment and operations spending to July 2020 are:

- Total output of $456.8 million.
- Total GDP of $278.6 million.
- Total employment income of $174.6 million.
- Total employment of 2,364 FTEs.
- Total government tax revenues of $62.0 million.

The estimated economic impacts from Supercluster and partner investment in projects and from operations spending to July 2020 are summarized in Table A.

Table A. Economic impacts of the Supercluster to July 2020

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$231.3	$144.6	$102.7	1,216	$29.9
Indirect and Induced	$225.5	$134.0	$71.9	1,148	$32.1
Total	$456.8	$278.6	$174.6	2,364	$62.0

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[1] One FTE is the equivalent of one person working full time for a year. One FTE is the same as one "person-year" of employment.

[2] Government tax revenues include taxes on products, taxes on production, personal income taxes, and corporate income taxes. Government tax policies can change frequently and may result in substantial changes to the amount of tax revenues generated.

[3] Impacts are based on data as of July 8, 2020.

Near-term Economic Impacts to March 2023

From the time of its incorporation in May 2018 to March 2023, the Supercluster and its partners are anticipated to invest a total of $298.3 million in projects, with an additional $23.0 million in operations spending. The estimated economic impacts created by project investment and operations spending to March 2023 are:

- Total output of $636.7 million.
- Total GDP of $390.0 million.
- Total employment income of $246.0 million.
- Total employment of 3,683 FTEs.
- Total government tax revenues of $86.9 million.

The estimated economic impacts from Supercluster and partner investment in projects and from operations to March 2023 are summarized in Table B.

Table B. Economic impacts of the Supercluster to March 2023

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$321.3	$202.5	$145.6	1,880	$41.9
Indirect and Induced	$315.4	$187.5	$100.4	1,803	$45.0
Total	$636.7	$390.0	$246.0	3,683	$86.9

Leveraging Effect of Partner Co-Investment

Because of the leveraging effect of partner co-investment, the near-term economic impacts per dollar of Supercluster investment are roughly doubled from what would have been experienced had no co-investment been involved.

Table C. Near-Term Economic Impacts per Dollar of Supercluster Investment

	Total Output Per Dollar	Total GDP Per Dollar	Total Employment Per Million Dollars
Impacts Without Partner Co-Investment	$1.97	$1.20	10.21 FTEs
Impacts with Partner Co-Investment	$4.19	$2.55	21.69 FTEs

Projected Long-term Economic Impacts[4]

Several methods for projecting long-term economic impacts were considered during the study. The method adopted was an average growth rate approach that involved four steps. In Step 1, the near-term investments to March 2023 were reviewed and projects that were identified to involve only near-term objectives were removed from the long-term projection past March 2023.[5] In Step 2, a desk-based review of past and predicted revenue growth rates for industries in which the remaining projects were involved was carried out. In Step 3, the economic impacts from the remaining projects were projected forward from April 2023 to April 2028 under the assumption that they would, on average, grow at a rate similar to those found through the desk-based review. In step 4, the projected impacts from April 2023 to April 2028 were added to the estimated near-term economic impacts to March 2023 to project the Supercluster's economic impacts for the ten years from its incorporation to April 2028.

The review of past and predicted revenue growth rates for relevant industries indicated average compound annual growth rates in the range of 5.0 percent to 10.0 percent. Using those growth rates, the Supercluster's projected economic impacts for the ten years from the time of its incorporation to April 2028 are:

- Total economic output of $3,480.7 million to $3,928.5 million.
- Total GDP of $2,123.4 million to $2,396.4 million.
- Total employment income of $1,332.2 million to $1,503.2 million.
- Total employment of between 18,044 FTEs and 20,306 FTEs.
- Total government tax revenues of between $471.5 million and $532.1 million.

Table D summarizes the projected long-term economic impacts using an annual growth rate of 5 percent. Table E summarizes the projected long-term economic impacts using an annual growth rate of 10 percent.

Table D. Projected Total Economic Impacts to April 2028 at Annual Growth of 5 Percent

	Impacts to March 2023	Impacts from April 2023 to April 2028	Total Impacts to April 2028
Total output (millions)	$636.7	$2,844.0	$3,480.7
Total GDP (millions)	$390.0	$1,733.4	$2,123.4
Total employment income (millions)	$246.0	$1,086.2	$1,332.2
Total employment (FTEs)	3,683	14,361	18,044
Total government revenues (millions)	$86.9	$384.6	$471.5

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4 The long-term economic impacts that are actually realized will depend on the future outcomes of the funded projects; consequently, it will only be possible to estimate the long-term economic impacts accurately as the outcomes of the funded projects become evident over time.

5 Projects with only near-term objectives included some projects in the Capacity Building, COVID-19, and Strategic Project portfolios. Operations spending was also identified as having only near-term objectives. A total of $73.5 million in project investment and operations spending was identified as having only near-term objectives.

Table E Projected Total Economic Impacts to April 2028 at Annual Growth of 10 Percent

	Impacts to March 2023	Impacts from April 2023 to April 2028	Total Impacts to April 2028
Total output (millions)	$636.7	$3,291.8	$3,928.5
Total GDP (millions)	$390.0	$2,006.4	$2,396.4
Total employment income (millions)	$246.0	$1,257.2	$1,503.2
Total employment (FTEs)	3,683	16,623	20,306
Total government revenues (millions)	$86.9	$445.2	$532.1

1. INTRODUCTION

1.1. Study Purpose

Canada's Digital Technology Supercluster (the "Supercluster") is a cross-industry collaboration of diverse organizations, including some of Canada's leaders in healthcare, communications, natural resources, technology, and transportation. To help assess the effects of Supercluster and partner co-investments the Supercluster engaged Mansfield Consulting Inc. ("MCI") to carry out a study of the economic impacts of the Supercluster's activities and supported projects.

1.2. Scope

The scope for the study encompassed:

- Estimation of the near-term economic impacts created by the Supercluster. This involved estimating the economic impacts that have arisen from Supercluster activities (i.e., Supercluster operations and Supercluster and partner co-investments in projects) over two different periods of time. First, the economic impacts were estimated from the time of the Supercluster incorporation in May 2018 to July 2020 (the most recent date for which complete data existed at the time of the study). Second, the economic impacts were estimated over the entire expected lifetime of the Supercluster (i.e., from its incorporation in May 2018 to March 2023).

- Projection of the long-term economic impacts created by the Supercluster. This involved projecting the long-term economic impacts of Supercluster activities over the ten years from the time of its incorporation in May 2018 to April 2028. The long-term economic impacts consisted of the sum of the estimated near-term impacts to March 2023 and the projected impacts from April 2023 to April 2028.

1.3. About Mansfield Consulting Inc.

Mansfield Consulting Inc. provides specialized consulting services on economic and statistical issues. Mansfield Consulting Inc. was founded by Ed Mansfield Ph.D., who has more than thirty years of experience providing consulting services to public and private companies, professional associations, industry organizations, and government agencies. For more information on Mansfield Consulting Inc. please see **Appendix F**.

1.4. Report Limitations

The report is provided for information purposes and is intended for general guidance only. It should not be regarded as comprehensive or a substitute for personalized business or investment advice.

We have relied upon the completeness, accuracy, and fair presentation of all information and data obtained from industry representatives and public sources. The accuracy and reliability of the findings and opinions expressed in the presentation are conditional upon the completeness, accuracy, and fair presentation of the information underlying them. As a result, we caution readers not to rely upon any findings or opinions for business or investment purposes and disclaim any liability to any party that relies upon them as such.

Our analysis is based upon projections, founded on past events giving an expectation of certain future events. Future events are not guaranteed to follow past patterns and results may vary, even significantly.

Accordingly, we express no assurance as to whether the projections underlying the economic and financial analysis will be achieved.

