



GFCC

Global Federation of
Competitiveness Councils

Innovative and Sustainable Cities

Best Practices in Competitiveness Strategy

2016

Innovative and Sustainable Cities

Best Practices in Competitiveness Strategy

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2016

CHAIRMAN'S LETTER



On behalf of the board of directors and members of the Global Federation of Competitiveness Councils (GFCC), I am pleased to present the 2016 report, *Innovative and Sustainable Cities: Best Practices in Competitiveness Strategy*.

When the GFCC was formed almost seven years ago, it was predicated on the belief that sharing best practices among national competitiveness organizations and among nations would provide benefit to all. With the release of this year's report, we have again put that belief into practice and created what we hope will be a useful tool for competitiveness organizations and initiatives around the world.

GFCC members understand more than anyone that the nexus of sustainability, innovation, national competitiveness and economic prosperity can manifest into a higher standard of living for all.

It is the mission of the GFCC to actively promote debate and dialogue, competition and collaboration, and innovation above all else. This year's *Best Practices* is the first to include cases from our university members, reflecting their increasing participation with the GFCC. In this year's report, we also highlight outstanding examples of competitive cities from six countries from all parts of the world: Brazil, Canada, Ecuador, Korea, Saudi Arabia and the United States.

Best Practices in Competitiveness Strategy is issued annually by the GFCC. I hope you enjoy the 2016 edition.

Sincerely,

A handwritten signature in black ink that reads "Charles O. Holliday, Jr." The signature is fluid and cursive, with the first name "Charles" being the most prominent.

Charles O. Holliday, Jr.

Chairman, Royal Dutch Shell, plc

Chairman, Global Federation of Competitiveness Councils

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EXECUTIVE SUMMARY AND OVERVIEW

Innovative and Sustainable Cities

Cities are the engines of economic growth. Eighty percent of global GDP is generated in cities.¹ Cities and metros accumulate assets needed for innovation—talent, technology, capital and infrastructure of all kinds. They attract highly educated workers and entrepreneurs, who share and transfer knowledge within and across industries, and form networks humming with ideas, creativity, innovation and economic potential. These ecosystems drive a thriving and dynamic economy, which further attracts more of these critical assets in a virtuous circle. Due to the accumulation of these assets, high value growth industries, industry clusters and technology hubs tend to emerge and grow in metropolitan areas.

Emerging and converging population, economic and technological trends have spurred nations—their governments, businesses and universities—to significantly increase their attention to the infrastructure, systems, operations and culture of cities.

- The world is undergoing the largest wave of urban growth in history.** Today, more than half of the world's population lives in urban areas, a share expected to increase to two-thirds by 2050. In 2014, there were 28 mega cities (cities with 10 million inhabitants or more). By 2030, the number of megacities is expected to grow to 41.² The urban population is expected to increase from 3.9 billion in 2014 to more than 6 billion by 2045.
- Urban infrastructure is vital to economic growth and competitiveness, and under pressure.** Infrastructure is the bedrock of competitive economies, the circulatory systems that move the goods, services, ideas and people that are the lifeblood of an economy and society. However, increased urbanization and urban population growth have placed significant pressure on city infrastructure. In many older cities, infrastructure is crumbling or in disrepair with substantial investment needed to modernize transportation, water and sewer, energy and other systems.
- Population growth in cities has placed pressure at the nexus of energy and sustainability.** Cities account for close to two-thirds of world energy consumption and more than 70 percent of global greenhouse emissions.³ Many of the fastest growing urban areas lie in emerging and rapidly developing economies, driving the growth in both world energy consumption and carbon emissions.
- Cities are becoming drivers and platforms for innovation.** As the world's cities and metro areas grow so does the need for sustainable urban environments, which require new and scalable innovations—energy efficient buildings, new approaches to water and waste treatment, highly fuel efficient vehicles, smart grids, clean energy systems, and new housing and public transportation models. Some cities will be built from scratch, offering tremendous

1 World Bank, <http://www.worldbank.org/en/topic/urbandevelopment/overview>.

2 World Urbanization Prospects, United Nations, Department of Economic and Social Affairs, Population Division, 2014.

3 World Bank, <http://www.worldbank.org/en/topic/urbandevelopment/overview>.

opportunities for innovation in urban infrastructure, as well as design and systems that maximize sustainability, maintain the quality of life, and support the creative and enabling environments that foster innovation and competitiveness. New technologies—such as advanced materials, energy and energy efficiency technologies, and the digital revolution—are poised to deliver transformative solutions at every scale.

All around the world, cities, metro regions and the institutions that support them are deploying different strategies, plans and programs, and technologies to meet the challenges of creating competitive cities, and to fulfill their potential for economic growth and as homes for thriving, sustainable communities. These diverse pathways to making cities smart, sustainable and innovative are reflected in the 2016 GFCC Best Practices. Themes explored include: leadership for transformation, nurturing talent for competitive and innovative cities, smart and sustainable infrastructure, building ecosystems that underpin innovative cities, the critical role of digital technologies, how smart services evolve and grow, and barriers to change.

Leadership for Transformation

Across countries, a diversity of organizations—governments at different levels, private sector enterprises, universities and partnerships—lead efforts to make cities smarter and more efficient, to make them more sustainable, to better serve urban populations, and to build innovation ecosystems. Some of the most important roles leadership organizations play

are advocacy for change, and coordinating the many stakeholders, service providers and economic assets that must come together for transformation. Government often plays a critical role due to public ownership and government operation of infrastructure, government investments targeting change and transformation, and the ability to plan and implement nationwide efforts.

In Brazil, the Pontificia Universidade Catolica do Rio Grande do Sul (PUCRS) worked with government and businesses to develop and implement its TECNOPUC Ecosystem of Innovation to stimulate joint R&D and innovation activities, which included establishment of a Science and Technology Park. TECNOPUC was based initially on partnerships with three global businesses—HP, Dell and Microsoft.

In Canada, the University of Waterloo is leading a first-of-its-kind initiative—the Global Entrepreneurship and Disruptive Innovation (GEDI)—designed to leverage the region's innovation assets and accelerate the transition of on-campus research to industry. The GEDI is championed by the university's president, Feridun Hamdullahpur, and governed by a committee of internal university stakeholders, including the Office of Research, Accelerator Centre, Co-operative Education and Career Action, Office of Advancement, University Relations and the Provost Office. In addition, in the GEDI, Waterloo University is partnering with regional mayors, technology accelerators and economic development organizations to create a cohesive Toronto-Waterloo Innovation Corridor.

In Ecuador, the Secretary of Productive Development and Competitiveness for the Municipality of Quito has established the Competitiveness Council of Quito. The Council is chaired by the Mayor of the City, and has 15 members representing the city's economic sectors including commercial and industrial businesses, agriculture, tourism, financing, exporters, construction and universities. The Council's role is to focus on and coordinate work between the public sector, private sector and academia in developing a ten-year competitiveness agenda and roadmap for the city.

In Korea, the Korean government established an "integrated master plan for cities," a Ubiquitous (Smart) City (U-City) model that treats the city as an organic whole in order to optimize its functioning. Other government Ministries played a key role in implementing the master plan. The Ministry of Information and Communication announced "The Plan for Activation of U-City Construction" in 2006, while in 2009 the Ministry of Land, Transport and Maritime Affairs announced the first five-year "Comprehensive Plan for U-City," and then updated the "Comprehensive Plan" in 2013. These plans helped organize, focus and integrate the efforts of 49 local institutions.

In Saudi Arabia, the state-owned oil giant Saudi Aramco acts as a champion in the Dhahran Techno-Valley (DTV), an emerging energy innovation hub in the City of Dhahran. Saudi Aramco has helped build the capabilities of DTV by providing investment capital, technical talent and business opportunities; it also provides interregional and international connections via its networks and value chains. Saudi Aramco helps stimulate R&D within the hub and academic institutions, helps other stakeholders within the hub to bridge the commercialization gap through collaboration or supplier relationships. It has attracted companies such as Schlumberger, GE, Sipchem, Honeywell, Baker Hughes and others, which co-located in Dhahran to do business with Saudi Aramco. Finally, Saudi

Aramco is encouraging development of a strong IP protection system by filing its patents and licenses domestically and internationally, maintaining strong internal policies and processes for protecting its own IP and that of partners, and advocating for the enactment of comprehensive national IP policies.

The Saudi government is enacting policies to advance the Dhahran experience. One example is the Competitive Acceleration Program, in which stakeholders committed to reaching targets in a set of competitiveness indicators to increase the ease of doing business and enhance Saudi Arabia's competitiveness. The program culminated in enacting policies for promoting a more efficient market and business environment for both local businesses and foreign investors.

Nurturing Talent to Support Competitive and innovative Cities

Cities can serve as magnets to attract highly skilled talent and entrepreneurs, and serve as education and training grounds to prepare people for their roles in the global economy and for contributing to the competitiveness of cities.

In Brazil, as part of its TECNOPUC Ecosystem of Innovation, the Entrepreneur Tournament engages students in entrepreneurial skills development. During lectures and workshops focused on development of business ideas, students learn about Design Thinking, creativity, technological innovation, business modeling, market testing and preparation of a market pitch. Afterwards, students apply what they have learned, presenting business plans they have developed to a jury that selects the projects with the greatest potential to grow into a new business. In the nine years in which Entrepreneur Tournaments were held, more than 16,800 students have participated in seminars and workshops, training and projects.

Globally, Webster University's network of campuses extends to cities on four continents, educating thousands of students across the

world. To help develop global awareness and knowledge, study abroad students from Webster campuses can spend a term, a semester or a year at other Webster campuses. Webster students can choose to complete an entire degree program outside their home country or can transfer credits among campus locations. Yet, the assets of these campuses have not been optimized for the benefit of the whole university nor each individual campus and its home city. Established structures, geographic isolation, leadership orientations, limited communication infrastructure, and unique characteristics of a specific location—such as culture, economics, politics and regulations—are barriers to successful integration.

Two initiatives address this challenge. The Global Leadership Academy is a leadership development program designed to enhance Webster's institutional capacity for global work. The three goals of the year-long Academy are developing faculty and staff leadership skills, providing a comprehensive understanding of Webster's complexity and creating ambassadors to the communities Webster serves.

The Global Student Leadership Summit, held in 2015 and planned again for 2017, convened 29 students of 20 nationalities from 8 Webster campuses at the St. Louis, Missouri campus to discuss leadership and advocacy. They built their knowledge and skills, developed relationships with peers across the campus network, enhanced their intercultural competence, and gained a better understanding of the impact that student involvement has on students and Webster University worldwide. The program goal is that student participants return to their home campus and implement the skills and knowledge acquired to improve student life throughout the Webster University network.

Other initiatives include the Global Citizenship Program (GCP), a set of undergraduate degree requirements building students' knowledge in areas such as roots of cultures, social systems and human behavior, physical and natural world,

and global understanding. In the Global M.A. in International, students complete their degrees in five terms at five different locations.

Modern Infrastructure Makes Smart, Sustainable and Innovative Cities Possible

Physical infrastructure underpins a city's society, quality of life and economy, the ability of businesses and manufacturing to operate, and deployment of the workforce. There are many approaches to establishing and modernizing a wide range of infrastructure to make it more efficient and sustainable.

