

Chapter 2

Ottawa: Rise of a Smart Community

**Barry Gander, Bruce Lazenby, Charles Duffett, Greg Richards,
Mark Hoddenbagh, Mark Kristmanson, Ritch Dusome,
Sarah Linkletter and Sorin Cohn**

Abstract The need to communicate forced Canada to invent the tools of the modern Communications Age, which are now being used worldwide. Ottawa in particular became a hotbed of communications technology development, as it was

B. Gander (✉)

i-CANADA, 1919 Pereau Road, Canning, NS B0P 1H0, Canada
e-mail: barrygander@yahoo.com

B. Lazenby

Invest Ottawa, 80 Aberdeen St, Ottawa, ON K1S 5R5, Canada
e-mail: blazenby@investottawa.ca

C. Duffett

City of Ottawa, 110 Laurier Ave W, Ottawa, ON K1P 1J1, Canada
e-mail: charles.duffett@ottawa.ca

G. Richards

Telfer School of Management, IBM Centre for Business Analytics and Performance,
University of Ottawa, 55 Laurier Ave E, Ottawa, ON K1N 6N5, Canada
e-mail: richards@telfer.uOttawa.ca

M. Hoddenbagh

Partnership and Applied Research, Algonquin College, 1385 Woodroffe Ave,
Ottawa, ON K2G 1V8, Canada
e-mail: mark.hoddenbagh@algonquincollege.com

M. Kristmanson

National Capital Commission, 202-40 Elgin Street, Ottawa, ON K1P 1C7, Canada
e-mail: mark.kristmanson@ncc-ccn.ca

R. Dusome

Centre of Excellence in Next Generation Networks, 555 Legget Drive,
Tower a, Suite 600, Ottawa, ON K2K 2X3, Canada
e-mail: ritch.dusome@cengn.ca

S. Linkletter

EPSI, 6 Sainte-Marie, Gatineau, QC J8Y 2A3, Canada
e-mail: SLinkletter@epsi-inc.com

S. Cohn

Conference Board of Canada, 255 Smyth Rd, Ottawa, ON K1H 8M7, Canada
e-mail: scohn@rogers.com

home to government Research and Development Laboratories. It also had a heritage of innovation from local inventors who pioneered many of the electronic aids used in households today. Innovation, therefore, was given a springboard for growth in Ottawa's culture. Innovation is the driver of the Smart Economy today, responsible for three-quarters of all economic growth in the USA since World War II. It is triggered by associations of ideas are intuitive; it arises from hunches and that vague hard-to-describe sense that there is an interesting solution to a problem that has not yet been addressed. The number of innovations in a centre is directly tied to the number of linkages in a centre: the higher the linkages between people, the greater the momentum of the innovation. To be effective as an economic force, a second ingredient is needed: the ability to find the commercial value of the innovation. This value-adding characteristic has thus far been difficult to assess due to the tentative nature of innovations in their early stages. In Ottawa, a new assessment tool is being used that can detect the overall intensity of the "Smart City" environment, based on hundreds of factors. Another new tool drills down to the organizational level and assesses the efficiency of the organization's ability to commercialize innovation. These tools can be used by any city wishing to obtain a Smart Economy.

Keywords Smart Economy • Smart City • Innovation • Ottawa • Canada • Technology development • Economic growth • Innovation tools • Smart City assessment • Smart Economy assessment • Smart City awards • Smart City standards • Innovation development

"Our knowledge sector contributes billions of dollars to our economy; innovation and collaboration are at the heart of our growth".

Jim Watson, Mayor, City of Ottawa [1]

2.1 Forward

Ottawa is the capital city of the country that *created* the Communications Age.

Necessity drove Canadians to invent the ingredients of the Communications Age: the telephone itself was invented in Canada, and the world's first long-distance telephone call was made in Canada. Canadians heard the first broadcast of voice on a radio transmission [2]; launched the first domestic communications satellite (Anik); saw the first direct-to-home satellite transmission (a Canadian hockey game); made the first international connection to the Internet; and invented the first digital telephone exchange—one that ushered in today's Digital Era in the Communications

Age. Other Canadian innovations that are fundamental to the digital age include the touch screen for computers and the Internet search engine.

This focus on Communications is not surprising for Canada, because the country owes its *existence* to Communications.

Canada was formed when separate provinces decided to unite rather than face the prospect of being absorbed by a powerful neighbour. The solution hinged on the provision of a railway to connect the country from coast to coast...a promise made on Confederation Day in 1867 and completed in 1885. In <20 years, it spanned a distance of 4000 km. Foreshadowing the future, a *telegraph line accompanied the rail track*, highlighting the importance the emergent country already placed on electronic communications.

A high proportion of the basic tools of today's Communications Era that emerged from Canadian innovations originated in the capital city of Ottawa. As it took its pioneering steps, Ottawa became, in a sense, the "**Measure of Innovation**"—the standard of success against which other centres can be compared. Ottawa is also the place where **innovation itself** has first been measured in a realistic and useful set of indicators for growth.

This chapter will explore:

1. How Ottawa's unique position gave it an advantage in creating the linkages that made it a Smart City innovation powerhouse; and
2. How Ottawa's new tools to assess innovation and Smart Communities prepare the city for future success.

"Innovation" here is understood to have different but complementary meanings for business and society. *Business innovation* enhances corporate value by attracting customers with better/cheaper products and services and by surprising the competition with more effective and efficient internal and external processes and capabilities. *Community innovation* blends business and social values to differentiate the city and enhance prosperity and well-being.

A "Smart Community" is defined as a collaborative, entrepreneurial area of higher social harmony, employment, effective education, satisfactory recreation, and better safety and health care from the effective use of information infrastructure and resources. It is much more than infrastructure and technology: it is the mobilization of social and business resources behind a common vision of a community's future.

Smart City status is important to Ottawa because it has to maintain its competitiveness in the face of global forces that are driving the development of competing Smart Communities at a fevered pace:

1. New major centres of creativity, wealth, and social importance are coming into prominence every year across the globe;
2. People are crowding into cities and communities at a pace never experienced before; and
3. The immense pressure this migration puts on city infrastructure and civic interaction requires a new level of problem-solving.

The fundamental reason for the exponential growth of Canadian—and global—Smart Cities is that they can mobilize the great density of urban people to organize an adequate social response to the challenge of growth. The larger the city, the more people are likely to come into contact with each other. Ease of access to ideas and opportunities drives the productivity of the city. Today, fast communications have the potential of making every location a “super-city”.

In Canada, urbanization rates match the global trend. The surge in city living over suburban living is no longer an “emerging trend” but “the new normal” as millennials and a growing number of their parents transform downtown cores across much of Canada at dizzying speed, according to a new report [3]. For example, that urbanization trend—the shift to living and playing close to work—continues to blur the lines between commercial and residential development in downtown cores, fuelling the creation of new office towers and even spurring a resurgence in rental-apartment construction for the first time in decades.

With 79 % of its population living in urban centres, Canada ranks 40th on the list of most urbanized countries in the world. It is predicted that by 2025, Canada will have 82 % of its population in urban centres [4].

This growth in urbanization is expected to continue in Canada for two reasons:

- The older Canadian economic model of reliance on rurally based resource industries such as lumber, oil, and agriculture is giving way to an economy based on knowledge industries, which tend to favour urban concentrations; and
- The Canadian cities of 100,000+ population are growing fastest of all, because of immigration from other countries where the new arrivals cluster in the larger centres, plus migration from the Canadian countryside.