Additionally, the findings and opinions expressed in the presentation constitute judgments as of the date of the presentation and are subject to change without notice. We are under no obligation to advise of any change brought to its attention which would alter those findings or opinions.

2. ABOUT THE SUPERCLUSTER

2.1. Overview of the Supercluster

The Supercluster is an industry-led consortium based in Vancouver. The organization brings together small, medium-sized, and large companies, research organizations, post-secondary institutions, and not-for profit organizations. It is one of five Superclusters across Canada that were established in 2018 and are supported by the Government of Canada's Innovation Superclusters Initiative, along with public and private co-investors which makes up its membership.[6]

The mission of the Supercluster is to:

- Create a critical mass of world-leading digital technology companies in BC and Canada that develop innovative products, platforms, and processes.

- Transform Canadian industries through the digitization of business, prioritizing industry, specific needs and delivering productivity gains and competitive advantages at the firm and industry levels.

- Grow the economic benefits for the region and for Canada by generating new companies, scaling-up existing firms, enabling performance improvements in Canada's sectors of strength, and positioning BC as a global hub for digital technology innovation.

2.2. Partner Organizations

The Supercluster involves partner organizations from across Canada. Partner Organizations consist of Members and Associates. Members are organizations that have made an explicit commitment to co-invest in projects alongside the Supercluster. Members drive the development of the Supercluster's investment strategy, determine program focus areas, and develop and lead projects. Associates are organizations that are exploring how they bring and receive value from the Supercluster and that may be invited to participate in projects. Associates are encouraged to participate in projects to explore new partnerships. [7]

At present there are over 600 Members and Associates. A map indicating the locations of partner organizations is contained in **Appendix B.**

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[6] Canada's Digital Technology Supercluster Strategic Plan 2018-2023.

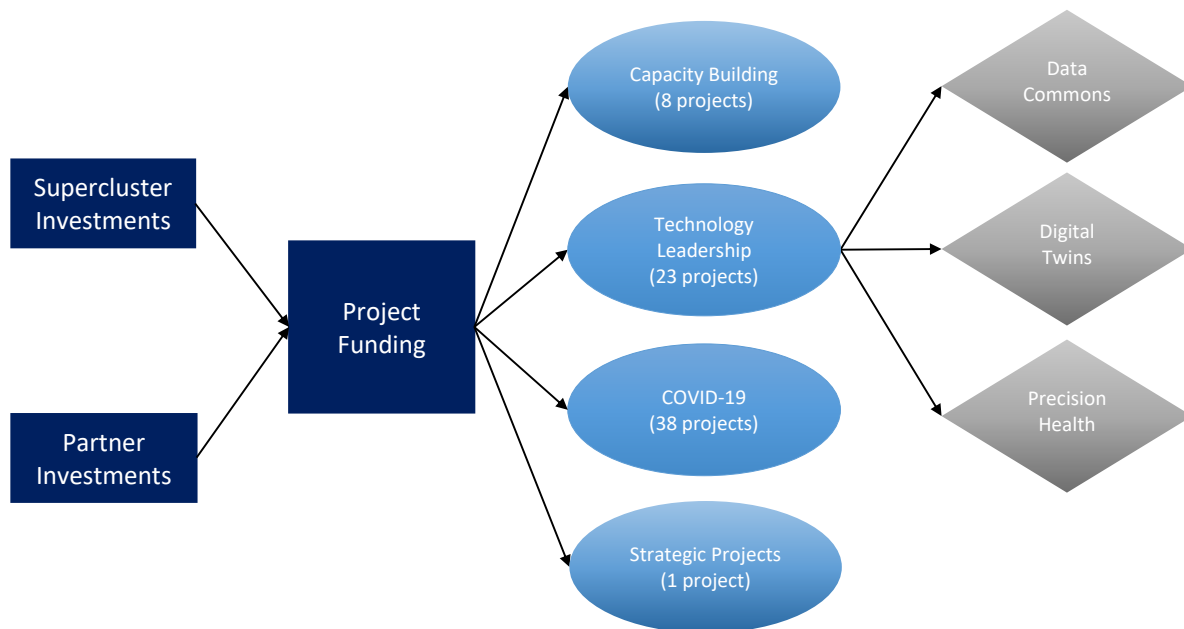[7] Supercluster 2018-2019 Annual Report.

2.3. Programs and Supported Projects

The initial investments by the Supercluster were done through the Capacity Building Program and the Technology Leadership Program.[8] The Capacity Building Program involved partnering with employers, educators, and community organization to build job ready world leading talent in Canada's digital technology firms. The Technology Leadership Program consisted of Data Commons projects, Digital Twins projects and Precision Health projects:

- Data Commons projects provide new digital solutions by aggregating data resources into shared platforms for exploration, machine learning and innovative application development.

- Digital Twins projects use digital technologies to create virtual production environments for real-time operations management, simulation modelling and training.

- Precision Health projects aim to establish Canada as a leader in data-driven health innovations that support disease prevention, early diagnosis, and personalized treatment.

With the onset of the COVID-19 health emergency, the Supercluster launched a new program aimed at developing solutions to problems created by COVID-19. The COVID-19 program, and an accompanying stand-alone strategic project, were created at the end of March 2020 and supported projects that could be deployed quickly and bring together industry, government, and researchers in new ways. Figure 1 illustrates the Supercluster's investments in programs and projects to July 2020.

Figure 1. Supercluster Programs

2.4. Examples of Supported Projects

The following five examples illustrate the range of projects supported by the Supercluster through its programs[9]. A list of projects supported by the Supercluster is contained in **Appendix C**.

Example 1. Capacity Building Program - *Future Capital Project*

The Future Capital project provides investment education that enables women to lead and shape the future of the economy. Through the Future Capital program, it is anticipated that 500 Canadian women will gain access to a new platform for education, become members of an emerging network of women decision-makers in the tech and innovation ecosystem, and gain new opportunities to lead innovation within Canada. The Future Capital Project is led by Female Funders and includes partner organizations Microsoft and Simon Fraser University.

Example 2. Data Commons Program - *Forest Machine Connectivity Project*

The goal of the Forest Machine Connectivity project is to improve the efficiency of forestry operations by digitally transforming and modernizing the timber harvesting supply chain. The project is using Industrial Internet of Things (IIoT) network of 'smart' devices to monitor, collect, exchange, analyze, and deliver valuable insights to contractors, machine operators, and managers. The consolidated data will help forestry workers identify and resolve timber harvesting bottlenecks in real time and to develop best practices throughout the timber supply chain that will improve productivity, efficiency, and the competitiveness of Canada's wood products manufacturing industry.The Forest Machine Connectivity Project is led by Mosaic Forest Management, and includes partner organizations Canfor Partners, University of BC and Lim Geomatics.

Example 3. Digital Twins Program - *The Learning Factory Digital Twin Project*

The Learning Factory Digital Twin project aims to develop a "virtual reality" or "digital twin" of the manufacturing process of aerospace components. The project is intended to enable hands-on learning and research to drive continuous improvements through predictive maintenance, real-time monitoring, and quality control. The digital twin will also inform future work and create a new approach to advanced aerospace manufacturing. The Learning Factor Digital Twin Project is led by Avcorp Industries Inc, and includes partner organizations AMPD, Boeing, Convergent Manufacturing Technologies, Llamazoo, Microsoft and the University of BC.

Example 4. Precision Health Program - *Dermatology Point-of-Care Intelligent Network Project*

One in six Canadians are likely to develop some form of skin cancer during their lifetimes. Early detection of skin cancer is critical to improving the chances of survival, yet there can be up to a six month wait time to see a dermatologist. By using AI-powered medical imaging that incorporates dermatology and pathology data and images, the Dermatology Point of Care Intelligent Network Project aims to enable patients to be diagnosed in days, rather than months, anywhere in Canada. The Dermatology Point of Care Intelligent Network Project is led by Change Healthcare, and includes partner organizations MetaOptima, Careteam, Providence Health Care, University of BC, University of Victoria, and the BC Cancer Agency.