In Brazil, a Smart Grid infrastructure is being developed for the City of Barueri, which will provide numerous benefits. Using smart meters, consumers will be able to monitor daily power consumption, and pay variable pricing according to the day and time energy is consumed. Wireless radio frequency technology and power line communications for information and data transmission will enable the distribution company to have more accurate information about energy consumption and the status of the energy network. Energy interruptions in the system, the problem's origin and extent will be automatically identified. It will be possible to program the automatic re-composition of the system in contingency situations. For the distribution company, as energy consumption is better distributed across time, it is possible to increase asset utilization. Automated monitoring and systems optimize the distribution of energy according to demand, resulting in better operational efficiency. Deployed in a very dense industrial region, the Smart Grid will reduce companies' needs for generators.

In the United States, water supply and water infrastructure are important issues for manufacturing and residential communities. In February 2016, the Council on Competitiveness, along with partners Marquette University and

A. O. Smith Corporation, gathered more than 50 experts on water and manufacturing to identify and discuss challenges and opportunities related to water, energy and manufacturing using the Milwaukee, Wisconsin region as a case study. With 86 percent of the state of Wisconsin bordered by water, issues at the intersection of water and manufacturing are a priority. Milwaukee's economy was founded on manufacturing industries that were highly dependent on the abundance of fresh water. The City of Milwaukee has already taken steps to improve its water stewardship. Among these efforts is the production of Milorganite, an organic nitrogen fertilizer created from solid waste collected from sewage treatment plants. In addition, Milwaukee is integrating natural systems with the built environment in projects such as green roof installations and rain barrels.

Company commitments to water stewardship were highlighted at the dialogue. For example, Wisconsin-based Kohler Company—a global leader in kitchen and bath plumbing fixtures—has helped U.S. consumers reduce water use by 110 billion gallons over the last ten years, saving \$1.3 billion in water, sewer and energy costs. Kohler is committed to helping reduce another 100 billion gallons of water use in the next three years. Also, MillerCoors, the second largest beer company in America, is implementing the Alliance for Water Stewardship Global Standard at its Milwaukee brewery. The brewery's has increased the efficiency of its water usage, and showcases its green roof and rain garden to thousands of people who tour the brewery each year.

Building the Ecosystems that Underpin Innovative Cities

A city's economic assets include sources of research and technology, businesses, human capital, financial capital and culture. But institutions and networks are needed to knit these diverse assets together into innovation ecosystems, creating an environment for entrepreneurship, new business formation, and

the development and growth of industry clusters and technology hubs. Around the world, there are different approaches to integrating economic assets into engines of innovation.

In Brazil, PUCRS developed the TECNOPUC Ecosystem of Innovation to stimulate joint R&D and innovation activities within the community. Elements of TECNOPUC include: the STARTUP GARAGE Business Modeling Program, a space for ideas, and technology and innovation projects for entrepreneurs coming from the academic units of PUCRS who seek support to develop a business model; CREATIVE GARAGE, which offers companies space and routine work for business development, as well as tutorials and the possibility of using the environment and equipment in TECNOPUC's pre-incubator; CREATIVITY LABORATORY, a space in which people and their companies or institutions expose their ideas, problematize, discuss, negotiate, make decisions and create strategies to solve problems; BUSINESS ACCELERATION PROGRAM, which supports entrepreneurship originating from university research (spin-offs) or present in the TECNOPUC (startups); and CULTURES OF INNOVATION, in which TECNOPUC sponsors seminars for the exchange of experiences about effective interaction with the world's leading innovation markets.

PUCRS is developing an innovation hub and industry cluster anchored by the university at its Science and Technology Park. Along with IT industry anchors Dell and HP, which have concentrated their Brazilian R&D centers in TECNOPUC, other global players have been attracted to the TECNOPUC hub, including Microsoft, Accenture, Tlantic, Sonae and ThoughtWorks, as well as large national enterprises, such as DBServer, Globo.com and Randon Group.

In Canada, GO Productivity is focusing on the human element of innovation—for example, how and how often people within a specific community work together in collaborative teams

to identify and resolve challenges, develop new and better processes, and create solutions to problems that may not have been previously identified, a tremendous barometer of how effective an innovation ecosystem can be. GO Productivity suggests that the key to higher levels of innovation and its real impact on business is directly linked to “Investment in Human Capital.”

The design of the ecosystem or culture itself is important in supporting investment back into its people, allowing them to pursue higher levels of innovation. This includes an environment that supports many, and the right kind, of “collisions”—human interactions around new idea generation, development, testing and refinement, and implementation. Interactions can include various conversations, meetings, training and learning sessions, and events, both formal and informal, that allow for significant collaborative design and development opportunities. In cities, these interactions take place between a wide range of organizations; various service providers, stakeholders, suppliers and customers, government and not-for-profits all need to be included in the ecosystem that supports these interactions and their associated “collisions.” These collisions are crucial to producing “serendipitous moments”—the unpredictable, unexpected “eureka”-type moments that can occur when people come together for a brief period around a particular idea or theme, and experience a breakthrough. Unfortunately, most firms do not design for collisions to occur, halting opportunities for more innovation. There needs to be real thought around what structures should be in place, the use of time and space, characteristics of physical space, and what freedoms and expectations are encouraged within defined boundaries. Also, there needs to be consideration and communications around the values supported and promoted within the ecosystem.

In Canada, the University of Waterloo is launching the Global Entrepreneurship and Disruptive Innovation initiative (GEDI) to

accelerate the transition of university research to industry to create regional economic opportunities. GEDI's vision is to create a dynamic link between research, industry and disruptive startups, by creating a nexus of innovation: a physical space where business leaders, entrepreneurs and academic researchers can connect and collaborate. GEDI will provide four key services: connecting industry partners with the university's impact-driven research, giving companies the opportunity to collaborate on research projects; helping businesses tap into the pool of innovators at the university, such as graduate students and faculty; assessment services that help enterprises determine how well their internal systems foster innovation; and leadership development through executive-level education, a master's degree in innovation, innovation coaching, and dissemination of the latest in innovation research through white papers and conferences. The university's longstanding creator-owner intellectual property policy has helped foster a strong entrepreneurial culture among faculty and students, and spawned a thriving startup ecosystem second only to Silicon Valley in its density. This entrepreneurship is further supported as Waterloo runs the largest free startup incubator on any campus in the world, which has helped Waterloo students establish 120 companies to date.

In Ecuador, the City of Quito's competitiveness agenda has five pillars: productive development, infrastructure and connectivity, innovation, investment and social development. Areas of focus include: encouraging private sector participation in projects identified as a priority for the city such as mobility, sustainability and tourism; investment and formation of Quito's investment agency; fostering an ecosystem for industry cluster development; and improving the ease of doing business areas of regulation for which the municipality has responsibility such as starting a business, dealing with construction permits and registering property.

In Saudi Arabia, the City of Dhahran recognized that it could not simply import an innovation culture through enterprise acquisitions. It needed requisite elements to support knowledge transfer, such as a critical mass of local skills, widespread adoption of technology by public and private sectors, and the appropriate legal and cultural institutions. The Dhahran Techno-Valley (DTV) has helped overcome these challenges by bringing together various stakeholders—universities, private sector institutions, MNCs and the public sector, among others—in an effort to collaborate on research and leverage knowledge of local markets. The state-owned oil giant Saudi Aramco is playing a critical role. First, Saudi Aramco is leveraging intellectual capital by encouraging knowledge sharing through its collaboration with King Fahd University of Petroleum and Minerals researchers, and cross-pollination of ideas, for example, by organizing innovation forums. Second, through R&D satellites across its international networks (e.g., Houston, Texas and other locations), Saudi Aramco is facilitating the transfer of complex knowledge and promoting Dhahran as a hot spot for innovation. Third, by utilizing its local and international links, Saudi Aramco is helping steer DTV in directions that better meet regional and international needs.

In the United States, the Council on Competitiveness, along with partners Marquette University and A. O. Smith Corporation, gathered more than 50 experts to discuss water, energy and manufacturing in the United States. Stakeholders highlighted efforts to strengthen the innovation ecosystem for water research and technology. For example, the Milwaukee, Wisconsin-based Water Council launched a water innovation scouting program called PROOF, expected to connect emerging technologies from government laboratories, universities and entrepreneurs to commercialization across industry sectors. A. O. Smith Corporation—a global manufacturer of water heaters and boilers—has several projects, including the ICE Institute (Innovation, Commercialization and

Exchange) to promote start-up businesses in freshwater technology, and bridge the gap between research and industry. A. O. Smith will also provide support in a global outreach program that works to identify and broaden efforts to develop sensor technologies for monitoring fresh and wastewater. Marquette University is collaborating with industry to develop cross-functional sensors for water monitoring equipment, and faculty are fostering academic-industry partnerships on big data in the water sector.

Digital Technologies Play a Central Role in Building Smart Cities

Information and communications technologies (ICT) provide powerful tools to connect people into networks, to connect people with critical information and services, to improve the efficiency of government services, and to establish smart and sustainable city infrastructure.

In Brazil, São Paulo, the biggest city in Brazil and pioneer in smart city initiatives, operates three centers focused on specific city management activities. The Center of Emergency Management is responsible for integrating meteorological information in the city, the Traffic Engineer Company gathers information on traffic, and the Operations Center of the State Police is responsible for monitoring security. Each of those agencies used to maintain an independent Center to integrate their activities. As a response to the increasing number of emergencies, mainly linked to summer rain, that were dispersed through all three agencies, the city realized the need for a smarter and faster way to gather and interpret this kind of data. In 2016, working with IBM, a platform was developed to create the CMGI (Integrated Monitoring and Management Center).

The CMGI, located in the city center is responsible for: receiving and integrating data coming from individual agencies, analysis and interpretation of information, decisions about adequate

response to emergency events, communication of required actions to responsible agencies, broadcast of information, and real time indicators regarding emergencies throughout the city. The main area of CMGI's focus is weather related emergencies: tree falling; flooding; land sliding; and also some innovative uses, such as management of shelters and blankets for homeless people during the winter.

Another smart initiative in the state of São Paulo was also developed in collaboration with IBM. ARTESP—the regulatory public agency for transportation—needed a system to manage 30 state roads that are the responsibility of 20 different concessionaries. Until 2014, the ARTESP control process was strictly manual. Using IBM solutions to solve the problem, a platform gathers data coming from each of the concessionaries, and enables ARTESP to act promptly to accidents and perform predictive maintenance. 360-degree cameras monitor more than 70 percent of the roads. Car counting sensors, connected toll plaza systems and emergency telephones send data in real time to the operations center.

The successful experience in São Paulo led different cities to replicate its integrated operations center model. For example, Porto Alegre's Center for Integrated Command of the City (CEIS) supports city management during critical situations and emergencies, including the use of about 850 cameras in the city. Through CEIS, big city critical situations involving traffic and natural events are identified, and decisions made in an integrated and prompt manner. When an accident is identified, traffic is re-routed by the Public Company of Transportation and Circulation (EPTC) to facilitate medical access to the area. The Secretary of Health, and the service of the Municipal Humanitarian Emergency Service coordinate medical attention. Then EPTC adjusts traffic to reduce impact to users. Similarly, the cameras can easily identify a flooding, and actions can be undertaken by different agencies.