In fact, these factors are driving Canada’s largest urban centres (Toronto, Montreal, Vancouver, and Ottawa) to grow at a faster rate than other centres [5].

Canada’s relatively small share of the global population (0.5 %) despite its rank of second largest country in the world means that to sustain its position in the world economy, the country has to make full use of all the “power tools” that innovation can provide. Each centre has to be a Smart City; each town has to be a Smart Community; and each rural area needs to be a Smart Region.

This is the value of Ottawa: it is the spear-point for Canadian Smart Community development, and indeed, because of Canada’s pre-eminent place in the Smart City movement, for other communities around the world.

2.2 Linkages, Innovation, and Ottawa

Some 20 years ago, the Canadian Advanced Technology Alliance (CATA) did a survey of 12 cities across Canada, to determine what factors led to their prosperity [6]. The single most commanding factor was the **closeness of the bonds between**

the companies within the city and with the city's institutions. The closer the linkage between these groups, the faster was the rate of innovation.

Linkages in fact drive innovation in such a fundamental way that the act of innovating is an act of linking, both at the product level and at the community level.

The Smart Economy is an economy of linkages.

2.2.1 Innovation-Generation Capability Depends on Linkages

We are surrounded by innovations today, like a fish is surrounded by water, and—like the fish—it is often hard for us to realize the totality of our immersion. From clothes to communications, we are coddled by the results of a thousand years of innovations. Our environment now consists of the accumulated and linked labour of millions of inventive people, working decade after decade. Understanding the cumulative power of innovation allows a better analysis of how it can be encouraged to shape into an *intentional future*—the Smart City future.

“Innovation” in this sense is the realization (i.e. the implementation and the successful exploitation/commercialization) of a good idea to add value in monetary and/or social ways. It differs from pure “research” in that research is the discovery of previously unknown knowledge. Research costs “money”; innovation makes “money”.

According to expert Stephen Johnson [7], innovation is intuitive; it arises from hunches and that vague hard-to-describe sense that there is an interesting solution to a problem that has not yet been addressed. According to Johnson, these hunches are slow-developing and cumulative. Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time. Some of those parts are conceptual: ways of problem-solving or recasting what constitutes a problem in the first place. Some of them are, literally, mechanical parts.

Good ideas are triggered by inspiration from concepts that are adjacent to them. The greater the field of available adjacent hunches, the faster the rate of innovation. This is what Johnson calls “the adjacent possible”, a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself. The boundaries of the adjacent possible grow as the innovation cluster grows. Linkages expand opportunities for, and success of, innovation exponentially.

Innovation follows linkages—this is a proposition that can be demonstrated historically, with the precursor of the Internet, the Post Office. In nineteenth-century America, there was a correlation between the presence of a post office and the subsequent rise in the number of patents issued in a particular county. That relationship remained even after accounting for population and numerous other variables. Moreover, because the burst of patents followed the arrival of a post office,

rather than vice versa, the authors of a recent study [8] say that the relationship is causal: where the post office increased linkages, innovation bloomed.

This extends to the fine-grain level of single organizations. An increase in linkages within a company leads to faster innovation. In companies that limit innovation to a select few leaders, says a recent study, there is “a tenfold increase in innovation when all employees are both expected and given the permission to find ways to innovate and improve their organizations every day” [9].

Even within companies, innovation happens through links, concurrently, between various domains. Firm-level innovation is best seen as a set of overlapped processes in various stages of development [10] (Fig. 2.1).

This is why linkages are so important: innovative environments are better at helping their inhabitants explore the adjacent possible, because they allow greater and more diverse numbers of ideas to novel ways of recombining those parts.

Smart Cities are environments that do more than allow people to “think outside the box”—they allow minds to move through multiple linked boxes.

Often, the concepts created by these linkages produce products that themselves deliver *only* linkages.

The Twitter platform, for example, derives from a deliberate strategy that Dorsey, Williams, and Stone embraced from the outset: they built an emergent platform first, and then they built Twitter.com as a platform for linkages. Other platforms that provide linkages offer stellar examples of the important role that linkages have in the Innovation Economy:

- The world’s largest taxi company owns no taxis; it links customers to drivers (Uber)
- The largest accommodation provider owns no real estate; it links customers to accommodation (Airbnb)
- The largest phone companies own no infrastructure; they provide online linkages (Skype, WeChat)



Fig. 2.1 Overlapped views of innovation domains. *Source* BD Cohnsulting presentation

- The most valuable retailer has no inventory; it is a middleman with linkages (Alibaba)
- The most popular media owner creates no content; it is solely concerned with linkages (Facebook).

The ability to establish effective linkages is the key to success for a Smart Community. A Smart Community—be it a small city, a metropolis, or a connected region—takes advantage of an exponential rise in power. As linkages grow, everything that involves creativity and innovation—patents, R&D budgets, “super-creative” professions, inventors—follows a law of compounding value, such that an area that had ten times the linkages of its neighbour was not just ten times more innovative; it was 17 times more innovative. An area with 50 times the number of linkages than another area is 130 times more innovative.

Different sectors within Canada, such as health care and education, exhibit linkages that have been made possible by technologies such as the Internet of Things (IoT), the Cloud, and Big Data. In today’s health care environment, for example, open technologies allow health information to cross departmental boundaries and allow data manipulation and information management tasks, plus the provision of an extensive range of information services. As the health care sector continues to mature in its utilization of computer-based technologies for health records, the focus on data analysis and interpretation to improve decision-making, to advance greater efficiencies, and to drive improved system performance will continue to grow. Similarly in education, through immersive learning, students are able to experience virtual environments from historical settings to underwater laboratories.

Through the deployment of these technologies, Canada is moving up the value chain from a natural resources economy to one based on the value-add of innovative products. Collectively, the companies that make up the high-tech slice of the Toronto Stock Exchange are now valued at more than \$250-billion, a number greater than the aggregate value of the mining sector [11].

2.3 The Spread of Innovation Linkages Through Ottawa

Ottawa has been able to use this compounding power of linkages to supercharge the innovation underlying its Smart Economy. The results today demonstrate the interaction of a Smart Community’s linkages and innovation:

- Ottawa has the highest number of patents per capita of any Canadian city;
- Ottawa has 65 federal government laboratories to help companies test products and create ideas;
- Ottawa leads all cities in Canada in knowledge occupations;

- Its five colleges and universities help generate the highest concentration of scientists, engineers, and patents in Canada, and the second highest in North America;
- It has international linkages as a home to 130 embassies and consulates from other nations; and
- It's 2000 knowledge-based companies in Life Sciences, Cleantech, Defence and Aerospace, Digital Media, Film and Television, Communications Technologies, and Software.

Tracing the growth of Ottawa's success shows again how innovation builds from historical linkages.

In the early years of Ottawa's growth, a practical challenge was to stay alive during the cold winter months. Ottawa and the area around it became a centre for the production of wood-burning stoves. A local innovator, Tomas Ahearn, had a contract to build the first electric streetcars in Ottawa. He designed efficient electric heaters to keep the cars warm. Linking that concept with the local expertise in stoves, Ahearn created the world's first electric stove. Ottawa, in fact, was the first place in the world where electrically cooked food was served, in August of 1891 (Fig. 2.2).