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[9] Project descriptions supplied by the Supercluster.

Example 5.COVID-19 Program - *Early Detection of COVID-19 Through AI*

Early detection and mitigation of potential infections is critical to flattening the curve and minimizing future waves of pandemic outbreaks. Current testing requires close contact to measure body temperature on an individual basis. Being able to scan large numbers of people in hospitals, stores and airports will be an important tool to ensure the health of Canadians. The Early Detection of COVID-19 Through AI Project applies existing security cameras and computer vision technology to develop a passive screening system to identify people with a fever and who are at risk of having COVID-19, protecting the health and safety of Canadians. The Early Detection of COVID-19 Through AI Project is led by PatriotOne Technologies, and includes partner organizations Cisco, University of BC, University of North Dakota, and the Cincinnati Reds.

3. CREATION OF ECONOMIC IMPACTS BY THE SUPERCLUSTER

## 3.1. Pathways Through Which the Supercluster Creates Economic Impacts

A traditional business creates economic impacts as it earns revenue and spends money on staff, supplies, and other items. A traditional business tends to focus its activities in a particular industry and carries out its activities in a specific year. As a result, it is comparatively straightforward to estimate its economic impacts.

The Supercluster, however, has a different mandate and functions differently from a traditional business. As a result, it creates economic impacts through pathways that differ from those of a traditional business. In particular:

- Leveraging Effect of Partner Co-Investment. The funds invested by the Supercluster are accompanied by additional funds that are contributed by its partners. As a result, because of the leveraging effect of partner co-investment, the impacts created per dollar of Supercluster investment are much higher than what would be realized by a traditional business that has only its own funds to invest.

- Investments in Many Different Industries. The projects in which the Supercluster invests span a wide variety of industries rather than a single industry.

- Attraction of Subsequent Investment from Other Sources. Because of Supercluster investments, some projects are able to attract additional investment from other sources, thereby providing additional leverage from Supercluster investment.

- Investments in Commercialization and Problem-Solving Projects. Supercluster investments are targeted at commercialization and problem-solving projects that are intended to produce long-term effects, such as innovative new products, platforms and processes, productivity gains for Canadian industries, enhanced competitiveness for Canadian businesses, and advances in the delivery of health care services. These long-term effects are, in turn, expected to result in sustained economic impacts.

The pathways through which the Supercluster creates economic impacts are illustrated in Figure 2.

Figure 2. Creation of economic impacts by the Supercluster
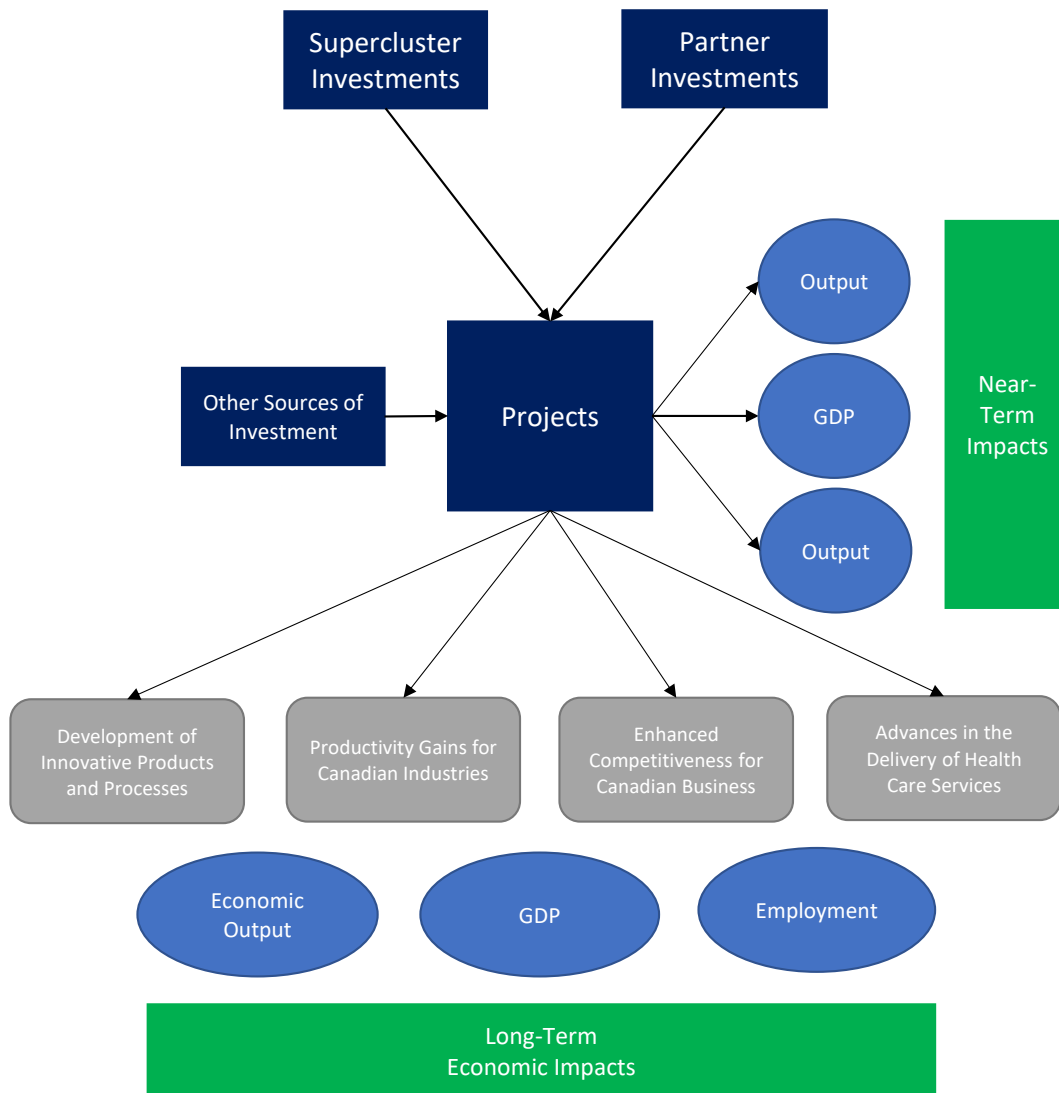
The potential for long-term economic impacts is already being demonstrated by supported projects. A recent survey of representatives from 32 supported projects conducted in August 2020 by the Supercluster found:

- The supported projects have produced 102 new products.

- Sixty-eight percent of representatives responded that their organizations were able to form new business partnerships as a result of the supported projects.

- Forty percent of representatives responded that the supported projects had led to increased international exports.

4. ECONOMIC IMPACTS

4.1. Overview of Economic Impact Analysis

The goal of an economic impact study is to quantify the economic contributions that an industry or operation makes to a region. In general, economic impacts are viewed as consisting of well-established, quantitative measures of economic activity. The most common of these measures are output, GDP, employment income, employment, and government tax revenue:

- **Output** is the total gross value of goods and services produced by a given organization, industry, or project, measured by the price paid to the producer. This is the broadest measure of economic activity.

  o *Example: An airplane parts manufacturer buys aluminum from a metals producer for $100 and adds value to it by producing airplane parts, which are then sold for $300. Economic output would total $400 which is the value of all sales in the chain of activity. The value of the aluminum is therefore counted twice, once as an intermediate good for the parts manufacturer, and again in the value of the parts.*

- **Gross Domestic Product ("GDP")**, or value added, refers to the additional value of a good or service over the cost of inputs used to produce it from the previous stage of production. Thus GDP is equivalent to the unduplicated value of goods and services produced.

  o *Example: An airplane parts manufacturer buys aluminum from a metals producer for $100 and adds value to it by producing airplane parts, which are then sold for $300. GDP or value added would total only $300 (as opposed to $400 economic output). This is because value added subtracts the sale of the purchased aluminum (intermediate input) of $100 from the total sales price of $400, resulting in value added of $300.*

- **Employment income** is the total amount of wages and salaries paid to employees

- **Employment** is the number of additional jobs created. Employment is measured in terms of full-time equivalents ("FTEs").[10]

- **Government Tax Revenue** is the total amount of tax revenues generated for federal, provincial, and local government.[11]

Economic impacts may be estimated at the direct, indirect, and induced levels.