Globally, Webster University makes significant use of digital infrastructure to increase human connections and collaborative work across its network of global campuses. Webster's Global Wide Area Network connects all campuses across the globe, creating consistent and reliable service for all constituents at higher speeds and greater bandwidth. The new platform has enabled video conferencing across the network, invaluable as a substitute for costly travel and in building connections among campuses, their faculty, staff, and students. For example, video conferencing and regularly scheduled events bring members of the community in contact with each other. Academic conferences and summits hosted by each campus on topics such as born global entrepreneurship, humanitarian rights, global communications trends, the Eurozone, Asian regional cooperation, and women's empowerment draw members of the university community who can attend virtually.

In the 1990s, Webster was an early adopter of online courses and programs, provided asynchronously via the web due to time zone differences among campuses. Today, to coordinate academic and operational activities among Webster's European campuses, video-enabled classrooms enhance the ability to coordinate course offerings in synchronous modes. Courses can originate at any of the European campuses and be delivered to students at each of the other campuses, optimizing and diversifying enrollments and faculty expertise in such courses.

In Korea, a world leader in ICT, the U-city (smart city) model is equipped with cutting-edge IT, enabling smart capabilities and services. For example, these include: in transport, real-time public transport information service; in safety, intelligent unmanned security and monitoring of mountain fires; in the environment, monitoring via sensors and CCTVs; in healthcare, telemedicine and personal medical advice; and in education, remote lecturing, presence check with RFID, U-classroom, and searching and reserving books

and digital items. As a “Smart City” plan extended the U-City initiative, new smart city projects using ICT were identified. These include, for example: smart parking (parking spaces identified in real-time and payment of parking fees via a smart phone application), smart crossroad (smart bollard and safety fence installed in front of the elementary school to detect traffic violations and sound an alarm), smart streetlamps (CCTV and WIFI function added to save energy and prevent crimes), smart building (monitors information on building management necessary to reduce energy consumption), and situation-based smart home (identifies the safest escape point during a fire).

Evolution and Spread of “Smart” Cities

A model project or ICT platform can spark the evolution and spread of efforts in other cities or city functions, with new and diverse applications evolving from the original. Others take new tools and new capabilities and mold them to their specific needs.

In Brazil, the Integrated Operations Center envisioned in São Paulo was expected only to monitor and predict weather emergencies, but the infrastructure and its potential functionalities led to an integrated center supporting traffic, urgent medical response, and surveillance and security. In Recife, the Center of Traffic Operations operates about 600 cameras to monitor traffic in the city. As the application has been deployed, use of the system has been extended to improve safety and support the police mapping criminality. Initially, operations centers in São Paulo and Porto Alegre did not have these extended applications, but have since adopted them.

Similarly, the platform developed by the municipality of Curitiba goes beyond the idea of an integrated center. The Institute for Research and Urban Planning (IPPUC) developed a geo-referenced platform. Through the platform, the IPPUC is able to detail and supervise

implementation of the Curitiba Master Plan, providing an advanced tool for public land management.

In Korea, the “U-City” project is evolving. The first U-City plan was designed primarily for developing the basic infrastructure, including application of core technologies, and Korean cities have emphasized different elements of U-City. For example, Songdo established a standardized model for U-City and U-City infrastructure. The Mapo District (Seoul) mainly expanded the service and infrastructure for vulnerable citizens such as children, seniors and the disabled. Yeosu encouraged the use of bicycles to reduce its carbon emissions, forming a growing green U-City. The Eunpyong District (Seoul) provided various safety services and integrated with an existing disaster management system, developing an upgraded model for a safer city. Also, the basic U-City infrastructure has established the foundation on which the Korean government is developing various smart city projects.

Barriers to Change

Major transformations can confront a variety of barriers to change, ranging from culture and habit, to financing and existing systems.

In Brazil, in developing and implementing the TECNOPUC Ecosystem of Innovation, which included proposing actions to transform education, the Pontificia Universidade Catolica do Rio Grande do Sul faced the challenge of the traditional inertia within the academic and university environment.

In Brazil, in São Paulo's smart system to manage roads across the state, the main issue encountered during implementation of the platform was not the technical challenge, but the change of communication protocol among different concessionaries. Used to manual operations, they were resistant to the changes needed to comply with new information requirements.

In Canada, as Waterloo University launched its GEDI program to connect businesses to its impact-driven research, a key challenge was clearly articulating to external stakeholders how GEDI complements, rather than duplicates, the work of existing technology accelerators and innovation hubs within the Toronto-Waterloo Innovation Corridor. Other challenges have included finding ways to align industry needs with the other research demands placed on faculty, and align industry timelines with academic schedules. Finally, there is the challenge of financing GEDI.

In Korea, the U-city project has been less than optimal due to the dispersed efforts taking place under the U-city umbrella—Smart Water Grid by the Ministry of Land, Infrastructure and Transport; Internet of Things business of Smart City by the Ministry of Science, ICT and Future Planning; and the Smart Grid project by the Ministry of Trade, Industry and Energy. Korea seeks an integrated approach to achieve the synergistic effect. There are many institutions involved whose efforts must be coordinated. There was a limitation on effective and timely development, especially for harmonizing roles between the central government and local governments. Also, there were gaps between cities in implementing the U-City plan, because some local governments did not have an adequate budget.

In Saudi Arabia, development of the innovation ecosystem in the City of Dhahran faced the challenges of a dearth of scientists, government red tape and the need to develop a culture of innovation, rather than relying solely on enterprise acquisitions. Other barriers and challenges revolved around the business environment. Executives at MNCs pointed to a persistently high cost of doing business in Dhahran, due to factors such as unwieldy immigration laws and visa restrictions. Copyright issues also present a challenge to protecting intellectual property; regulations that exist on paper are often not

enforced. With such perceived risk, few MNCs were willing to devote money and effort to R&D in Dhahran.

The technology cluster is sponsored by the state, which creates challenges in the budgeting process for city clusters and small-scale enterprises working on promising technology. Research budgets can be compromised due to financial crisis or other factors. Some budgets for R&D institutions were cut and the lack of a vibrant private sector led small companies to complain of insufficient funding sources. Another crucial problem was the dearth of statistical data, which hampered efforts to understand market demands, for example, financial feasibility studies for new products. Finally, cultural attitudes often got in the way of innovation. Outsiders note a prevalent “why do we need this” sensibility, in which taking risks, such as investing in blue-sky research that sometimes leads to real breakthroughs, is not encouraged.

BRAZIL

Smart Cities in Brazil: Some Drivers and Players Paving the Path of Competitiveness and Quality of Life

Introduction

An underlying assumption behind the idea of smart cities is the pivotal role of urban areas as engines of economic growth and development. On the one hand, cities are clusters for education, health-care, culture, technological innovation, entrepreneurship, social services, government administration, and communications, as well as the rules and institutions that create the social environment for doing business and investing in new technologies that promote evolution. On the other hand, urbanization also comes with challenges in areas such as energy, mobility, waste disposal and management, employment, and other issues regarding social inclusion and environmental sustainability. These challenges are even more important when considering that, according to the Department of Economic and Social Affairs of the United Nations, UN-DESA (2015), 89 percent of the urban agglomerations expected to emerge by 2030 are located in less developed countries (see Table 1). Many of these urban spaces combine economies that promote



productivity and wealth creation with diseconomies that must be overcome to preserve and reinforce their role as poles for wealth creation.

Therefore, the current scenario requires cities to develop and implement ways to manage these challenges. It is clear that many of the existing approaches have been, in different degrees, based on information and communication technologies (ICT), but “[t]he concept of smart city is far from being limited to the application of technologies to cities,” as presented by Albino et al. (2015). We argue for a comprehensive perspective: smart cities, especially in a developing country context, should be understood and promoted

Table 1: Number of urban agglomerations of income groups expected to emerge until 2030, by size of urban settlement

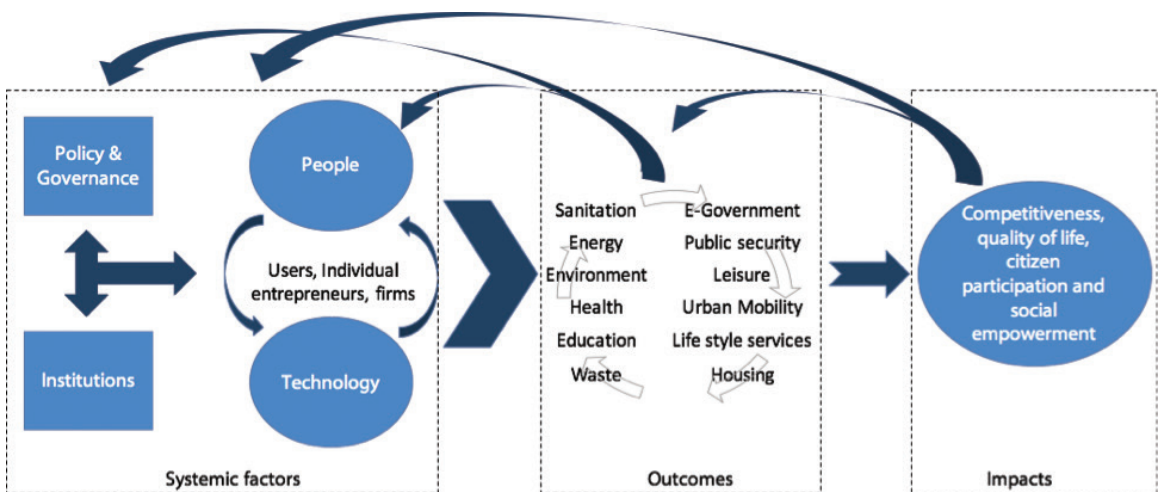
	High-income countries	Upper-middle-income countries	Lower-middle-income countries	Low-income countries	Total
10 million	0	6	6	1	13
5 to 10 million	3	4	5	8	20
1 to 5 million	17	68	43	13	141
Total	20	78	54	22	174

as an economic and social space that fosters creative initiatives—not necessarily high-tech ones—to tackle modern challenges to achieve higher living standards and sustainable, inclusive and environment-friendly growth. This paper describes how the idea of smart cities and the underlying technologies materialized in the Brazilian context. In Section II, a conceptual framework is presented, in which key drivers of smart cities are identified, explaining how they determine the outcomes in the cases presented in Section III. This framework is not only an analytical tool for the cases, but also a provider of key elements for a coherent identification of efforts being carried out in Brazilian smart cities, and the potential of innovations in different knowledge fields to create growth, dynamic competitiveness, and wellness. Finally, in Section IV, there is a short discussion on policy implications derived from the selected cases.

Conceptual Framework

Figure 1 presents the conceptual framework used for the identification and analysis of the most relevant smart cities solutions being deployed in Brazil. Creative solutions for a city's problems usually are developed and marketed by three types of actors: local small and medium enterprises (SMEs) or entrepreneurs searching for appropriate solutions for local problems, local service providers using technology to make existing services “smarter,” and global companies implementing solutions with adaptations to local needs. These players are represented in the interface between people and technology, and they often interact with other agents within the innovation system. The outcome deriving from these interactions are smarter essential services, which will eventually have a positive impact on competitiveness, quality of life, citizen participation, and social empowerment.