The linkages continued. By the late 1940s, the first of the computing companies emerged, with the start-up of computing devices. Its technology, linked to technology from the National Research Council, sparked the emergence of Leigh Instruments, financed by a local businessman in the stove manufacturing business. Leigh Instruments in turn spun out Lumonics, whose laser systems were created with linkages to Ottawa's Defence Research Board.

This created a pattern in Ottawa, where companies located in two "magnetic" areas of Ottawa: the central core, home to two universities and several federal research laboratories, and the West End (Kanata) area, original home of the stove manufacturing businesses and where the giant Nortel company (originally Northern Telecom) came to be located.

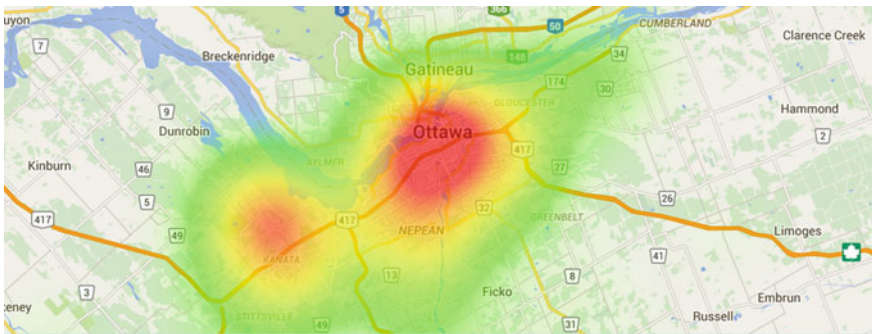


Fig. 2.2 A "heat map" of knowledge-based industries in the Ottawa area. *Source* Invest Ottawa

The original decision by Northern Electric in the late 1950s to establish a research facility in the region was made after a judicial decision in the USA cut off its ready access to patents from the Western Electric Co. Its purchase of a substantial tract of land on the outskirts of Ottawa as the future home of Bell Northern Research (BNR), largely because of the concentration of federal government laboratories in the nation's capital, created a steady stream of industrial engineers, researchers, and managers moving into the region. Many of the leading entrepreneurs in the Ottawa telecommunications and photonics cluster began their careers as researchers for BNR or its failed subsidiary, Microsystems International Ltd (MIL). Both technical and entrepreneurial talents left Nortel over the years to form new firms in the region. The demise of MIL was significant for the cluster in two respects—it attracted a large number of highly skilled IT scientists and engineers to the Ottawa area in the 1970s and its closure released a significant number of skilled workers into the regional economy, many of whom went on to found, or work for, new firms. More than 20 local start-ups emerged from the collapse of MIL, including some of the cluster's leading firms, such as Mitel and Mosaid. A similar emergence of new companies occurred after Nortel was dissolved; the new companies formed exponential numbers of linkages that would help speed the growth of innovation.

A consistent feature is the centrality of skilled labour as the single most important local asset in attracting and holding firms in the region. The most important early source of talent in Ottawa was BNR (Bell Northern Research). The establishment of BNR in Ottawa in the late 1950s drew thousands of industrial engineers, researchers, and managers into the region. This influx provided the critical mass of talent needed to exploit later developments in telecommunications and photonics.

The joint origins of these communications-focused companies led to high levels of internal networking, both formal networks and informal and interpersonal contacts. These linkages still exist between firms in related industries, such as photonics and telecom in Ottawa. Some firms in individual clusters rely upon a local supply base for certain inputs, but the vast majority draw components and knowledge inputs from a diverse array of geographical sources. The most important linkages, however, are to markets, particularly international markets, as many of the firms were geared to supply continental and international markets from their inception.

2.4 Ottawa's Rich Sources of Innovation Linkages

Today, Ottawa has a thriving culture of innovative companies and organizations, continuing to provide linkages for successful products. A few of the more prominent include

Federal Government Agencies

As Canada's capital, Ottawa is the headquarters for most of the country's foremost research institutions. These are hubs for linkages for social as well as technological and business innovation.

Agriculture and Agri-Food Canada Ottawa Research and Development Centre

The Ottawa Research and Development Centre of Agriculture and Agri-Food Canada leads Eastern Canada (Manitoba to Prince Edward Island) in crop development, targeting corn, soy, spring wheat, winter wheat, oats, and barley. The Centre also has a national mandate for assessing and utilizing biodiversity and environmental resources for Canadian agriculture. It operates the Central Experimental Farm, established in 1896, which comprises 427 ha (1055 acres) of open space in downtown Ottawa. Its experts research new plant varieties, soil management, animal breeding, and food processing [24].

Canadian Institutes of Health Research

The Canadian Institutes of Health Research (CIHR) is the Government of Canada's health research investment agency. Located in Ottawa, CIHR's mandate is to "excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system". Its funding covers cancer research, ageing, genetics, child and youth health, immunology and public health, among others. It also builds research capacity in underdeveloped areas and training the next generation of health researchers, and focuses on knowledge translation that facilitates the application of the results of research and their transformation into new policies, practices, procedures, products, and services. It is one of the agencies providing \$156-million annually to Ottawa's ten hospitals [25].

CanmetENERGY

CanmetENERGY is Canada's leading research and technology organization in the field of clean energy. It has a team of 450 scientists, engineers, and technicians that make it a leader in clean energy technologies. It focuses on fuel-efficient vehicles, cleaner fossil fuels, energy-efficient buildings, bioenergy, Canada's oil sands production, renewable energy such as solar and water power, and industrial processes [26].

Communications Research Council

The Communications Research Council (CRC) is Canada's federal centre of excellence for wireless telecommunications R&D, be a leading contributor to solutions for wireless demand in a modern economy. The CRC prepares Canada for the opportunities available in the 1000 times increase in mobile data traffic by 2020, by performing wireless telecommunications R&D that advances the efficient exploitation of the radio spectrum, and serves as the government's leading source of scientific knowledge and long-term technical advice for spectrum management, regulation, and policy purposes. It takes part in strategic R&D collaborations that

leverage CRC's activities, resulting in knowledge and technology transfer, to the benefit of the 280,000 Canadians who work in the mobile sector, Canadian industry, the economy and citizens [27].

Defence Research Development Centre, Ottawa Research Centre

The Ottawa Research Centre develops technologies in support of Space Systems and Technology, Cyber Operations, Communication and Signals Warfare, Radar Sensing Exploitation, Radiological Nuclear Defence, and Navigation Warfare. Ottawa is also home to the Department of National Defence (DND), whose purpose is to provide the Canadian Armed Forces (CAF), other government departments, and public safety and national security communities with the knowledge and technology needed to defend and protect Canada [28].

Innovation, Science and Economic Development Canada

The Ottawa-based federal Ministry of Innovation, Science and Economic Development Canada works with Canadians in all areas of the economy and in all parts of the country to improve conditions for investment, enhance Canada's innovation performance, increase Canada's share of global trade, and build a fair, efficient, and competitive marketplace [29].

International Development Research Centre

The International Development Research Centre is a Canadian federal Crown corporation that invests in knowledge, innovation, and solutions to improve lives and livelihoods in the developing world. It initiates, encourages, supports, and conducts research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical, and other knowledge to the economic and social advancement of those regions. In doing so, it supports networking and knowledge sharing between scientific, academic, and development communities in Canada and developing countries [30].