- **Direct** impacts are changes that occur in "front-end" businesses that would initially receive operating revenue and incur expenditures. In the case of the Supercluster, the direct impacts occur at the Supercluster's operations and with projects supported by the Supercluster.

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[10] One FTE is the equivalent of one person working full time for a year. One FTE is the same as one "person-year" of employment.

[11] Please note that government revenues are estimated using Statistics Canada input-output multipliers. The government tax revenues include taxes on products, taxes on production, personal income taxes, and corporate income taxes. Government tax policies can change frequently and may result in substantial changes to the amount of tax revenues generated.

- **Indirect** impacts arise from changes in activity for suppliers of the "front-end" businesses. In the case of the Supercluster, the indirect impacts occur with suppliers to the Supercluster operations and suppliers to supported projects.

- **Induced** impacts arise from spending on goods and services resulting from increases to the payroll of the directly and indirectly affected businesses. In the case of the Supercluster induced impacts result from the spending of staff from the Supercluster operations and staff from the supported projects.

MCI developed estimates of the economic impacts by following an input-output modelling approach that utilized economic impact multipliers developed by Statistics Canada. Input-output modelling is a widely used method, which facilitates comparisons between reported results for different projects, organizations, or industries. For a glossary of economic impact terminology please see **Appendix A**. For additional information on the methodology, please see **Appendix D**.

4.2. Key Strengths and Limitations of Economic Impact Analysis

While an economic impact analysis provides useful information regarding the economic contributions of an industry or organization, it is important to aware of mindful of its key strengths and limitations.

- Economic impact analysis provides estimates, not precise calculations. To borrow a concept from statistical sampling, the results of an economic impact analysis can be thought of as having an associated "margin of imprecision.[12] Statistics Canada's economic impact multipliers are based on reported, industry-wide, data. As a result, they represent average effects estimated across entire industries which may or may not reflect the activities of a specific organization. In addition, the economic impact multipliers reflect the structure of the economy in the particular year that the economic data were collected.[13] Under usual circumstances one might reasonably expect only small changes in the structure of the economy to occur from one year to the next. However, when a structural shift occurs in the economy, such as may be the circumstance with the current COVID-19 pandemic, the economic impact multipliers may not reflect the changed economy until some years after the event. Consequently, the results of an economic impact analysis should be viewed as being approximations.

- Economic impact analysis is best suited for analyzing traditional businesses and industries. Statistics Canada's economic impact multipliers are produced for business categories classified according to NAICs categories. NAICs (which stands for North American Industry Classification System) is a system that places a business into an industry category based on the type of work it does. For traditional businesses that operate in established industries the NAICs categories are well-defined and the accompanying economic impact multipliers generally reflect the operations of the businesses well. However, for non-traditional businesses, especially ones involved in research

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[12] A statistical sample has an associated "margin of error" that can be calculated using statistical theory. The use of the term "margin of imprecision" in this report is intended to express the fact that the results of an economic impact analysis come with some level of uncertainty in the results. However, unlike statistical sample, the uncertainty in an economic impact analysis cannot be calculated from theory.

[13] Due to reporting lags Statistics Canada's economic impact multipliers normally reflect the structure of economy as it was four or five years before the date of the economic impact analysis.

and development or commercialization in new or emerging industries, there may not be a NAICs classification that precisely matches the organization's specific activities.

- Economic impact analysis addresses only one aspect of overall economic benefits. As noted earlier, the measures included in an economic impact analysis are narrow in scope and do not include measures of broader economic benefits, such as:
    - Invention of new scientific methodologies.
    - Training of skilled people.
    - Creation of research networks.
    - Increasing the stock of useful knowledge.
    - Innovations that lead to cost savings in or improvements in service delivery.

Such broader economic benefits may be substantial and may even be the focus of an organization's activities. Consequently, while economic impact analysis provides useful information on some aspects of the economic effects created by an organization, a more complete picture requires additional information that is based on other complementary measures. [14]

4.3. Sources of Near-Term Economic Impacts

The near-term economic impacts arise from two sources:

- Economic impacts created by Supercluster support for projects. These are economic impacts that result from Supercluster and partner co-investments in projects.

- Economic impacts created by Supercluster operations. These are economic impacts that arise from the Supercluster's own operations, including the employment of its staff and expenditures on goods and services.

The sum of the economic impacts created by support for projects and economic impacts created by operations are referred to in this report as the combined economic impacts of the Supercluster.

We have estimated the near-term economic impacts over two timeframes. The first covers the time from the incorporation of the Supercluster in May 2018 to July 2020 (the most recent month for which complete data were available at the time of the report). The second covers an extended timeframe, from the time of the incorporation the Supercluster in May 2018 to the anticipated end of its operations at the end of March 2023. The economic impacts for the second timeframe consist of the estimated impacts that occurred to July 2020, plus additional ones that are projected to arise from further support for projects and operations spending from July 2020 to March 2023.

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[14] As noted in a recent report by the Office of the Parliamentary Budget Officer (The Innovation Superclusters Initiative – A Preliminary Analysis. Office of the Parliamentary Budget Officer. October 6, 2020): "Measuring innovation can be challenging. There is not one widely used metric that tells a complete story; instead, there are many that can each provide valuable insights."

4.4. Near-term Impacts to July 2020

<u>Economic impacts created by Supercluster investment in projects.</u> As of July 2020, the Supercluster had invested in a total of 70 selected projects, with total project investment of $223.3 million, consisting of $105.1 million in Supercluster investment and $118.2 million in partner co-investment. The projects comprised:

- Eight projects in the Capacity Building Program, with a total investment of roughly $5.3 million.

- Twenty-three projects in the Technology Leadership Program, with a total investment of roughly $108.2 million. These included six Data Commons projects, six Digital Twins projects, and eleven Precision Health projects.

- Thirty-eight projects in the COVID-19 Program, with a total investment of roughly $109.7 million.

- One strategic project with a total investment of $0.1 million.

Table 1 summarizes the project investments to July 2020 by program.

Table 1. Project Investment to July 8, 2020

	Investment as of July 8, 2020	Percent of Investment
Capacity Building Portfolio		
Supercluster	$2,717,865	51.5%
Members	$2,559,403	48.5%
Subtotal	$5,277,268	100.0%
Technology Leadership Portfolio		
Supercluster	$41,649,072	38.5%
Members	$66,540,117	61.5%
Subtotal	$108,189,189	100.0%
COVID-19 Portfolio		
Supercluster	$60,732,527	55.3%
Members	$49,001,608	44.7%
Subtotal	$109,734,135	100.0%
Strategic Project		
Supercluster	$40,000	40.0%
Members	$60,000	60.0%
Subtotal	$100,000	100.0%
Total Project Investment		
Supercluster	$105,139,464	47.1%
Members	$118,161,128	52.9%
Grand Total	$223,300,592	100.0%

The estimated economic impacts created within Canada by those investments are:
- Total output of $440.8 million.
- Total GDP of $267.8 million.
- Total employment income of $167.3 million.
- Total employment of 2,280 FTEs.
- Total government tax revenues of $59.6 million.