Figure 1: Conceptual Framework



The development and implementation of smart city solutions must consider not only business enterprises, universities and research institutes, but also (and mainly) policy and governance mechanisms, institutions, and a broad societal structure in which people, firms, research institutes, and technology itself are embedded. On the one hand, local governments can play a central role in smart cities through the design and implementation of supportive policies, creation of economic opportunities, implementation of transparent governance, promotion of collaboration between multiple players, promotion of entrepreneurship, investment, targeting schemes, and definition of priorities for smart cities initiatives, among other strategic actions. On the other hand, the institutional structure provides incentives and constraints for individual actions. As discussed in the next section, social rules, norms, expectations, conventions, and beliefs can be determinant factors for the diffusion and scale-up of some smart city solutions.

Feedback loops and multidirectional causal relationships are also considered. People affect and are affected by technology, as are policy, governance, and institutions. In addition, resulting outcomes and impacts also affect the system as a whole. For instance, some solutions may have a positive impact on education, which, in turn, may provide an opportunity for enhancing citizen participation and influence over local decision-making, or enhance absorptive capacity for the use of existing technologies. Moreover, other outcomes may generate further impacts that can be self-reinforced. For example, better quality of life can attract a high-skilled labor force that, in turn, can be determinant for the success and further improvement of competitiveness of cities,

or a Smart City can be deemed more attractive for investments, which can also enhance different systemic factors.

From the above, a matrix is envisaged to position smart city solutions according to the type of agents and expected outcomes associated, as presented in Table 2. Such an arrangement will be one important criterion for selecting the cases of smart city solutions in Brazil presented in the next section.

The following section presents two cases positioned differently in the matrix. While Integrated Operations Centers enhance the quality of life in Brazilian big cities, the Smart Grid Application attracts investments and enhances competitiveness in a specific region. Tendencies have been identified from specific conditions of Brazilian cities and local competencies developed in response to an increasing demand for technological solutions applied to cities' problems. As it will be seen, type of actors differs in each case.

Cases

Case I: Integrated Operations Centers in Brazilian Big Cities

The World Cup and the Olympic Games have relied on solutions aiming to improve intelligence and control of the city management Integrated Operations Centers that have been launched as a response to major weather related emergencies and mobility problems. They have been spreading out to other big cities and gained improved functionality, with companies and local governments working together in response to a combination of local competences and necessities.

Table 2: Type of agents and expected outcomes associated with smart city solution

	Capacity to attract investments and enhance competitiveness	Enhanced quality of life	Citizen participation and social empowerment
Local solutions for local problems developed by local entrepreneurs	(1)	(2)	(3)
Local services that became ‘smarter’	(4)	(5)	(6)
Global solutions designed by global corporations including adaptations to local needs	(7)	(8)	(9)

The Pioneer Case of São Paulo

São Paulo smart city initiatives are pioneers in Brazil, dating from the early 2000s. São Paulo is the biggest city in Brazil, with almost 12 million inhabitants, and one of the 10 most populated cities in the world; across the Metropolitan Region, São Paulo has more than 20 million inhabitants. The city operates at least three centers focused on specific activities. The Center of Emergency Management (CGE) is responsible for integrating meteorological information in the city, the Traffic Engineer Company (CET) gathers information on traffic in an integrated location, and the Operations Center of the State Police (COPOM) is responsible for monitoring security. Each of those agencies used to maintain an independent Center to integrate their activities.

As a response to the increasing number of emergencies, mainly linked to summer rain, that were dispersed (and sometimes replicated) through all three agencies, the city realized the necessity of a smarter and faster way to gather and

interpret this kind of data. In 2016, working with IBM, a platform was developed, aiming to create an Integrated Operations Center to enhance the capacity of the previous systems. Three months after beginning implementation, the CMGI (Integrated Monitoring and Management Center) is already operational, and is still under development to add new features and capabilities. The investment related to software and services used in the endeavor is about US\$ 2.7 million.

Today, the CMGI is located in the city center and responsible for: receiving and integrating data coming from individual agencies, holistic analysis and interpretation of information, decisions about adequate response to each set of emergency events, communication of required actions to responsible agencies, broadcast of sensible information, and real time indicators regarding emergencies throughout the city. The main area of CMGI's focus is weather related emergencies: tree falling, flooding, land sliding, and also some innovative uses, such as management of shel-

ters and blankets for homeless people during the winter. Although there is no official report on the results yet, the Center has notably improved control and management of the city.

Another smart initiative in the state of São Paulo was also developed in collaboration with IBM. ARTESP—the regulatory public agency for transportation—demanded a system to manage roads across the state. Operation of the 30 state roads is the responsibility of a group of 20 different concessionaries. Until 2014, the ARTESP control process was strictly manual, counting only on calls and agents spread through the 6400 km of roads across the 271 municipalities of the state. This process was evidently ineffective, causing long periods of time before road assistance reached accidents, poor maintenance, numerous cases of road crimes, and slow actions to discover and respond to problems, jeopardizing the overall quality and negatively affecting more than 20 million users.

In 2014, the Brazilian consultancy enterprise Magna Sistemas won a public contract to implement a Center of Operations to gather and centralize information about São Paulo roads. Using IBM solutions, tailored specifically to the problem, the endeavor took only months to begin trial operation. Today, the project is in an advanced maturity level, and about 60 percent of the whole process is automated. The platform gathers data coming from each of the concessionaries, and enables ARTESP to act promptly to accidents, perform predictive maintenance, and strictly observe adherence of the companies to regulation. As in the case of CMGI, the system con-

trolled by ARTESP and implemented by IBM has notably improved control and management of not only one city, but also a whole region.

More than 70 percent of the roads are monitored by 360-degree cameras, in high resolution and with zoom capabilities. Also countless car counting sensors, connected toll plaza systems, and emergency telephones send data in real time to the operations center.

According to the developers, the main issue encountered during the implementation of the platform was not the technical challenge, but the change of communication protocol among different concessionaries. Used to manual operations, they were resistant to the changes needed to comply with new information requirements. The platform is open to third party developing partners and is already used worldwide for other purposes, offering the possibility for further improvement of road services, expansion to city traffic, and use in security, biometrics, and open and closed events management.

The Diffusion of Integrated Operations Centers in Brazil

The perception of described benefits in São Paulo management has led different cities to replicate its model. Currently, several Brazilian cities rely on Integrated Operations Centers, and an immediate response to city situations has become a requirement for city managers. Besides São Paulo, cities such as Curitiba, Recife, Porto Alegre, and Belo Horizonte run Integrated Operations Centers. These experiences are briefly described below.

In Porto Alegre, an Integrated Operations Center has been in operation since 2012. Called the Center for Integrated Command of the City of Porto Alegre (CEIS), it aims to support city management during critical situations and emergencies. The Center has been implemented by Digifort, a Brazilian multinational company specialized in IP surveillance systems and responsible for integrating images from about 850 cameras in the city. Similar to the Center developed by IBM, Porto Alegre centralizes information for dissemination to technicians from 18 municipal agencies.

Through CEIS, typical big city critical situations involving traffic and natural events have been identified in the Center, and decisions made in an integrated and prompt manner. Thereby, when an accident is identified, traffic is re-routed by the Public Company of Transportation and Circulation (EPTC) to facilitate medical access to the area. First, the Secretary of Health (SMS), and the service of the Municipal Humanitarian Emergency Service (SAMU) coordinate medical attention. Then EPTC adjusts traffic to reduce impact to users. Similarly, the cameras can easily identify a flooding, and actions can be undertaken by different agencies. The Civil Defense Department (GADEC), for instance, is activated to guarantee the protection of citizens, the Municipal Department of Urban Cleaning (DMLU) is responsible for proper cleaning of the area, and the Municipal Secretary of Construction and Roads (SMOV) is responsible for any improvements to prevent repeated situations in the area.

The system is open to State and Federal Agencies, and a space is dedicated to the press, which disseminates information to Porto Alegre's

population. As the system is successfully used, other cities in the country are deploying similar initiatives based on Porto Alegre's technology, including Belo Horizonte, Cuiabá and Vitória. Similar to Digifort, other national companies are entering the market and/or expanding to new markets. Digifort has provided IP systems for many applications in Brazil and abroad, showing how Brazilian solutions for smart cities are already competitive. The company operates in more than 20 countries and sells products in biometrics, mobile applications for security and monitoring, and optical character recognition systems (to identify stolen cars, for example).

Due to local necessities of Brazilian cities, companies are developing specific solutions that can be deployed in other cities. In addition, as technologies are introduced in the market and companies appropriate them, new products are developed. As solutions to smart cities become a growing market, more players enter the marketplace, start competing, and integrating new technologies.

Implementation of smart city initiatives in Porto Alegre has led to a simplification in the structure of the administration, improvements in access to education, adoption of new technologies in diagnosis and health, as well as improvements in public transportation, and adoption of energy saving measures (Azambuja et al. 2014). Adopting the approach presented in Table 2, center solutions enhance the quality of life in the city and build the capacity to migrate from sector 2, in which entrepreneurs develop local solutions for local problems, to sector 8, in which global solutions

are designed by global corporations and adapted to local needs. For example, Digifort has evolved into a global company through local solutions.

Similarly, in Recife, the Center of Traffic Operations (CTTU) operates about 600 cameras to monitor traffic in the city. As the application has been deployed, the use of the system has been extended to improve safety and to support police mapping criminality. Initially, neither São Paulo or Porto Alegre had these extended applications, but have since adopted them. The application may be further extended to new uses, such as working to monitor the cleanness of specific regions and the frequency of public services.

This extension of the application's function at the Centers is possible due to a complementarity with other initiatives. In this sense, the municipality of Recife supports Porto Digital, a technological park to foster innovation. The initiative hosts different companies and experiments to develop smart cities' solutions. Those companies have tested smart city solutions in the technological park and sold products to other cities in the country. For example, Serttel is a Brazilian company responsible for the implementation of intelligent smart traffic control in São Paulo, Rio de Janeiro, and Recife, and the bike sharing system sponsored by Itaú Bank in São Paulo.

It is important to mention two fully deployed projects run by SENAI Innovation Institute for Information and Communication Technologies (ISI-TICs), an R&D center based in Recife that is part of a large network of laboratories under Brazilian National Industry Confederation coordination. The first, called "Onda Verde" (Green Wave), helps drivers find faster ways to their destination

according to data coming from traffic lights. The initiative "SWAN" is another example, a successful solution for water consumption management. The ISI-TICs has increasingly grown its activities in the past two years and has partnered with companies such as GM, Whirlpool, Serttel, Mecsul, and DSP-Geo.

Complementing the solutions above, the platform developed by the municipality of Curitiba goes beyond the idea of an integrated Center. The Institute for Research and Urban Planning (IPPUC) developed a geo-referenced platform to gather all public tools in the Curitiba metropolitan region. Esri, an American geo-referencing service provider, provides the system and Exati, a local company works in system development.

Through the platform, the IPPUC is able to detail and supervise the implementation of Curitiba Master Plan, providing an advanced tool for public land management. The system enables standardization and consolidation of spatial information, with more homogeneous management of municipalities in implementation of programs. Once citizens have access to the platform and easier access to public facilities, the platform serves as a communication tool with citizens as well, improving quality of life and business conditions in the city.