National Research Council

The National Research Council (NRC) is comprised of three integrated R&D divisions, each guided by advisory bodies composed of industry leaders. Under these three umbrella R&D divisions, there are 12 integrated and consolidated portfolios focused on key industry sectors, or areas of R&D. These portfolios represent areas of strategic importance and economic value for Canada. Within each portfolio, there are a variety of programs focused on addressing specific business-identified priorities and challenges through a unique offering of technical and advisory services, research facilities, licensing opportunities, and programs and partnership opportunities.

NRC offers Canadian businesses access to unique research infrastructure as well as the experts to optimize its use. This includes aerospace engineering and manufacturing, astronomy, high-throughput DNA sequencing, photonics, biotechnology, and nanotechnology—to name just a few. Access to these facilities allows innovative businesses to pursue blue sky R&D opportunities here in Canada, while lowering the risks associated with R&D and accelerating product development [31].

Social Sciences and Humanities Research Council

The Social Sciences and Humanities Research Council (SSHRC) works on social innovation to find new ways to overcome pressing social challenges and deliver community services and strengthen communities as a whole through research. It coordinates from its Ottawa office the work of 24,000 full-time professors, 21,000 doctoral students and 46,000 Masters students, and oversees the granting of some \$345-million in scholarships. It focuses on Aboriginal, digital, environmental, disability, and business research. For business, it invests more than \$100 million in management, business, and finance, covering some 1500 research projects. In the digital field, SSHRC moves beyond pure technology and builds valuable insights about people who will, ultimately, fuel Canada's success [32].

City of Ottawa

The City of Ottawa supports an **Innovation Centre**, as a one-stop shop and “mashup” of technical, business and market capabilities, resources and expertise that helps technology entrepreneurs and companies launch, grow, and thrive. It provides promising entrepreneurs and technology firms with the technical, business, and market capabilities they require to thrive. It serves as a springboard for these ventures, helping them to reduce risk, accelerate growth, and spur commercial success and economic development in our community.

In addition to core business advisory services, the City of Ottawa provides mentorship for innovation through the **Innovation Pilot Program**. This new program is designed for local, national, and international start-ups to pilot new technologies, products, or services with the City of Ottawa. The program focuses on technologies, products, or services that will provide a benefit to programs and services offered by the City to residents. These new projects are to be unique and innovative, and have yet to be widely commercialized.

Invest Ottawa

Invest Ottawa delivers collaborative economic development programs and initiatives that increase entrepreneurial momentum, wealth and jobs in the City of Ottawa and its surrounding region while marketing Ottawa's diversified economy and high quality of life. Invest Ottawa offers business webinars and workshops, mentorship and business advice, start-up and incubation services, and international expansion services. It also delivers an “Innovation Clinic” to help companies find out where they need to focus to meet their business objectives for innovation [33].

Crown Corporations

National Capital Commission

The National Capital Commission (NCC) is the federal Crown agency dedicated to ensuring that Canada's capital is a dynamic and inspiring source of pride for all Canadians, and a legacy for generations to come. Building on more than a century of experience, the NCC provides unique value in the capital region by fulfilling three specific roles: long-term planner of federal lands, principal steward of nationally significant public places, and creative partner committed to excellence in development and conservation.

The NCC encourages creativity and innovation in everything it does. This means building strong relationships with people and organizations throughout the region and across the country, and fostering strategic partnerships, alliances, and collaboration with a diverse range of stakeholders—from local municipalities, Aboriginal communities, and government departments to national and international organizations.

Initiatives to foster innovation linkages include the **Capital Urbanism Laboratory**: An innovative gathering place where leaders, experts, professionals, interest groups, and the general public can come together to share knowledge and learn about the elements that go into the short- and long-term planning and stewardship of a national capital. Discussion topics include emerging trends and best practices for supporting and promoting excellence in urbanism, protecting natural and built heritage, enhancing environmental conservation and sustainability [34].

The Natural Sciences and Engineering Research Council of Canada

The Natural Sciences and Engineering Research Council of Canada (NSERC) aims to make Canada a country of discoverers and innovators for the benefit of all Canadians. The agency supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects. NSERC researchers are on the vanguard of science, building on Canada's long tradition of scientific excellence. Over the last 10 years, NSERC has invested more than \$7 billion in basic research, projects involving partnerships between postsecondary institutions and industry, and the training of Canada's next generation of scientists and engineers [35].

Universities and Colleges

Algonquin College

Algonquin College offers students hands-on experience, integrated with classroom activity. Providing “degrees that matter”, Algonquin graduates are equipped to start work immediately, through training that is tightly tied to the business environment. The goal of the college is to be a global leader in digitally connected applied education and training [36].

Carleton University

Carleton University is a dynamic research and teaching institution dedicated to achieving the highest standards of scholarship. It strives for innovation in research, teaching, and learning. Carleton's graduates have an entrepreneurial spirit, are prepared for careers in the rapidly changing job market, are driven by a desire to change the world, and number 125,000 [37].

University of Ottawa

The University of Ottawa (uOttawa) is the largest bilingual (English–French) university in the world. Its advances in social sciences, health, science, and the humanities make uOttawa a unique place to learn, grow, and excel. In addition to being a major economic force in Ottawa, its 5000 employees provide more than 450

programs in 10 faculties and achieve a 97 % employment rate for graduates. Advanced courses like the IBM Centre for Business Analytics and Performance (CBAP) support research and curriculum development in the domains of Business Analytics (BA), Business Intelligence (BI), and Performance Management (PM) [38].

Université du Québec en Outaouais

The Université du Québec en Outaouais connects academics and students to Quebec's educational network with its \$300 million in research financing, and draws in leaders from Eastern Canada and beyond. A large part of UQO programs are rooted in the specific needs of the labour market and society; such is the case of programs in education, health sciences, administrative sciences, computer sciences, social work, and psychoeducation. Having made a breakthrough into the world of applied sciences with the computer engineering program, UQO now offers a new program in natural sciences. The university also offers a series of masters- and doctoral-level programs [39].

Private Sector

Alcatel-Nokia

Nokia Networks purchased control of Alcatel in 2015, uniting two telecommunications giants into a network solutions provider with a significant global customer base. The Alcatel research team in Ottawa is dedicated to making global communications more innovative, sustainable, and accessible for people, businesses, and governments worldwide. Its mission is to invent and deliver trusted networks to help customers unleash their value [40].

Apple

Apple—the world's largest company by market value—is setting up a research facility in Canada. Reports indicate that Apple has leased 22,000 ft.² of office space in Kanata, the west-end suburb of Ottawa known as a tech hub. It may focus on the development of the iCar, Apple's driverless car [41].

Avaya

Avaya is a leading provider of solutions that enable customer and team engagement across multiple channels and devices for better customer experience, increased productivity, and enhanced financial performance. Its world-class contact centre and unified communications technologies and services are available in a wide variety of flexible on-premises and cloud deployment options that seamlessly integrate with non-Avaya applications. The Avaya Engagement Environment enables third parties to create and customize business applications for competitive advantage. The Avaya fabric-based networking solutions help simplify and accelerate the deployment of business critical applications and services [42].

Centre of Excellence for Next-Generation Networks

Canada's Centre of Excellence in Next-Generation Networks (CENGN) bridges the gap between research and commercialization. It is a consortium of industry, academic, and research leaders dedicated to accelerating the commercialization of

next-generation communications solutions. CENGN's internationally recognized testing centre employs interoperability between multiple software and hardware products, providing a unique environment to commercialize advanced products, applications, and services.