The estimated economic impacts are summarized in Table 2.

Table 2. Economic impacts of Supercluster supported projects to July 2020

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$223.3	$138.6	$97.8	1,172	$28.7
Indirect and Induced	$217.5	$129.2	$69.5	1,108	$30.9
Total	$440.8	$267.8	$167.3	2,280	$59.6

Economic impacts created by Supercluster operations. As of July 2020, the Supercluster had operational expenditures of approximately $6.8 million. The estimated impacts created within Canada by those operational expenditures are:

- Total output of $16.0 million.
- Total GDP of $10.8 million.
- Total employment income of $7.3 million.
- Total Employment of 84 FTEs.
- Total government tax revenues of $2.4 million.

The estimated economic impacts are summarized in Table 3.

Table 3. Economic impacts of Supercluster operations to July 2020

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$8.0	$6.0	$4.9	44	$1.2
Indirect and Induced	$8.0	$4.8	$2.4	40	$1.2
Total	$16.0	$10.8	$7.3	84	$2.4

Combined impacts of Supercluster supported projects and operations. The economic impacts of supported projects can be added to economic impacts of operations to arrive at the combined impacts. The combined estimated economic impacts from Supercluster support for projects and its operations to July 2020 are summarized in Table 4.

Table 4. Combined economic impacts of Supercluster support and operations to July 2020

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$231.3	$144.6	$102.7	1,216	$29.9
Indirect and Induced	$225.5	$134.0	$71.9	1,148	$32.1
Total	$456.8	$278.6	$174.6	2,364	$62.0

4.5. Near-term Impacts to March 2023

Economic impacts created by Supercluster investment in projects. To March 2023 the Supercluster and members anticipate making a total investment in projects of $298.3 million. The projected economic impacts created within Canada of the total investment are:

- Total output of $590.7 million.
- Total GDP of $359.0 million.
- Total employment income of $224.9 million.
- Total employment of 3,441 FTEs.
- Total government tax revenues of $80.0 million.

The projected economic impacts are summarized in Table 5.

Table 5. Economic impacts of Supercluster support for projects to March 2023

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$298.3	$185.2	$131.4	1,753	$38.4
Indirect and Induced	$292.4	$173.8	$93.5	1,688	$41.6
Total	$590.7	$359.0	$224.9	3,441	$80.0

Economic impacts created by Supercluster operations. To March 2023 the Supercluster anticipates total operations expenditure of $23.0 million. The projected economic impacts created within Canada by operations spending are:

- Total output of $46.0 million.
- Total GDP of $31.0 million.
- Total employment income of $21.1 million.
- Total Employment of 242 FTEs.
- Total Government Revenue of $6.9 million.

The projected economic impacts are summarized in Table 6.

Table 6. Economic impacts of Supercluster operations to March 2023

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$23.0	$17.3	$14.2	127	$3.5
Indirect and Induced	$23.0	$13.7	$6.9	115	$3.4
Total	$46.0	$31.0	$21.1	242	$6.9

Combined impacts of Supercluster supported projects and operations. The projected economic impacts of supported projects can be added to the economic impacts from operations to arrive at the combined impacts. The combined estimated economic impacts from Supercluster support for projects and its operations to March 2023 are summarized in Table 7.

Table 7. Combined economic impacts of Supercluster support and operations to March 2023

	Output (millions)	GDP (millions)	Employment Income (millions)	Employment (FTEs)	Government Revenue (millions)
Direct	$321.3	$202.5	$145.6	1,880	$41.9
Indirect and Induced	$315.4	$187.5	$100.4	1,803	$45.0
Total	$636.7	$390.0	$246.0	3,683	$86.9

4.6. Leveraging Effect of Partner Co-Investment in Projects

As noted earlier, the funds invested by the Supercluster are accompanied by co-investments from partner organizations. Because of the leveraging effect of partner co-investment, the near-term economic impacts per dollar of Supercluster investment are roughly doubled from what would have been experienced had no co-investment been involved. Table 8 shows that partner co-investment resulted in the total output per dollar of Supercluster investment increasing from $1.97 to $4.19, total GDP per dollar of Supercluster investment increasing from $1.20 to $2.55, and total employment increasing from 10.21 FTEs per million dollars of investment to 21.69 FTEs per million dollars of investment.

Table 8. Near-Term Economic Impacts per Dollar of Supercluster Investment

	Total Output Per Dollar	Total GDP Per Dollar	Total Employment Per Million Dollars
Impacts Without Partner Co-Investment	$1.97	$1.20	10.21 FTEs
Impacts with Partner Co-Investment	$4.19	$2.55	21.69 FTEs

To provide additional context for the economic impacts per dollar of Supercluster investment. Table 9 shows the average economic impacts per dollar of investment for a selection of major industries. As can be seen from that table the economic impacts per dollar of Supercluster investment is substantially higher than the average economic impacts per dollar of investment for many major industries and well above the average for all industries.

Table 9. Economic Impacts per Dollar of Investment in Selected Canadian Industries[15]

Industry	Total Output Per Dollar	Total GDP Per Dollar	Total Employment Per Million Dollars
Mining, quarrying, and oil and gas extraction	$1.94	$0.99	5.21 FTEs
Information and cultural industries	$0.93	$1.06	7.56 FTEs
Manufacturing	$2.16	$0.91	7.04 FTEs
Professional, scientific, and technical services	$1.94	$1.21	10.22 FTEs
Non-residential building construction	$2.01	$1.00	8.54 FTEs
Government education services	$1.77	$1.30	12.83 FTEs
All industries	$1.93	$1.09	9.11 FTEs

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[15] Calculated from Statistics Canada Economic Impact Multipliers.

5. PROJECTED LONG-TERM ECONOMIC IMPACTS

5.1. Overview

There are a variety of challenges with projecting long-term economic impacts from investments in commercialization and problem-solving projects such as those supported by the Supercluster. Among the challenges are:

- The long-term success or failure of a commercialization project is uncertain. At the time of the investment, the long-term success or failure of a commercialization project is unknown. The economic impacts that such a project will create depend on its ultimate success or failure, which only becomes evident over the course of time.

- Successful commercialization projects may produce many important "spin-off" effects. Successful commercialization projects may lead to products, processes and new businesses that were not considered part of the original project scope. The economic impacts from these spin-off effects can be substantial and can exceed those envisioned for the original project.

- Commercialization projects may require extended timeframes to achieve success. Unlike most traditional industries, commercialization projects – especially ones that may involve subsequent research and development - may involve an extended length of time before economic impacts are realized. As noted by the Congressional Budget Office of the United States "Industry studies of pharmaceuticals have found that new drugs entered the market about 20 years after public investments in biomedical research and about 12 years after targeted, disease-specific research. In the absence of other evidence, CBO estimates that the macroeconomic effects of spending on basic R&D begin only after 20 years, and that it will take another 20 years to realize the full effect. For applied R&D, the effects are considered to begin sooner – starting after 10 years – but still taking another 20 years to realize their full macroeconomic impact."[16]

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[16] Estimating the Long-Term Effects of Federal R&D Spending: CBO's Current Approach and Research Needs. Congressional Budget Office, June 2018.

5.2. Approaches Reviewed

Several possible methods for projecting long-term economic impacts were reviewed during the study, including an "economic multiplier" approach, an "investment portfolio" approach, and a "average growth approach". A brief summary of these three approaches and their applicability to the Supercluster is as follows:

- Economic multiplier approach. This approach uses published studies on the increases in an economic measure (for example, GDP) that have been reported to result from investments in research and development.[17] Challenges with employing this methodology for the Supercluster include the general nature of the published studies (sometimes involving government spending on both military and civilian research) and the foreign jurisdictions to which they often refer. In addition, the lack of definition for the timeframes used for the research life-cyle, the lack of consistency in terms of measurement systems employed and the lack of documentation on the of treatment of factors such as partner co-investment makes this approach difficult to use reliably.