Tendencies to Integrated Operation Centers

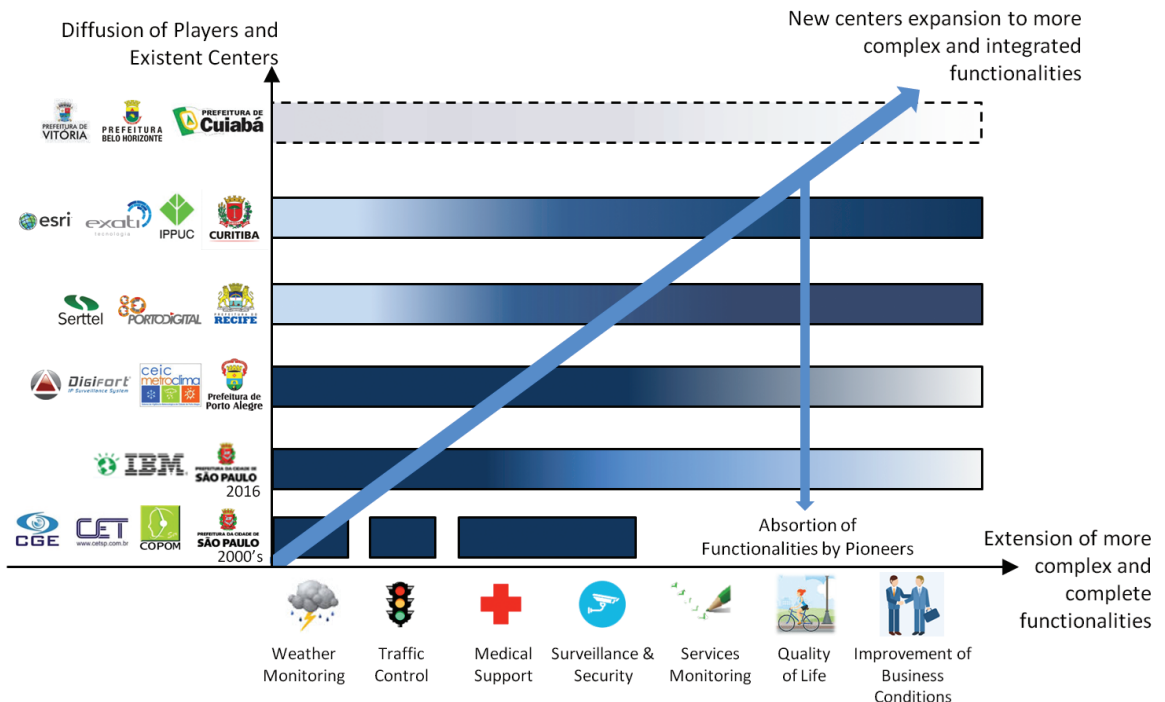
Centers have quickly become a tool and environment to promote new business and technologies. In contrast to using cameras merely to visualize what is going on in the city, the intelligence of the agencies is used to improve services and integrate actions between different departments that would otherwise be isolated and make separate decisions.

Those tendencies are presented in Figure 2, highlighting the relationship between the diffusion of players and Integrated Operations Centers, and the extension to more complex and complete functionalities.

As we see the domains of application of the described Centers, it is possible to identify extensions in all of them. The Center envisioned in São Paulo was expected only to monitor and predict weather emergencies, but the developed infrastructure and its potential functionalities led to an integrated Center supporting traffic, urgent

medical response, and surveillance and security. However, these features are not yet available and there are still no functionalities directly available to the population or developed by citizens. On the opposite side, Curitiba offers a geo-referenced platform with services available to citizens, where not only citizens have access to more integrated information about public services, but it also facilitates the integration and management of city infrastructure by the government. Therefore, as more complete applications are developed and solutions improved, centers become much more integrated, leading to improvements in business

Figure 2: Tendencies to Brazilian Integrated Operation Centers



conditions and enhancement of citizens' quality of life. The promotion of digital inclusion initiatives is also an important step to provide better conditions for citizens. Nevertheless, there are still many new and old challenges to overcome, and one should not expect that an Integrated Operations Center would solve all of them.

Players on Integrated Operations Centers

The development of integrating centers depends on different players. In the case of São Paulo, technology development depended mostly on an international corporation, which implemented an integrated system allowing authorities to act faster, by means of much more accurate information. It was a global solution developed and deployed in response to a local demand.

However, as Centers become more diffused and more integrated, new players are required and are able to participate. As we see in the presented cases, different players have entered the market and cooperated in more complex and complete functionalities. Not only global corporations such as IBM, but national companies such as Digifort and Serttel are able to compete in this new market and apply local knowledge to reduce problems associated with big cities. In addition, results of Integrated Operations Centers have motivated municipalities to take a financial—and also organizational—effort to integrate and get agencies working toward a common objective. Agencies and governmental bodies have different systems and operational behaviors that must be reconciled to allow common actions. This is an effort in terms of IT adjustments, common procedures, and functionalities.

While activities to gather information and integrate agencies in Brazilian cities are resulting in Centers capable of managing big cities in a much smarter way, it is evident that further tools must be deployed and actions taken to consider any of the Brazilian cities smart. In addition, Integrated Operations Centers are still isolated actions and no homogenization or coordination is seen in a broader perspective. Initiatives such as FiWare, of the European Union, could be envisioned, aiming a broader deployment of applications and solutions, using a common platform for future developments.

Mentioned Companies: IBM (MEI), Magna Sistemas, Digifort, Serttel, Esri, Exati.

Case II: Smart Grid Digital Application

While Brazil is distinguished for its development of biomaterials and bioenergy, smart energy consumption in the country is less well known. A pioneer initiative has been led by AES Eletropaulo in Barueri, a city in the Metropolitan Region of São Paulo known for hosting many industries and headquartering numerous companies in Brazil. The use of energy and smart consumption are issues for the city, where companies and production rely heavily on the electricity network.

The central idea is to install an infrastructure of digital meters that allows Barueri to manage its electricity consumption in real time through the company's trading system, relying on development of smart meters. Usually, energy consumption is measured by electromechanical meters that are manually read periodically. New meters will allow a direct communication with the energy provider, indicating the consumption and any interruption in energy supply.

This Smart Grid initiative involves a variety of operational and infrastructural developments, including smart meters, a smart network, and systems reducing energy losses. Electronic power conditioning, and control of the production and distribution of electricity are important aspects of the Smart Grid and are being developed with different partners.

The project will be deployed starting with the necessary infrastructure, enabling the development of new smart solutions in the city. In addition, more accurate information about local and global consumption will be available, leading the distribution company to more efficient energy management.

Underlying Solutions to Smart Grid

In this case, AES has developed a partnership with the Brazilian company WEG, a specialized components provider. The enterprise will develop a smart meter for energy savings and provide new functionalities to consumers. As an immediate result, consumers will be able to access daily power consumption through a display in the equipment or on the website of the power distribution company. In addition, once the system communicates with AES, the company will be able to automatically identify energy interruptions, the problem's origin, and its extent.

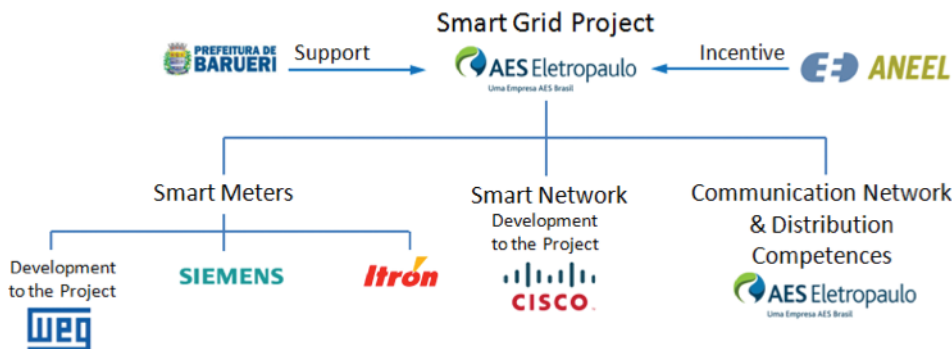
Communication between meters and the distribution company will be developed by Cisco. Smart Grid technology applied in the project was developed at the Cisco Center of Innovation located in Rio de Janeiro. The solution provided by the company integrates radio frequency technology and power line communication. While radio frequency

technologies use wireless networks to transmit information, power line communication relies on the power lines themselves for data transmission.

By using both radio frequency technologies and power line communication, the distribution company can have simultaneously more accurate information about local and global consumption, and the status of the energy network, leading to better energy management and smart energy distribution control. The solution is under development and is a result of a local service becoming smart through new communication technologies and energy infrastructure. The initiative is attracting investments in green energy, complementing Smart Grid initiatives. This is the case of renewable energy micro-generation and variable pricing according to the day and time energy is consumed. In addition, the centralization of all information will be done in a concept-metering center, connected in a network of meters planned to be redundant.

Smart Grid under development in Barueri relies on an open standard communication, allowing for interoperability of meters provided by multiple suppliers. In this regard, not only will WEG provide meters to the Smart Grid, Siemens will be one of the providers for the first batch. All together with Itron, an American company dedicated to delivering end-to-end Smart Grid and smart distribution solutions, the companies will provide 62,000 smart meters for the project.

Figure 3 presents the relationships of technology providers and project participants in the Smart Grid implementation in Barueri.

Figure 3: Relations and Players of the Smart Grid Application implemented in Barueri

Applications and Benefits

As in the Smart Grid project, smart meters replace electromechanical meters. Of 62,000 meters installed, 2,100 will be installed aiming to prevent illegal consumption in the grid. The Smart Grid infrastructure applied in Barueri also allows the deployment of innovative solutions for automating the distribution of energy. Thus, it will be possible to program the automatic re-composition of the system in case of contingency situations, and the automatic control of voltage and reactors. This is possible due to a telecommunication system interconnecting the substations to the operations center. A line of fiber optics and digital radios is already installed in Barueri, allowing the connection of voltage concentrators and other equipment that are being acquired or developed for the project. Due to this communication infrastructure, service restoration, isolation of grid problems, and localization of problems will be possible.

In parallel to contingency activities, an additional optimization of energy consumption based on the participation of consumers is envisioned. Due to Smart Grid meters, consumers are able to monitor their energy consumption in real-time and improve energy management. In addition, smart grid meters enable the commercialization of energy produced in micro scale by consumers, for example through solar energy systems. Reduction

of electric tariffs is also possible through variable pricing according to the time energy is consumed. Smart homes and differentiated services, and programs to optimize consumption may be developed, looking for new adherents.

Many of the applications and developments resulting from the Smart Grid initiative can lead to benefits for both consumers and the distribution company. Improvement of energy supply quality benefits householders and companies in the Barueri region. As a very dense industrial region, the Smart Grid initiative reduces the necessity of particular generators by companies, improving security of energy supply, potentially reducing energy cost to consumers.

For the distribution company, as energy consumption is better distributed across time, it is possible to increase the efficiency of assets use, in which lower peaks of energy are demanded meet the region's necessity. Moreover, as monitoring and actions are automatic, operational systems optimize the distribution of energy according to demand and a better operational efficiency is achieved. Losses in the system, including illegal consumption and systems with low efficiency, are reduced as well.

Mentioned companies: AES Eletropaulo, Siemens (MEI), Cisco (MEI) e Weg (MEI).