CENGN brings together major players in the global telecommunications sector to provide a unique multi-vendor platform populated with state-of-the-art network equipment, which allows companies and researchers to access a "real-world" environment. CENGN provides these companies with significant market advantage by accelerating product research and reducing product development time and costs [43].

Ciena

Ciena makes the network infrastructure programmable, so it can easily adapt to the changing needs of users. When that programmability is combined with network-level applications, network operators can rapidly deliver new services and support new applications. Ciena's years of creating solutions for the world's largest and most reliable telecommunication networks have led to more than 1550 US patents and patents pending, as well as more than 500 additional foreign-issued patents and applications. Ciena has 5000 employees worldwide [44].

Conference Board of Canada

The Ottawa-based Conference Board of Canada is the foremost independent, not-for-profit research organization in Canada. It delivers insights on economics, public policy, and organizational performance. Its 200 employees research and analyse economic trends, as well as organizational performance and public policy issues. An exemplary catalyst for linkages, its conferences and institutes connect public and private leaders, and through its affiliation with the Conference Board of New York, it provides ties to 2000 companies in 60 countries [45].

Ericsson

Ericsson is a driving force behind the Networked Society—a world leader in communications technology and services. It has long-term relationships with every major telecom operator in the world allow people, business, and society to fulfil their potential and create a more sustainable future. With approximately 115,000 professionals and customers in 180 countries, it combines global scale with technology and services leadership. Its networks connect more than 2.5 billion subscribers. Ericsson's Ottawa location performs research on advanced network technology; together with Avaya, Ciena, and Genband, Ericsson bought Nortel's research divisions in 2009 [46].

GENBAND

GENBAND is a global leader in real-time communications software solutions for service providers, enterprises, independent software vendors, systems integrators, and developers in over 80 countries. Kandy, its award-winning, disruptive real-time communications software development platform, is built from the company's global telecommunications network and security technologies. The platform

enables these companies to easily embed a full suite of voice, video, chat, screen-sharing, and collaboration capabilities into their existing business, Web, and mobile applications. GENBAND's market-leading solutions, which are deployable in the network, on premise or through the cloud, help its customers connect people to each other and address the growing demands of today's consumers and businesses for real-time communications wherever they happen to be [47].

Venus Cybersecurity Corporation (VENUS)

VENUS is a not-for-profit organization designed to make Canada a leader in cybersecurity. VENUS provides its membership with the people, space, and infrastructure to work on complex, leading-edge cybersecurity problems affecting individuals, businesses, and governments throughout the world. The interdisciplinary approach, served by a business ecosystem created specifically to address cybersecurity issues, provides its membership with a rate of return that is expected to be ten times greater than if they worked independently [48].

Additional Private Companies

Ottawa is the headquarters to more than 1500 associations and not-for-profit organizations. More than 1700 companies are engaged in the innovation-intensive knowledge sector in the city. The companies include these companies and these innovation linkage hubs:

The **Defence** sector is an innovation hub for 10,000 workers and includes General Dynamics, Loughheed Martin, MDS, INGRobotic Navigation and Maritime Way Scientific.

Among the 120 innovative companies in the **Cleantech** sector are Clearford, Energate, and Enslyn.

Digital Media is a hive of interactivity in Ottawa, with Star Wars Rebels, Gigataur, XYZyborg8, Magmic, and Fuel; all companies come together in the Ottawa International Animation Festival.

Creative minds in the **Film and Television** industry add \$50 million in revenue to the city each year, shooting 700 film days.

Ninety per cent of Canada's **Communications Technologies** are created by researchers in Ottawa, using the CENGN centre, in companies that deserve special mention: Alcatel-Lucent with its research arm in Ottawa, Cisco, and its Ottawa R&D division expanding to some 2000 experts, Ericsson with its strength in WiFi services, Huawei and its \$67-million Research Centre, 60-year Ottawa veteran Mitel serving 60 million global users, TV spectrum expert 6Harmonics, BTI Systems and their innovative networks serving 40 countries, and pioneering network company Newbridge Networks, purchased by Alcatel for \$7-billion.

Life Science innovators work in more than 100 companies in Ottawa, including Abbott Point of Care, MedDev, Gamma-Dynacare Medical Laboratories, and Nordion.

The **Software** sector is an Ottawa innovation strength, with more than 20,000 experts working for some 600 companies, including names like QNX (acquired by Blackberry for \$200 million in 2010) Cognos (acquired by IBM for \$4.9 billion),

Halogen (which raised \$50 million through an IPO in 2013), Kinaxis (with a \$100-million IPO in 2014), and Shopify (valued at \$1 billion with a 2014 IPO of \$100 million).

All of these companies—and the research laboratories that catalyse them—have their fires of innovation fuelled by unique international linkages. 130 embassies in Ottawa help entrepreneurs get direct access to a unique conjunction of four major economic blocks that Canada alone simultaneously connects to: the USA, China, the EU, and the Commonwealth.

These linkage centres are critical to Ottawa's construction of a Smart Economy based on Innovation.

Invest Ottawa, for example, is a one-stop agency that drives entrepreneurial growth.

CENGN propagates excellence in next-generation networks. The partnerships and project goals are varied: one project involves the orchestration of data connectivity and unites Telus and Cenex to synchronize a network to ensure optimal data routing, another project unites Jupiter Networks and Inocybe in showcasing a complete Smart City programmable infrastructure and network.

2.5 Effective Innovation and Ottawa's Innovative Metrics

2.5.1 *Measuring Innovation*

Ottawa is obviously interested in sustaining its innovation drive and Smart Economy. Understanding the basics of how it works requires measurement, for if something cannot be measured it cannot be managed. Ottawa has therefore been very interested in pioneering the measurement of innovation value.

“When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind”.

Lord Kelvin [12]

Organizations—companies and communities—evolve through similar stages of birth, growth, maturity, and decline; yet, they can last much much longer than individual people thanks to (i) renewal capabilities—ideas and/or people; and (ii) continuous innovation to adapt to changing environments and to fight threats. Innovation enables growth, avoidance of decline and, ultimately sustainable success (competitive-wise if business, relevance-wise if public/social entity) [13].

Throughout history, innovation has been the engine driving humanity towards economic and social progress. This has been done through the creation of new or better products and services; through the development of new ways to address

production, social problems, health issues, etc.; and through the creation of new economic and/or civic entities, industries, and entire markets. An organization’s success (be that a company or a community) is predicated on having a vision to rally the people in the organization, the will to succeed in spite of all obstacles and competitive difficulties, together with the knowledge and means for achieving the necessary tasks [14] (Fig. 2.3).

The ultimate goal of innovation is to create value for the organization and to maintain or enhance its position—a competitive position in the market if it were a business, or a relevant position in the socio-economic–political environment if it were a community or a government organization. Innovation is a by-product of the interplay of discovery “push” and user need “pull”. While “research” can be construed as the transformation of money into knowledge, “innovation” implies the transformation of knowledge into value and ultimately economic and social benefits. The attitude towards innovation, the types of innovation pursued, and the levels of risk accepted depend upon the situation of the organization in its environment (market). In the end, the biggest risk to an organization—be that a business, a community, or a government department—is that it does not innovate and evolve consistently enough to stay competitive/relevant and survive.