- Investment portfolio approach. This approach models the economic impacts from supported projects as if they were investments in a portfolio of stocks. For each supported project, possible outcomes and associated probabilities are specified, and a computer simulation is carried out that produces a distribution of possible outcomes for the portfolio.[18] At present, possible outcomes and associated probabilities have not been developed for the supported projects; consequently, this approach could not be used for this study. However, we believe this approach may prove a useful tool for projecting the long-term impacts of the Supercluster and suggest its potential future use be investigated further.

- Average growth approach. This approach involves using the near-term economic impacts as a base, and projecting those impacts forward using average growth rates. [19] The average growth rates are identified through a review of past and forecasted future growth rates for industries in which the projects participate (for example, in the case of the Supercluster such industries as high tech, aerospace, agritech and life sciences). The use of an average growth rate recognizes that some projects will enjoy more success than others and assumes that economic impacts will, on average, keep pace with revenue growth. This was the approach selected for use in this study. [20]

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[17] This approach was noted in a recent report from the report by the Office of the Parliamentary Budget Officer (The Innovation Superclusters Initiative – A Preliminary Analysis. Office of the Parliamentary Budget Officer. October 6, 2020):

[18] Although it may sound imposing the probability distribution of possible outcomes is straightforward to understand. For example, it may show that after, say, five years, there is a ninety percent chance that between 1,000 and 3,000 jobs will be created; a five percent chance that less than 1,000 jobs will be created and a five percent chance that more than 1,000 jobs will be created.

[19] Usually revenue growth rates.

[20] To see a recent example of how this method was used for a specific industry (in that case the BC Agritech Sector) please see https://foresightcac.com/blog/view/study_of_the_bc_agritech_sector/

5.3. Approach Followed

An average growth approach was followed for projecting the long-term economic impacts. This involved four steps. In Step 1, the anticipated investments to March 2023 were reviewed and projects that were identified to involve only near-term objectives were removed from the projection past March 2023. As shown in Table 10, this resulted in the removal of roughly $73.5 million of Supercluster and partner investment from the long-term projection.

Table 10. Investment Expected to Produce Long-Term Impacts

	Supercluster and Partner Investment to March 2023 (millions)	Investment Expected to Produce Only Near-Term Impacts (millions)	Investment Expected to Produce Long-Term Impacts (millions)
Capacity Building	$15.3	$15.3	$0
Technology Leadership	$173.2	$0	$173.2
COVID-19	$109.7	$35.1	$74.6
Strategic Project	$0.1	$0.1	$0
Operations	$23.0	$23.0	$0
Total	$321.3	$73.5	$247.8
Percent	**100%**	**23%**	**77%**

In Step 2, a desk-based review of past and predicted revenue growth rates for industries in which the remaining projects were involved was carried out. Based on that review most projected (or recently experienced) average compound annual growth rates ("CAGR") for revenues in relevant industries were identified as being between 5.0 percent and 10.0 percent. (Please see **Appendix E** for a selection of data sources reviewed.)

In Step 3, the economic impacts from the projects expected to produce long-term impacts were projected forward from April 2023 to April 2028 under the assumption that they would, on average, grow at rates similar to those found through the desk-based review. In Step 4, the projected impacts from April 2023 to April 2028 were added to the estimated near-term economic impacts to March 2023 to project the Supercluster's economic impacts for the ten years from its incorporation to April 2028.

5.4. Projected Long-Term Impacts

Based on the identified average compound annual growth rates of 5.0 percent to 10.0 percent the Supercluster's projected long-term economic impacts over the ten years from the time of its incorporation to April 2028 are:

- Total economic output of $3,480.7 million to $3,928.5 million.
- Total GDP of $2,123.4 million to $2,396.4 million.
- Total employment income of $1,332.2 million to $1,503.2 million.
- Total employment of between 18,044 FTEs and 20,306 FTEs.
- Total government tax revenues of between $471.5 million and $532.1 million.

Table 11 summarizes the projected long-term economic impacts using an annual growth rate of 5 percent. Table 12 summarizes the projected long-term economic impacts using an annual growth rate of 10 percent.

Table 11. Projected Total Economic Impacts to April 2028 at Annual Growth of 5 Percent

	Impacts to March 2023	Impacts from April 2023 to April 2028	Total Impacts to April 2028
Total output (millions)	$636.7	$2,844.0	$3,480.7
Total GDP (millions)	$390.0	$1,733.4	$2,123.4
Total employment income (millions)	$246.0	$1,086.2	$1,332.2
Total employment (FTEs)	3,683	14,361	18,044
Total government revenues (millions)	$86.9	$384.6	$471.5

Table 12 Projected Total Economic Impacts to April 2028 at Annual Growth of 10 Percent

	Impacts to March 2023	Impacts from April 2023 to April 2028	Total Impacts to April 2028
Total output (millions)	$636.7	$3,291.8	$3,928.5
Total GDP (millions)	$390.0	$2,006.4	$2,396.4
Total employment income (millions)	$246.0	$1,257.2	$1,503.2
Total employment (FTEs)	3,683	16,623	20,306
Total government revenues (millions)	$86.9	$445.2	$532.1

Appendix A – Glossary of Economic Terms

Term	Definition
Output	Output is the total gross value of goods and services produced by a given company or industry measured by the price paid to the producer. This is the broadest measure of economic activity, Output measures the value of all sales of goods and services, including all final purchase and intermediate inputs, which results in the double counting of intermediate purchases. *For example, a furniture manufacturer buys wood from a sawmill for $100 and adds value to it by producing a piece of furniture which is then sold for $300. Economic output would total $400—the value of all sales in the chain of activity. The value of the wood is therefore counted twice—once as an intermediate good for the furniture manufacturer and again in the value of the furniture.*
Gross Domestic Product (GDP)	Gross Domestic Product ("GDP"), or value-added, refers to the additional value of a good or service over the cost of inputs used to produce it from the previous stage of production. Thus, GDP is equal to the unduplicated value of goods and services produced. GDP isolates only the additional value of goods and services produced and is defined as economic output less intermediate inputs. *In the previous example of the furniture manufacturer, the value-added totals only $300 (as opposed to $400 economic output). This is because value added subtracts the sale of the purchased wood (intermediate input) of $100 from the total sales price of $400, resulting in value-added of $300.*
Employment Income	Employment income is the total amount of wages and salaries paid to employees.
Employment	Employment is measured in terms of full-time equivalents ("FTEs"). One FTE is the equivalent of one person working full-time for a full year. One FTE is also the same as one "person-year" of employment. For example, one person working full time for a year equates to one FTE. Two people each working full time for half a year also equate to one FTE.
Government Tax Revenue	Government tax revenue is the total amount of tax revenue generated for different levels of government, including municipal, provincial, and federal taxes.
Direct Impacts	Direct impacts are changes that occur in "front-end" businesses that would initially receive expenditures and operating revenue as a direct consequence of the operations and activities of an industry, organization, or project. *Example: A project spends money on hiring and employing staff. Those staff members would be considered the direct employment created by the project.*
Indirect Impacts	Indirect impacts are changes that occur at suppliers to the "front-end" businesses. *Example: The project spends money purchasing office equipment, which in turn supports employment at an office equipment supplier. The employment created at the supplier would be considered indirect employment created by the project.*
Induced Impacts	Induced impacts are due to shifts in spending on goods and services as a consequence of the payroll of the directly and indirectly affected businesses. *Example: As a result of project spending, wages are received by project staff and by employees with the office supply company. Those staff and employees, in turn, make consumer purchases that create jobs within the general economy. The employment created within the general economy by the spending of staff and employees would be considered indirect employment created by the project.*