Conclusions

This paper presents two cases of Smart Cities in Brazil, supported by a conceptual framework based on systemic factors, outcomes, and impacts of Smart Cities initiatives. A matrix of agents and outcomes associated with smart solutions is proposed, and cases were selected based on their expression of impact in the matrix. In this regard, while Integrated Operations Centers enhance the quality of life in Brazilian big cities, Smart Grid Digital Application in the city of Barueri is attracting investments and enhancing competitiveness in a specific region.

Both cases present the robustness of Brazilian solutions, driven by the necessities of big cities. In the case of Integrated Operations Centers, companies and city governments have collaborated to implement local solutions, improving government management and service quality to the population. Diffusion of Centers has been followed by more functions available to the population and impact on the quality of life. As companies develop solutions that make Centers more integrated and, as the solutions are more widely adopted, solutions for local problems develop into global solutions for big cities and local entrepreneurs become global companies.

Smart Grid Digital Application in Barueri is an initiative capable of attracting investments and enhancing competitiveness through better energy management. Initiatives depend on different developments made in partnership with big companies in Brazil, mostly by multinationals. The infrastructure to be deployed will enable further developments in mobility and energy, developing the infrastructure for electric cars, and local production and commercialization of energy.

The presented cases are not solely local projects, but rather initiatives leading to transformation in big cities and Brazilian companies, successfully designing and implementing globally-connected local innovation, promoting sustainability in innovation initiatives and policies, investment projects, and city life. Cases present how smart cities can

impact city management, enhancing quality of life and companies' competitiveness, whether by demand for technological solutions developed by companies, or by an infrastructure that enables business opportunities and further technological deployments.

The National Industry Confederation (CNI) represents and defends Brazilian Industry's interests before federal, state and municipal governments through a nationwide network of private entities responsible for initiatives to support industrial development and competitiveness.

Under the leadership of CNI, the Brazilian Entrepreneurial Mobilization for Innovation (MEI) is one of the most successful forums in regard to innovation that gathers the Founders and CEOs of the 120 biggest and most innovative companies in the country.

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BRAZIL

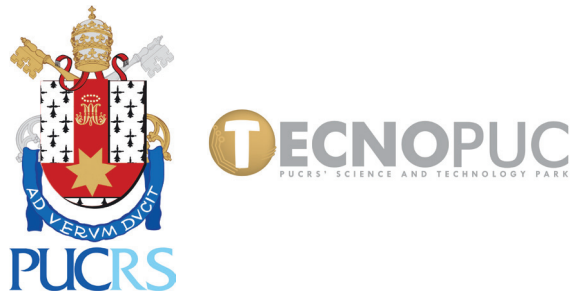
Education, Research, Entrepreneurship and Innovation: The Case of PUCRS and TECNOPUC

The Challenge

The so-called Knowledge Society involves a reorganization of society and its institutions, generating changes in economic, social and political processes, based on access to new information technologies and communications. In this new society, the ability to learn is the main competitive advantage of organizations and individuals, requiring new pedagogical learning forms. Today, the acquisition of knowledge is not confined to physical space (in traditional educational institutions), or time (in one single period). The Knowledge Society requires continuing education. In this ever-changing world, old models of learning are questioned and new teaching approaches emerge, based on *learning by doing*, creativity, the ability to innovate and learning how to learn.

Therefore, the society focused on innovation expects universities to adopt new pedagogical approaches that respond to current demands, as well develop new skills and concepts of time and space in the learning process. In this regard, learning to learn means learning to reflect, raising questions, adapting quickly and continuously by questioning the surrounding cultural environment. The university collaborates in the development of a global project of perennial human development, building an educational process that addresses different dimensions, such as cognitive, community, caring, ethics and social justice.

In this new century, harmonizing a culture of innovation with a sustainable long-term vision, while maintaining quality and tradition, is a challenge that must be tackled effectively. In other words, the new role of the university includes expanding its traditional focus on education and training (teaching and research), and a new mission of



direct involvement in society's process of economic, cultural and social development. In this context, the university should be entrepreneurial, developing mechanisms that incorporate characteristics from the Knowledge Society into its educational plan and management model. For a Catholic university to be innovative and respond to societal needs, there is the additional challenge of making the necessary changes in a manner consistent with its guidelines and operational context.

It is imperative to overcome the traditional inertia within the academic and university environment, and propose transformative actions in education and training aligned with the new Knowledge Society under construction, one that is mainly inter- and transdisciplinary, entrepreneurial, sustainable and characterized by knowledge as its most important production factor. It is also necessary to foster innovation and entrepreneurial competence of PUCRS' academic community, as a way to expand its relationship with society and propose affirmative development actions based on the Triple Helix (a leading role for universities in engaging industry and government in generating new knowledge, technology, innovation and economic development).

How was the challenge overcome?

PUCRS has developed its own model of operation to stimulate joint research, development and innovation (RD&I) activities with the community using, where possible, available tools and assets (such as incentive laws, funds, public calls, and PUCRS resources), recognizing the importance of cooperation between public and private organizations, and other universities. Called TECNOPUC Ecosystem of Innovation, the model aims to affirm PUCRS' strategic positioning as an innovative and entrepreneurial university, and also recognize the concepts of innovation, entrepreneurship and sustainability as fundamental guidelines for the steady development of the university's academic and management practices.

Who were the stakeholders involved?

TECNOPUC is the result of an integrated action involving government, businesses and society. The ultimate goal is to create an innovation ecosystem aimed at increasing the competitiveness of its actors, improving the quality of life of their communities and making the academic capabilities of the university available to society, promoting scientific and technological development of the region. Additional objectives include:

- Attract research and development companies (RD&I) to work in partnership with the university,
- Promote the creation and development of new businesses,
- Attract research projects and technological development,
- Encourage innovation and company-university interaction,
- Generate synergy between academia and companies.

Who were the leaders, catalyzers, and enablers?

PUCRS' rise in recent years is related directly to the synergy between its actions and the convergence of its strategies. These include establishing a Science and Technology Park, introducing new concepts aimed at research, development and innovation, as well as reshaping its educational and pedagogical practices based on these new experiences. From this broad set of actions emerges an entrepreneurial university, built on the foundation of its history and tradition, and recognized for its contemporary leadership in the field of innovation. As a result, we see the strengthening of its intellectual capital connected to an organic and constantly changing society.

What types of barriers were faced in implementation? How were they overcome?

By proposing actions to transform education, the traditional inertia within the academic and university environment had to be overcome.

What results were obtained?

It is clear that the dynamics of this process involving innovation, development and knowledge have profoundly altered the university's relationships, inducing changes in the posture of the university

community and its relations with society. Based initially on partnerships with three global businesses—HP, Dell and Microsoft—the growth of TECNOPUC reflects the potential of the intellectual capital available at PUCRS and its ability to attract new businesses, whether graded, spin-offs or start-ups; this is shown by the high number of innovative projects and other indicators:

Knowledge Generation:

- More than 50 undergraduate courses
- More than 100 specializations (Lato Sensu)
- 45 graduate courses (Stricto Sensu)
- More than 25,000 undergraduate students
- More than 5,000 graduate students
- More than 1,500 teachers—90 percent teachers and doctors
- More than 5,000 employees

Technology Transfer:

- 109 national patents requested (since 1999)
- 50 international patent applications (since 2002)
- 25 prototypes developed in 2014

Intellectual Capital:

- 124 organizations in TECNOPUC
- 26 companies incubated in the Raiar incubator
- 6,300 jobs created
- More than 500 direct fellows in companies
- More than 80,000 m² of built area and available for RD&I

Entrepreneurship and innovation fostering highlights:**• Startup Garage:**

The Startup Garage Business Modeling Program is a welcoming space for ideas, and technology and innovation-based projects. Startup Garage is for entrepreneurs and groups of entrepreneurs coming from the academic units of PUCRS who have not started their businesses and seek support to develop a business model. Forty-five professors, students and scientific technicians participated in the first edition held in 2014. The 2nd Edition of the program took place in 2015.

• Creative Garage—Co-Working:

The program offers companies a personalized space and routine work for business development. The program environment and activities aim to improve participants' entrepreneurial profiles, as well as increase their awareness of cooperation and innovation. It offers tutorials, work dynamics and the possibility of using the environment and equipment in TECNOPUC Viamão creative pre-incubator. The program is free, 16 weeks long and offers two weekly meetings.

• Creativity Laboratory—CRIALAB:

This space is dedicated to the development of Creative Dialogues, in which people and their companies/institutions expose their ideas, problematize, discuss, negotiate, make decisions and create strategies to solve complex problems, accelerating the creative process (adding value for society and for business), while interacting with the different areas of knowledge.

• Business Acceleration Program—PROA:

This PUCRS initiative supports and develops innovative entrepreneurship originating from

university research (spin-offs) or present in TECNOPUC innovation ecosystem (startups), utilizing methodology that makes the sustainability of their innovations possible.

- **Cultures of Innovation:**

TECNOPUC sponsors seminars for the exchange of experiences about the potential of effective interaction with the world's leading innovation markets. Representatives of Israel and from other innovation environments, such as South Korea, France, England, Mexico, the United States and Canada, among others, have come to present and discuss their views. Complemented by business rounds, the seminars help to develop global integration strategies for innovative local companies.

Qualified Relationships:

- More than 100 researchers involved in RD&I projects
- More than 15 research structures involved RD&I projects
- More than 10 academic units involved in RD&I projects
- More than 150 RD&I projects
- More than US \$ 15,000,000 raised for RD&I projects
- Guided Tours: open access for society to learn about the physical area of TECNOPUC, in addition to interacting with entrepreneurs, researchers and students, who usually talk about their entrepreneurial experience in an innovative and entrepreneurial structure.

- Acceleration of synergies: this initiative connects companies, people, knowledge, processes and services, seeking to enhance actions aimed at innovation, research and development under the tutelage of analysis and management tools. The methodology helps create opportunities to stimulate the internal market for goods and services, facilitating shared development between companies, and allowing for cross-investment.

TECNOPUC's Internationalization Program

Considering the strategic direction of PUCRS to promote innovation, internationalization and interculturalism, it is important to note that, over the past three years, several international actions were triggered by TECNOPUC:

- Increased TECNOPUC's participation in international cooperation networks by signing MOUs/ Agreements with other innovation environments or international networks;
- Strengthened the soft-landing program (reception of foreign companies);
- Consolidated the take-off program (creating opportunities for our companies in foreign markets);
- Professionalization of Exchange Program for entrepreneurs with partner countries (i.e., CONNECT Program);
- Intensified participation in international missions, enabling the participation of TECNOPUC and RAIAR companies; and
- Ongoing training of TECNOPUC team.