The fundamental issue affecting an organization’s performance—be that a community or a business—is its management, and most specifically its innovation management, i.e. its capabilities to envision a good future and to drive effectively and efficiently towards achieving it. Success starts with leadership that nurtures a culture of entrepreneurship and pursues innovation *comprehensively, competitively,*

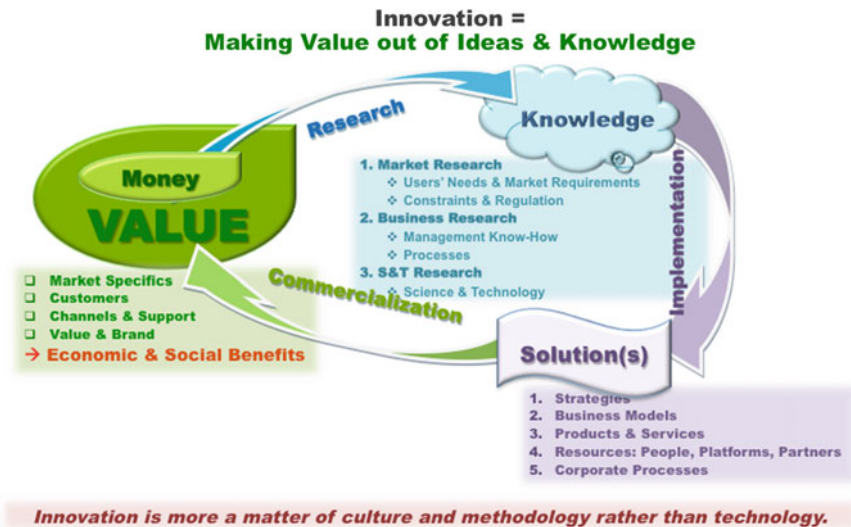


Fig. 2.3 Innovation means obtaining value from ideas. *Source* BD Cohnsulting presentation

and **methodically** with the right **metrics** to ensure tangible and timely value where it counts: in the market if a business, in the eyes of its citizens if a community.

One cannot understand and manage something without measuring it properly by determining the most important indicators and associating ways of evaluating them, i.e. the metrics. Having the right metrics is essential because metrics drive behaviour and determine how people are meeting their tasks and adapt in the face of change. For example, valuing research by the amount of money poured into it is akin to valuing a painting by the number of strokes the painter used to do it. Would we measure the value of fishermen by how many times they dip their rods (or nets) into water or by the quality and quantity of fish they get to take to market and feed their families?

Likewise, innovation without methodology is just luck. Effective innovation requires that people:

- Do the **right things** by establishing what the vision is, by knowing and preparing oneself, and by determining the priority things that need to be done first;
- **Do** the things **right**, which requires that one gets the necessary and sufficient means for having them done, that one organizes and executes methodically with the proper metrics, and that one evaluates and adjust as necessary;
- Learn and continue because competition and world changes never end and, therefore, innovation cannot end either (Fig. 2.4).

The c-FIT innovation management methodology [15] captures the eight critical stages for achieving success:

- **WHY:** learn about what innovation is about and agree to pursue it comprehensively, competitively, and methodically



Fig. 2.4 Key components of the competitive forward innovation technique. *Source* BD Cohnsulting presentation

- **WHO:** know about yourself (your organization), its leadership, its vision, its goals, what works and what does not at present
- **WHERE:** determine how well is your organization positioned in its environment (market) and what are its most important competitive attributes and needs
- **WHICH:** select the specific activities that are of highest priority, fund them, and resource them with the right people, platforms, tools, and partners
- **HOW:** plan and organize the selected portfolio of innovation activities' as proper projects with associated plans, budgets, milestones, and metrics in addition to having a balanced portfolio of corporate-level metrics (the score board)
- **Go-&-Do:** execute, measure, and manage the projects in the innovation portfolio
- **WHAT:** as timely as possible evaluate and adjust the corporate innovation portfolio; learn, improve, and continue
- **WE:** at all times, nurture a culture of innovation and enhance the structure and capabilities of the organization.

That is exactly what was undertaken in Ottawa—both with respect to the social aspects and metrics of Ottawa as a thriving community and with respect to the business innovation aspects of the core industries in the Ottawa region.

The Ottawa innovation studies are the first time that metrics have been used to measure the alignment of innovation culture with business goals and the market impact of their innovation investments. These surveys are innovations by themselves.

2.5.2 Metrics on Smart Community Linkages

As a framework for its metric on **social innovation** or Smart Community status, Ottawa used the *i*-Community Open Architecture (*i*-COA) model, developed by Bill Hutchison for *i*-CANADA, as the background for the development of the Intelligent Community Assessment by Stakeholders Tool (*i*-CAST) by Sorin Cohn, President BD Cohnsulting Inc [16]. This *i*-COA framework of smart or intelligent community capabilities looks at community culture, public and private development, institutions and their services to the community, the existing collaboration ecosystem, and the outcomes (Fig. 2.5).

The *i*-COA model is composed of five domains: place, infrastructure, collaboration ecosystems, solutions, and life, each of them subdivided into several dimensions:

1. The Place domain is the most stable one, being largely dependent on the existing environment within which the community has evolved throughout its history. It also contains the elements of governance overseeing its activities and takes advantage of its environment. This is the foundation.

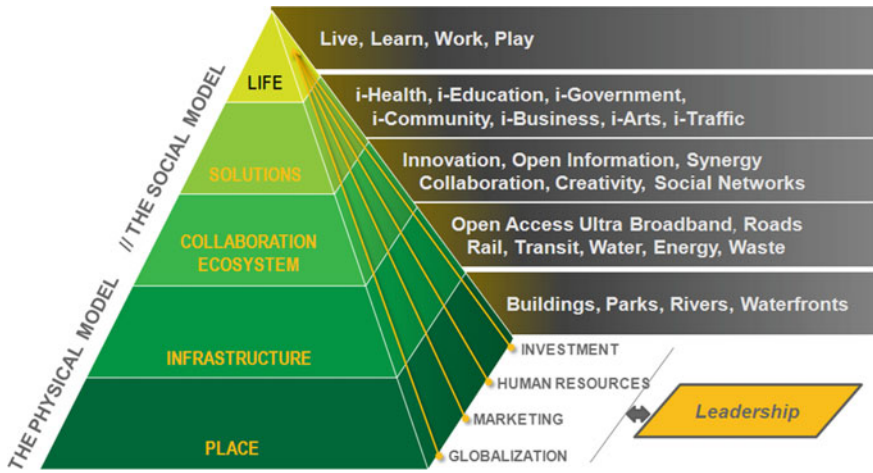


Fig. 2.5 Components of a Smart Community. *Source* i-CANADA presentation

2. The Infrastructure domain covers the usual services necessary to make the community live and work: roads and railways, energy services, water services, and very important nowadays the communication services—both fixed and mobile. Most of these are based on legacy developments and change in relatively long times.
3. The Collaboration domain addresses the levels of community involvement, how well its various elements work together, the entrepreneurial and innovation spirit of the community, its knowledge workforce and the ways by which the community markets itself internally and externally.
4. The Solutions domain covers the online eservices the community provides for its access to government, for its programs, for business development as well as for education, health, and also for recreation and culture.
5. At the pinnacle of the pyramid is the Life domain, which captures the quality of living and working and playing in the community in conjunction with the safety and social cohesion of the community.

The model shows that as the levels rise, the importance of the role played by linkages increases. In the realms of collaboration and solutions, for example, the value of the community is measured by how well it is interlinked.