Appendix B – Supercluster Members and Associates

The following map illustrates the Supercluster Members by location.
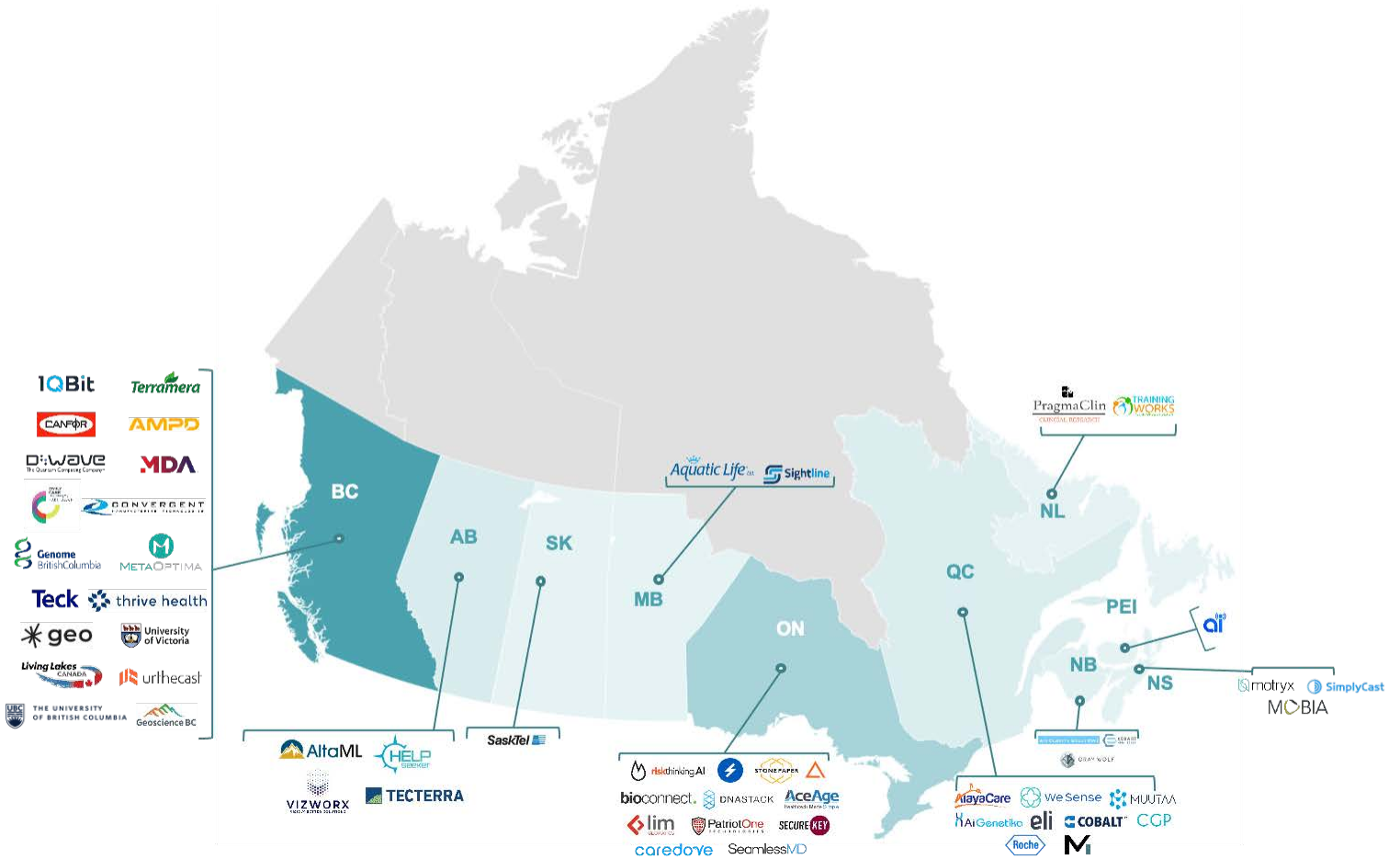
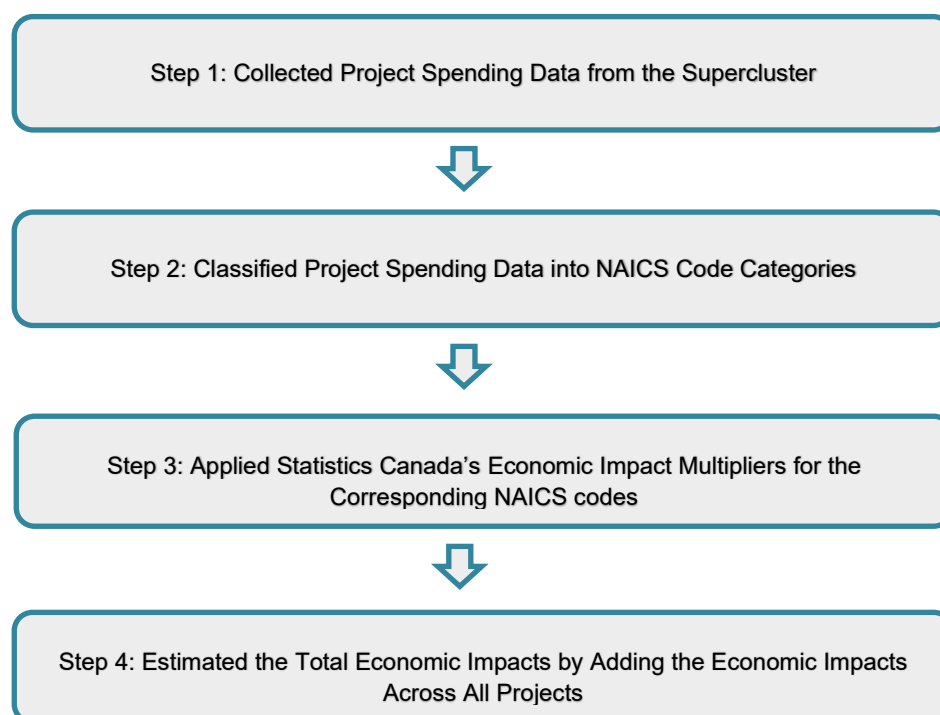# Appendix C – Projects Supported by the Supercluster

The following table lists the projects supported by the Supercluster to July 2020.

Capacity Building	Technology Leadership	COVID-19
Athena Pathways	Forest Machine Connectivity	Beacon - Realtime Global Data Sharing Network
Autonomous Systems Technician Design for Startups	The Learning Factory Digital Twin	Feeding our Front Lines
Future Capital HyperTalent	Dermatology Point-of-Care Intelligent Network	Rapid Repurposing of Drugs for COVID-19
Women's Entrepreneurship Program CAMPFIRE	Predictive Analytics for Manufacturing Processes	Risk Management Frameworks for Workplace Safety
Diversifying Talent in Quantum Computing	Tailored Health - Pharmacogenetics	Lifesaver II
Athena Pathways	The Secure Health & Genomics Platform Program	xrAI
Autonomous Systems Technician Design for Startups	Earth Data Store	Project ACTT - Access to Cancer Testing & Treatment in Response
Future Capital HyperTalent	Augmented Reality for Maintenance and Inspection	Looking Glass: Protecting Canadians in a Return to Community
Women's Entrepreneurship Program CAMPFIRE	Fresh Water Data Commons	Early Detection of COVID-19 through AI
Diversifying Talent in Quantum Computing	Intelligent Network for Point-of-Care Ultrasound	Confidential Virtual Addiction Treatment for Healthcare Workers
	Precision Agriculture to Improve Crop Health	Protecting Canadians by Predicting the Evolution of COVID-19
	Reducing Opioid Use for Pain Management	Feeding our Front Lines
	Applied Analytics for Flood Mitigation	Providing Safe and Effective Home Care During COVID-19
	Personal Health Wallet (MyPDx)	Point-of-Care Ultrasound for COVID
	Autism Sharing Initiative	Stronger Together: Social Infrastructure for Community Health
	Healthcare to Homecare	COVID Cloud
	Protecting Our Oceans	Digital Telework for Remote Physical Work
	TrustSphere	Improving ICU Capacity During COVID-19 Outbreaks