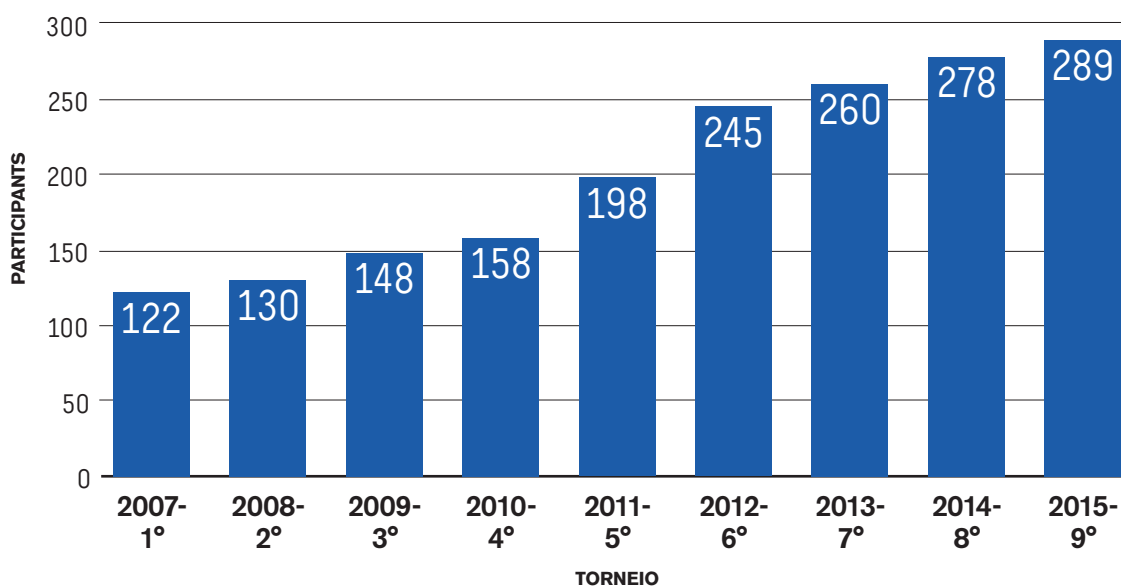
Due to these initiatives, the Science and Technology Park has already formed international partnerships with more than 150 innovation environments around the world.

In addition to these projects, which translate into significant numbers, TECNOPUC serves as a key connection point and source of information exchange between the university and companies. One of TECNOPUC's most important sources of input and human capital is the university, with its students, teachers and researchers. Therefore, developing the capacity of these actors and preparing new plans has required practices that transcend tradition and seek innovation processes as good examples to be pursued.

The Entrepreneur Tournament has also produced significant results in engaging students in entrepreneurial skills development, and raising awareness of the need to meet the demands of the Innovation Ecosystem TECNOPUC. In the nine years in which Entrepreneur Tournaments were held:

- 1,828 students registered (in the latest edition alone, held in 2015, more than 280 students participated, 40 projects were submitted, and 40 hours of training were provided);
- More than 15,000 students have participated in the awareness phase, when seminars, workshops, lectures, and Restless Chats are offered.

Number of Participants Entrepreneur Tournament



Overall, a total of more than 16,800 students have participated and, considering that PUCRS has about 30,000 undergraduate students per year, this level of participation represents more than 50 percent of the undergraduate student body.

Even more students are expected to participate in the next editions of the Entrepreneur Tournament, not only from PUCRS, but also from other universities. It is anticipated that twice as many students will participate, and that students coming from other universities will grow at least 30 percent. It is also expected that the group of participants will be more academically diverse, coming from a more heterogeneous set of courses.

In summary, after 13 years of systemic deployment, the positive outcomes of the pioneering TECNOPUC initiative are increasingly evident – both nationally and internationally. A sustainable innovation ecosystem has formed and progressed, and it is increasingly relevant to the city and society that surrounds it, producing products and services.

What was the impact of the solution implemented?

Taken together, two elements of the initiative are transforming the profile of the university and the behavior of its employees, raising the benefits they contribute to the community:

1. TECNOPUC—Innovation and Entrepreneurship:

Since the August 2003 opening of the PUCRS Science and Technology Park, TECNOPUC has created more than 6,000 jobs and engaged more

than 120 stakeholders. Beyond the numbers, TECNOPUC has become a key driver of regional economic development, and a model in Latin America as a modern Science and Technology Park focused on transforming research and innovation in business, and helping promote interaction between the university, business and government. Pioneers in the park and IT industry anchors, Dell and HP contributed significantly to this progress, concentrating their Brazilian research and development centers in TECNOPUC. Attracted to this growing hub of innovation and entrepreneurship, other global players have come to TECNOPUC, including Microsoft, Accenture, Tlantic, Sonae and ThoughtWorks, as well as large national enterprises, such as DBServer, Globo.com and Randon Group. But not only large companies benefit from this environment. Many startups have emerged, and realized the benefits of co-locating next to large companies, also settled in TECNOPUC, further developing the innovation ecosystem.

Concrete results achieved in various dimensions show this environment of collaboration and relationship building fosters innovation, and adds significant value in regional economic development. For example, the ANPROTEC study of Technology Parks and Business Incubators practices is quite illustrative in this respect, validating TECNOPUC as a consolidated park, excelling in all aspects (e.g., concept, infrastructure, capital, site integration, talent market, clusters, partners, governance and management, services, and knowledge); presenting mature practices; and getting top marks in infrastructure, services and as an innovation engine. In addition, the study acknowledged that the park now has a recognized brand and consolidated strategy to attract companies,

foster constant interaction with the university, and work in an integrated way with different levels of government.

Moreover, two new initiatives further support sustained growth of the Park and further align its world-class environment with the new trends of internationalization, co-working, design thinking, open innovation and networking:

- **Global TECNOPUC:** Housed in a modern building, Global TECNOPEC's innovative processes foster synergy and sharing. It aims to promote networking and open innovation projects among companies, stimulating interdisciplinary approaches and entrepreneurship. It has spaces for group work, anchored in virtual collaborative platforms that support new organizational working relationships that transcend location and time. Also focused on internationalization, Global TECNOPUC offers temporary space for external companies, for example, for those that need temporary space to develop new products and services for the global market.
- **INOVAPUCRS Condominium:** INOVAPUCRS fills an important gap in the innovation ecosystem by providing an environment designed to house companies that have graduated from the incubation process. It helps minimize the difficulties these companies may face when they require a transition period to the park or market environment.

In short, the performance of TECNOPUC can be explained as “qualified relationship” and “collaborative construction.” The Park fosters partnerships and collaboration between companies and

the university to stimulate innovation, as well as the social, environmental, cultural and economic development of society. It seeks to be recognized for promoting the improvement of society's quality of life, contributing effectively to a new developmental model where innovation and entrepreneurship, based on education and knowledge, are essential to the success and growth of our society.

2. Education—Transforming Actions in Teaching and Structural Practices:

“Entrepreneur Tournament” is a process of entrepreneurial learning, proposed by the Entrepreneurial Center of PUCRS, designed with the objective of stimulating an entrepreneurial culture at the university. The focus is on business proposition, creation of start ups and meeting society's demands. Since 2007, the Entrepreneurial Center has conducted this activity, recognized as the main event intended to encourage new behavioral processes in students, as well as to create new solutions by promoting development of new entrepreneurs and new businesses formation. In the initial editions of the tournament, the focus was on PUCRS' undergraduate and graduate students exclusively. Currently, with more comprehensive challenges, students from other universities are offered access to the center, keeping the objective of stimulating students' teamwork and entrepreneurial training.

The Entrepreneur Tournament gives students from different academic backgrounds an opportunity to put what they have learned in the classroom into practice. It also enables them to transcend the prevailing disciplinary culture, and develop a new inter- and trans-disciplinary per-

spective that reflects the current world and strategies that shape the development of a Science and Technology Park such as TECNOPUC. During lectures and workshops focused on development of business ideas, students learn about Design Thinking, creativity, technological innovation, business modeling, market testing and preparation of a market Pitch. Afterwards, students apply what they have learned within the spirit of competition, presenting business plans they have developed to a jury that selects the projects with the greatest potential to grow into a new business.

Again in this context, the synergy TECNOPUC helps create is evident, as these ideas are seeds that may grow into start-up businesses, then nurtured at the RAIAR incubator—an integral mechanism of the TECNOPUC innovation ecosystem fostering the establishment of start-ups in the park.

About the Author

Jorge Luis Nicolas Audy Graduated in Analysis of Information Systems from PUCRS (1983), Master and PhD in Information Systems from UFRGS (1990 and 2001), Specialist in Arts Management and Multimedia Technologies from PUCRJ and IBM (1992). He is currently a full Professor at the Faculty of Computer Science and of the Graduate Program in Computer Science and Vice President for Research, Innovation and Development of PUCRS. President of ANPROTEC (National Association of Organizations promoting Innovative Enterprises). Member of the Deliberative Council of EMPRAPII (Brazilian Company of Research and Industrial Innovation). Member of SBC (Brazilian Computer Society), SBPC (Brazilian Society for Science Improvement), AIS, IEEE and ACM.

For more information about TECNOPUC, contact tecnopuc@pucrs.br or the park director, Prof. Rafael Prikladnicki (rafaelp@pucrs.br) or Prof. Jorge Audy (audy@pucrs.br).

CANADA

Priority and Design of an Effective Innovation Ecosystem

When the topic of innovation and what it means to an organization comes up, many business leaders in Canada think immediately about product or technology.

It is quite natural that their first thought is about one of these assets. After all, these are the areas where businesses most often have clear-cut targets and goals around leveraging innovation to create growth.

But an innovation equation founded solely on these two areas is missing one very important consideration: people.

The employee factor, how often opportunities are created for staff to interact effectively and regularly with each other, plays a significant role in how innovation is conducted. How and how often people within a specific community have the ability to work together in collaborative teams to identify and resolve nagging challenges, develop new and better processes, and create solutions to problems that may not have been previously identified is a tremendous barometer of how effective an innovation ecosystem can be.

Indicators of Competitiveness

When measuring the impact of productivity investments, both businesses and communities tend to rely on the same old metrics, such as sales generated or jobs created, even though these are lagging indicators, and clearly do not predict future performance. Some leading indicators, such as investment in new capital equipment, or research and development spending, are slightly better predictors of future success (or failure), but still