The complete *i-CAST* analysis [17] is layered in five domains consisting of 26 critical differentiating areas covering over 100 dimensions of competitiveness that could be characterized by large numbers of indicators depending on the resolution required. To capture a balance view of the community status, the analysis can differentiate results the distinct perspectives of:

- The municipal staff,
- The business community,
- The residents in the community and, very important,

- The YOUTH in the community, for whom, and often by whom, the community is being built.

The results of the *i-CAST* study can be comprehended at a glance when they are portrayed as a “dashboard” in the form of a radial map, where an optimum outcome would be on the outer circle, and real-world results are part-way points on the measurements of the 26 critical areas of differentiation (Fig. 2.6):

From this map, it is easy to see how well *community involvement*, the spirit of *innovation*, and *entrepreneurship* are developed in any city. It is also easy to see where the shortcomings are that would lead to the improvement of an unsatisfactory result.

From the results of the *i-CAST* evaluation of Ottawa, it was found that Ottawa has the strongest Smart Community ranking in Canada. *The linkages that are the hallmark of an innovative or Smart Community were strikingly evident in each attribute of Smart Community development:*

- **Entrepreneurship:** 90 % said that entrepreneurs were celebrated and supported in Ottawa, and 68 % gave satisfactory marks to the success of the community businesses, government, and not-for-profit institutions in creating dynamic partnerships to foster innovation within the community;
- **Talent:** Two-thirds thought Ottawa had good community programs for enhancing digital (data) skills and increasing the knowledge-work constituency of the workforce, while 80 % said that more than half of Ottawa’s workforce had a college or university degree;

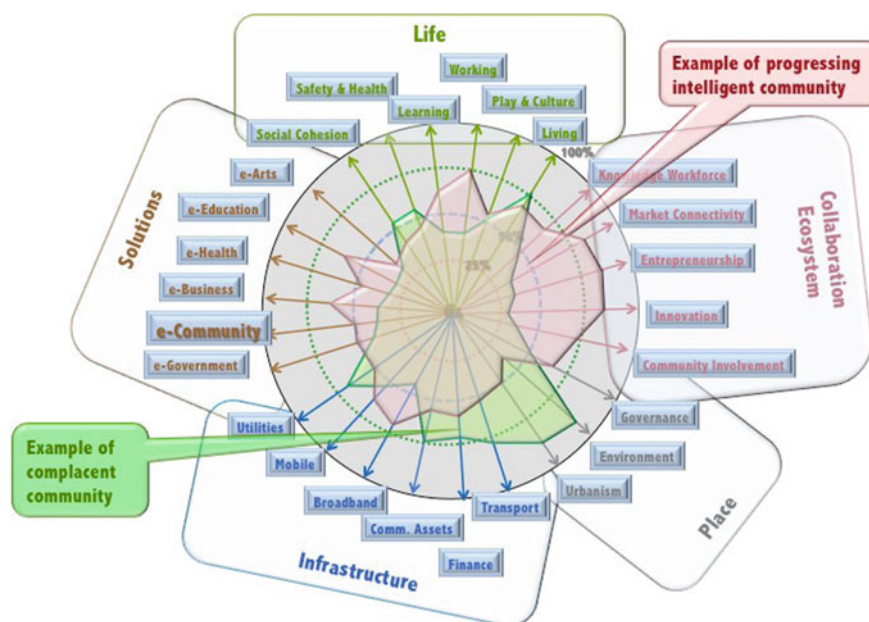


Fig. 2.6 Community assessment survey. Source Invest Ottawa presentation

- **Infrastructure:** 85 % think that the urban/rural infrastructure of streets, bridges, and buildings is sound; two-thirds gave good marks to the strength of financial effectiveness, transportation, and education; and 95 % have pride in the community and its environment;
- **Cooperation:** Three-quarters praised the intensity and effectiveness of collaboration between private businesses and civic institutions in their efforts towards a more vibrant, intelligent, and innovative community; and
- **Knowledge Economy:** More than half rated Ottawa as having a high knowledge economy rating.
- **Digital Equality:** 85 % of the community gave high ratings to the effectiveness of government programs for enhancing digital participation by underprivileged groups. More than 90 % praised programs the dealt specifically with women, children and youth, ethnic minorities and immigrants, and the unemployed.

These translated into very high marks on the community scorecard (Fig. 2.7).

Ottawa Intelligent Community Score Card:

Domain	Grades	Area	Grades	Score
LIFE	A-	Living	A-	8%
		Playing	B+	73%
		Working	B	65%
		Learning	B+	75%
		Safety & Health	A	81%
E-Solutions	B-	Social Cohesion	A-	78%
		E-Government	B-	59%
		E-Community	B	64%
		E-Business	C+	51%
		E-Health	B-	59%
		E-Education	C	48%
Collaboration Ecosystem	B-	E-Recreation	B	65%
		Community Involvement	C+	52%
		Innovation	B	61%
		Entrepreneurship	B	68%
		Marketing	C	46%
Infrastructure	B	Workforce	B	61%
		Transport	B	65%
		Financials	B+	75%
		Community Assets	A-	80%
		Broadband	B	61%
		Mobile	B	70%
Place	B+	Utilities	B	69%
		Governance	B	70%
		Environment	A-	77%
		Urbanism	B+	74%

Fig. 2.7 Ottawa’s rating as an intelligent community. Source Invest Ottawa presentation

2.5.3 Study of the Business Value of Innovation in Ottawa

Invest Ottawa decided it was important to complement the *i*-CAST evaluation of Ottawa as a Smart Community with an evaluation of Ottawa's business community using the Competitive corporate Innovation Management (c-IM) diagnostic tool also developed by BD Cohnsulting Inc [18]. The c-IM tool acts as an "Innovation Compass" helping companies enhance their competitive position through effective management of firm-level innovation by capturing "who" the company is, what its business objectives are, how it has managed its innovation investments, what are its business models, and how well it competes against primary competitors in their targeted markets (Fig. 2.8).

The **c-IM** diagnostic tool is based on the Value-add Comprehensive Innovation Management (**v-CIM**) framework, which can also be portrayed by a five-layer pyramid capturing the critical domains by which a company differentiates itself in the market. Business innovation is complex and multidimensional, and the interaction between innovation and the firm's organization depends on a multitude of factors some of which may be external to the firm itself. The **v-CIM** framework together with the metrics-based *competitive Innovation Management Techniques* (**c-FIT**) and associated tools enable companies to tune their innovation activities to market realities, align their management teams, select the necessary innovation targets, and manage methodically their efforts to accelerate company growth, avoid decline, and enhance position in the market.

Studies done by the Conference Board of Canada have demonstrated that investing in innovation is not sufficient to ensure success. Investments must be properly managed, and companies that invest without managing properly their



Fig. 2.8 Innovation management framework. Source BD Cohnsulting presentation

innovations perform significantly worse than those who do. The Canada-wide study found that fully one-in-four companies were investing heavily in innovation; yet, their innovation performance was negative—worse than if they had not been innovating at all. One-in-five companies had modest investment but—with high levels of innovation management—had innovation performance that added to the bottom line.