		Wellness.ai	Emergency Food Distribution Network
		Workplace Brain Health	Telewound Care Canada Virtual Pulse
		Satellite-based Environmental Analytics	DirectFood.store (DFS): Securing the Food Supply Chain
		Optimizing Healthcare through Applied Digital Twinning	Mental Health for Health Care Workers Providing COVID-19 Care
		Wayfinder ER	Making Virtual Care Happen: COVID-19 and the Health Connect A
			HEALTHYACCESS
			Rapid Deployment of Emergency Case Management
			Project ABC
			Lifesaver - Predicting emerging pandemics / Lifesaver PT II
			Mobile Wellness Declaration
			Leveraging AI in Canada's Social Response to COVID
			AI-based Prediction Tool for COVID-19 Patient Care
			Rapid Assessment of Disability Claims During and Post COVID-19
			Global Clinical Network for Infectious Diseases
			Clothing Tech to Remotely Connect to Care
			ReSTART: Post-COVID Surgeries and Medical Procedures
			Reduce Risk: Post-COVID Analytics Platform for Returning to Work
			Supporting Canada's Elderly During the COVID-19 Pandemic
			Supply Hub

Appendix D – Economic Impact Methodology and Assumptions

MCI's estimates of the economic impacts of the projects funding by the Supercluster were developed using an input-output model that employed Statistics Canada economic impact multipliers. A step-by-step overview of the methodology is outlined below.

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┌──────────────────────────────────────────────────────────────┐
│     Step 1: Collected Project Spending Data from the          │
│                      Supercluster                             │
└──────────────────────────────────────────────────────────────┘
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┌──────────────────────────────────────────────────────────────┐
│    Step 2: Classified Project Spending Data into NAICS        │
│                     Code Categories                           │
└──────────────────────────────────────────────────────────────┘
                              ⬇
┌──────────────────────────────────────────────────────────────┐
│   Step 3: Applied Statistics Canada's Economic Impact         │
│         Multipliers for the Corresponding NAICS codes         │
└──────────────────────────────────────────────────────────────┘
                              ⬇
┌──────────────────────────────────────────────────────────────┐
│  Step 4: Estimated the Total Economic Impacts by Adding the   │
│         Economic Impacts Across All Projects                  │
└──────────────────────────────────────────────────────────────┘
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In Step 1, MCI was provided project spending data by the Supercluster for each of the projects tin which it has invested. In Step 2 MCI classified the projects into NAICS[21] code categories based on their project descriptions and main type of activities in which they were engaged.

In Step 3 MCI used Statistics Canada's multipliers for BC (2015) with impacts across all provinces (i.e., including both within province and out-of-province impacts) to estimate the economic impacts by NAICS code category[22]. In Step 4 the impacts across all categories were summed to calculate the total economic impacts.

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[21] NAICS codes have been developed by the statistical agencies of Canada, the Untied States and Mexico and allow for classification of companies and enterprises into an industry that best defines them. This is used to report on statistical data related to the economy. Additional details can be found here: https://www.statcan.gc.ca/eng/subjects/standard/naics/2017/v3/introduction

[22] Please note that for Statistics Canada Multipliers express employment in terms of jobs. MCI converted jobs to FTEs by assuming one FTE would equate to working 1950 hours for a year. In 2015, across all industries in BC, the annual average number of hours worked per job was 1689 hours. Consequently, one job was considered to equate to 0.87 FTE (i.e., 1689 hours divided by 1950 hours).

Appendix E – Literature Review of Historical and Projected Growth Rates

The following are a selection of the historical and projected sector growth rates reviewed for the project.

Historical and Projected Growth Rates

Source/Report Name	Sector (jurisdiction)	Indicator	Data Available	Compound Annual Growth Rate[23]
Clean Tech Report Card for British Columbia KPMG (2016)	Cleantech (BC)	Total Revenues	$456 million (2014)	13.30%
Smart Agriculture Market by Agriculture Type, Software, Services, Application and Geography – Global Forecast to 2023 Markets and Markets (2018)	Smart Agriculture (Global)	Market Value	$9,760 million (2018) $17,490 million (2023)	12.39%
2019 Canadian ICT Sector Profile Innovation, Science and Economic Development Canada (2020)	Software and Computer Systems (Canada)	Revenues	$84.255 million (2019)	8.2%%
Special Report: BMO Blue Book Summer 2020 Bank of Montreal (2020)	Computer systems design and related services (Canada)	Employment	Average Growth Between 2014 and 2019	7.5%
Aerospace Materials Market – Growth, Trends and Forecast Mordor Intelligence (2019)	Aerospace materials market (Global)	Market demand	N/A	6.00%
Global Medical technology Industry Statistica (2019)	Medical technology	Revenue	Average growth to 2022	5.0%
2019 Canadian ICT Sector Profile Innovation, Science and Economic Development Canada (2020)	ICT Sector (Canada)	Total Sector Revenues	$210,511 million (2019)	4.9%
Pharmaceutical Industry Profile – Canadian life science industry ISED Canada and IQVIA Pharmafocus (2020)	Life Science (Canada)	Revenues	N/A	4.5%

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[23] Compound annual growth rates are reported as indicated in the source. Growth rates were not calculated using data converted to Canadian dollars. As a result, there may be some discrepancy between the reported compound annual growth rate and that which can be calculated using the data available.

Source/Report Name	Sector (jurisdiction)	Indicator	Data Available	Compound Annual Growth Rate[23]
Report of Canada's Economic Strategy Tables – Clean Technology (2018) Government of Canada	Clean Tech	Exports	Historical Growth Rate	4%
Report of Canada's Economic Strategy Tables – Health and Biosciences (2018) Government of Canada	Biosciences	Historical Growth Rate	Historical Growth Rate	4%
Global Aerospace & Defence Market Rockville Research (2019)	Aerospace and defence (Global)	Market demand	$1,727 billion (2019) $2,123 billion (2025)	3.50%
Global Fleet & MRO Market Forecast Commentary Oliver Wyman (2019)	Commercial air transport MRO market (Global)	Market demand	$108.8 billion (2019) $133.3 billion (2025)	3.45%

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Appendix F – About Mansfield Consulting Inc.

Ed Mansfield is the founder and president of Mansfield Consulting Inc. Ed has more than thirty years of experience providing consulting services to public and private companies, professional associations, industry organizations, and government agencies. Among the industry sectors in which Ed has worked are film and television, health care, energy, natural resources, transportation, utilities, agriculture and agrifood, tourism and major events.

During his career Ed has been a partner or principal with four major accounting and business consulting firms, including the last 10 years with MNP LLP, where he was the national leader for the firm's Economics & Research practice. Ed has Ph.D. and M.S. degrees in Applied Mathematics from the University of Washington, and a B.Sc. in Mathematics and Statistics from the University of BC

Ed has led nearly one hundred studies involving economic and community impacts. The studies have been prepared for all levels of government and private sector organizations across Canada and the United States

More information on Mansfield Consulting Inc. is available on our website: www.mansfieldconsulting.ca