The *c-IM* innovation compass is using an online questionnaire that undertakes a targeted competitive analysis and probes the executive understanding of the company's business models, innovation strategies, management practices, and the cultural alignment with business goals. Answering the probing questions requires no preparation and takes about 35 min of an executive time. The result is a multi-dimensional targeted competitive dashboard that reflects the executive mindset, the team alignment, and its management capabilities. The *c-IM* tool can be used as:

- **CEO Leadership Tool**, which zeroes on critical corporate issues, points to competitive imperatives, and determines areas for competitive improvement
- **Investor's Due-Diligence Tool**, which determines likelihood of investment success and corporate improvement needs by discovering deep-seated management views, by pinpointing to competitive weaknesses, and by assessing corporate innovation management capabilities
- **Executive Team Management Tool**, which points to executive misalignment issues, maps roadwork ahead, and unifies the team behind common goals.
- **Regional/Sectorial Industry Tool**, which provides insightful industry performance analyses necessary to determine directions for evolution as well as wiser support programs and investments.

2.5.4 Innovation Assessment in a Dashboard

The Ottawa 2015 business community *c-IM* innovation assessment was undertaken under the leadership of the Innovation Group at Invest Ottawa and the Economic Development Department of the City of Ottawa in the summer–autumn of 2015. More than 200 executives participated, 50 % of which were driving their companies to become leaders in their industry segments while 15 % of the executives were more interested in building their companies for outright sales as early as profitably possible. About 35 % of the companies participating in the study were in the start-up stage, while 32 % had attained the growth stage in their lifecycle. A good percentage (27.5 %) of companies considered themselves to be at the maturity stage while about 5 % admitted to be challenged in the decline stage.

In terms of age and size, about 44 % of companies were over 10 years old while 15 % were older than 30 years. Almost 20 % were very young at less than 2 years old, while 37 % were between 2 and 10 years. About 6 % of companies had annual revenues in excess of \$200 M, while 21 % had revenues between \$5 M and \$200 M. A rather large percentage (31 %) had revenues below \$200 k.

Ottawa being the federal capital of Canada, it was not surprising to find that about 30 % of companies in our study were in the Professional Services market, while almost 30 % were in the Information and Communications (ICT h/w and s/w) industry, with about 20 % of companies in the broad category of Service Providers that includes utilities, cable and telephone companies, etc. About 9 % were companies in the Cultural and Education markets, 6 % in the Life Sciences and Cleantech segments, and only 2 % in the manufacturing sector.

We do not consider R&D investments to be a good measure of the intensity of innovation in most companies because R&D is only one aspect of business innovation in addition to strategy development, innovation in corporate resources (training, etc.), innovation in corporate processes (including sales and marketing), etc. As time is money, we consider the average corporate time dedicated to all innovation activities to be a better measure of innovation intensity in a company. In Ottawa, about 55 % of companies claimed to make very high investments in innovation (>15 % of their corporate time), while 11 % claimed high investments (between 10 % and 15 % of corporate time) and a further 11 % had moderate investments (between 7 % and a 10 % of their corporate time).

In terms of their financial performance, despite their usual rosy glasses, about 22 % of executives stated having had a neutral CAGR growth over the past 3 years and 7 % acknowledged to a decline in their revenues. Almost 40 % of executives stated positive growth and a significant number (31 %) claimed strong positive growth (Fig. 2.9).

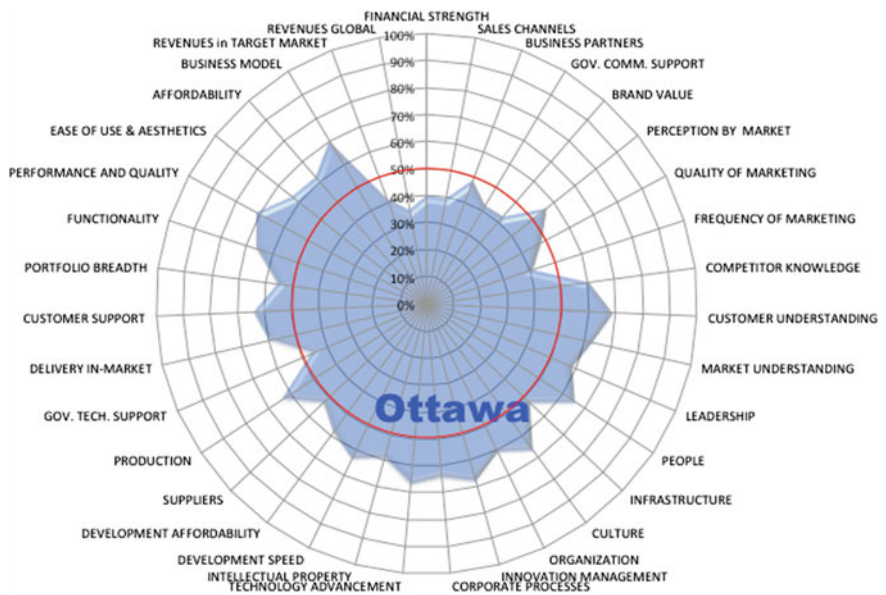


Fig. 2.9 Assessment of Ottawa executives for innovation strengths in their firms. *Source* BD Cohnsulting presentation

The c-IM Competitive Dashboard shown above presents the average competitive self-assessment against the primary competitors in the primary markets of the businesses participating in the study. The dashboard captures how Ottawa executives consider they are doing vis-à-vis their primary competitors across 35 competitive areas in five domains: Business Position at the top, Market Knowledge at the upper right, Resources and Organization at the lower right, Technology and Production at the lower left and Solutions Portfolio at the upper left. Performance is much worse than the competition towards the centre of the circle, and much better on the outside, with the red circle denoting competitive equivalence.

Ottawa businesses are quite competitive and doing better than the competition in terms of their product/service solution portfolios—affordability, functionality, performance, etc., as well as in terms of their market understanding, their leadership and resources, as well as their technology advancement, development agility, and affordability. On the other hand, Ottawa executives consider their companies to be somewhat less competitive in terms of commercial capabilities: revenues, channels to market and business partners. This can be partly correlated with the fact that, by their own admission, Ottawa companies are less aggressive in their marketing efforts. Surprisingly, despite their co-location with the major Federal Government support agencies, Ottawa executives appreciate that their companies benefit from less government support than their competitors.

Overall, the Ottawa c-IM Dashboard appears to be better than the one for the rest of Canadian companies, thus testifying to the fact that Ottawa is the innovation capital of Canada. Still, as mentioned above, there is scope for significant competitive improvement: better quality of marketing and more frequent marketing activities in the first place, and better sales channels to accelerate their revenues and boost their financial strength. Naturally, the other competitive imperative is to learn to take better advantage of the various government programs supporting technical and commercial innovation.

The c-IM Innovation Compass also provides an assessment of the innovation management practices in companies. On average, Ottawa businesses showed better practices (average grades in the C+ to B+ range) than those of companies in the rest of Canada, which had, on average, grades in the C to B range. As well, Ottawa businesses exhibited a somewhat better alignment of corporate culture with business goals and innovation strategies.

The most important aspect of our study is that it provided Ottawa business executives the c-IM Innovation Compass that reflected to them their reality-based competitive imperatives and the need for them to pursue innovation more comprehensively, competitively, and methodically with the right metrics to ensure performance in the market. In response to these developments, Invest Ottawa has decided to implement starting with the spring of 2016 an **Innovation Clinic**, where companies can acquire their own c-IM Innovation Compasses on the basis of which they can focus their innovation investments according to their strategic competitive imperatives.

By improving the fine grain of innovation at the commercial entity scale, Ottawa is addressing the fundamental unit of the Smart Economy. Together with changes made possible by measuring the City-scale challenges, the entire Smart Economy ecosystem is transformed.

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