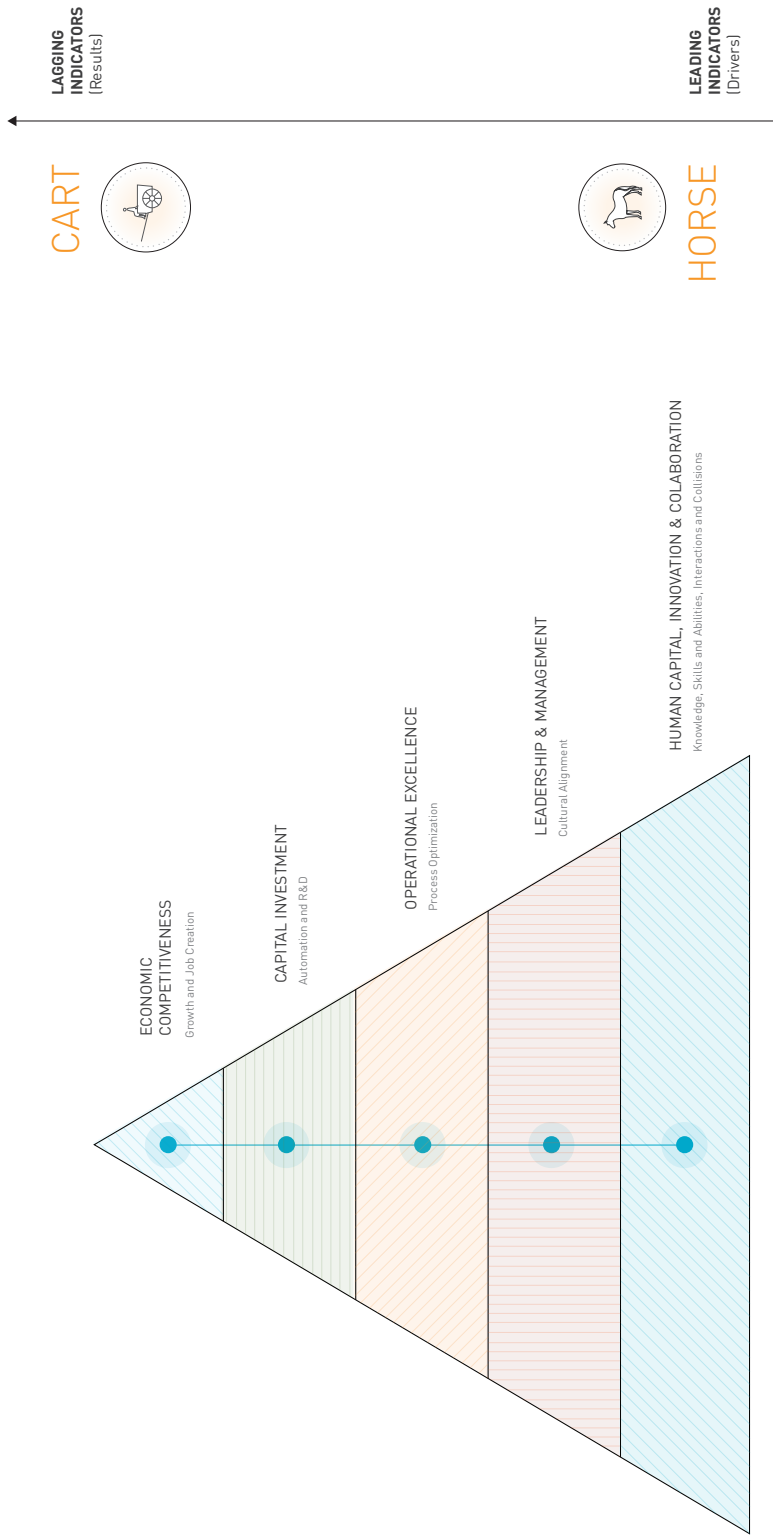


reflect only a portion of the overall picture. The reality is that lack of innovation capacity remains the biggest gap preventing firms from significant increases in competitiveness.

At GO Productivity, we suggest that the key to higher levels of innovation and its real impact on business is linked directly to “Investment in Human Capital.” Partly, this means generously investing back into your people. This includes training and learning, collaborative brainstorming and planning, and collective problem solving. But it is about more than that; it is also about creating specific conditions within an ecosystem to encourage innovation to happen. Gold star companies such as Google understand this better than anyone. And they live and breathe a culture that relies on it.

To better understand the impact of continued investment in people, at both a community and firm level, we must first reconcile industry’s obsession with trying to find the “One Driver to Rule Them All.” The question of “what is the most essential driver of competitiveness?” surfaces again and again. But this idea of searching for a “silver bullet” driver is a mistake. It is much more important to recognize the value of many different drivers, and to prioritize them in ways in which they can together create meaning and insight.

DRIVERS OF COMPETITIVENESS HIERARCHY



Drivers of Competitiveness Hierarchy

To that end, we recommend reinterpreting Maslow's Hierarchy of Needs for the individual, to build a similar pyramid illustrating the needs of a business community, whether that be defined as an individual firm, a small focused group of companies or even an area as large as a city. After all, cities and the organizations that drive growth in them are simply just groups of people interacting with each other towards various common purposes.

When we rearrange Maslow's pyramid to account for each of the core drivers of competitiveness (with the strongest indicators at the bottom), we get the below hierarchy.

For decades, stakeholders across Canada have had a myopic view in understanding what drives competitiveness by strictly examining the “cart” (i.e., the results). These lagging indicators reflect only what is already accomplished. The power of this pyramid lies in prioritizing the key factors and investments that actually lead to higher levels of competitiveness. The pyramid reminds us to calculate impact in a much more meaningful way via the most essential “leading” indicators, prioritizing what actually drives competitiveness, not the results of our efforts.

Highlighted in this pyramid, at a foundational level, the most essential needs for driving competitiveness are the needs for Human Capital. And it is in the very ecosystem that provides these needs where innovation can most strongly exist. Competitiveness and ultimately growth may be the goals, but without aligning the culture, knowledge and skills of your workforce to support the continuous improvement that leads to increased efficiency, the resources invested in the higher layers of the pyramid will never reach their full potential. And it all begins at this foundational layer of investment in human capital that houses the environment that enables innovation to occur—to allow for new partnerships, ideas and collaborations to drive change. In simplest terms, investment in human capital and the innovation

ecosystems that nourish those investments make up the essence of the horse that pulls the cart of competitiveness forward.

Designing Innovation Ecosystems: the Importance of “Collisions”

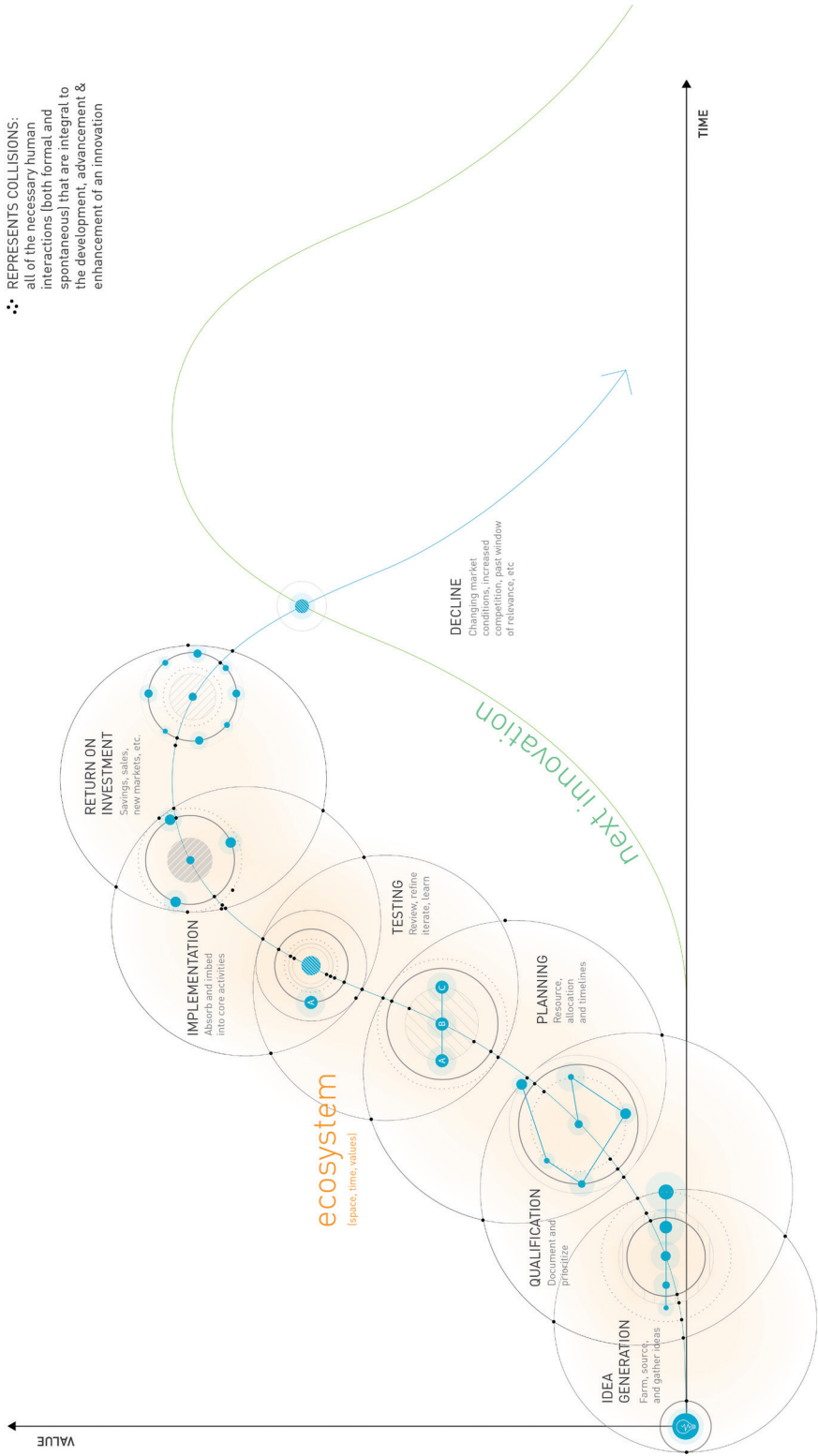
The characteristics of an ecosystem or culture that most effectively supports the regular investment back into its people, allowing them to pursue higher levels of innovation, are guided by several key elements. First, the design of the ecosystem itself is extremely critical.

One of the important conclusions drawn from the Centre for Social Innovation model (see interview excerpt) is that a very significant aspect of encouraging innovation to occur with regularity is the creation of an environment that supports many, and the right kind, of “collisions.” By its definition, the word “collision” can have a negative connotation. But from our knowledge of chemistry, we understand that, when two particles collide, there is the opportunity for pre-existing bonds to dissolve and new bonds to be formed. That, combined with the new direction particles can take post-collision, provides an accurate analogy around the idea of the importance of creating healthy collisions to foster innovation.

Collisions in a specific ecosystem—be that at a firm, in a business community or at the city level—are the necessary human interactions around new idea generation, development, testing and refinement, and implementation. When people come together and set aside pre-existing notions and form new bonds, ideas are given new life, and new products, processes and initiatives are born and improved. These types of interactions can include various conversations, meetings, training and learning sessions, and events, both formal and informal, that allow for significant collaborative design and development opportunities. In cities, these interactions take place between a wide range of organizations; various service providers,

LIFECYCLE OF INNOVATION

Designing for Collisions



stakeholders, suppliers and customers, government and not-for-profits all need to be included in the ecosystem that supports these interactions and their associated collisions.

Innovation requires collaboration, and collaboration itself requires collisions. But there is a particularly critical reason these collisions become even more important to fostering innovation. Again, learning from the Centre for Social Innovation model, these collisions are crucial to producing “serendipitous moments”—the unpredictable, unexpected “eureka”-type moments that can occur when people come together for a brief period around a particular idea or theme, and experience a breakthrough. These serendipity-producing collisions often take on a watershed-like quality, and often can be looked back upon as a defining moment in the development of a new business, product, process or general idea.

Innovation Ecosystem Design Ingredients: Space, Time, and Values

Unfortunately, most firms, just like cities, do not design for collisions to occur, which means they often do not experience the benefit of “serendipitous moments.” It is in this lack of design where the opportunity for more innovation is most severely halted. Having the right ingredients to create the system that promotes the continuous flow of healthy collisions can sometimes happen organically, but mostly it is a missed opportunity. There

needs to be real thought around what structures should be in place, the use of time and space, and what freedoms and expectations are encouraged within defined boundaries.

The physical space is a very important consideration, whether dealing with pre-existing space or a new space. Factors such as availability of light, furniture, walls, common area and meeting room space, accessibility, use of greenspace, traffic elements and more may be considered, in addition to the specific cosmetics that can influence the look and feel of the space.

Designing around use of time becomes a function of understanding how and how often people within the community are encouraged to participate in collisions and innovation related activities. Clear design around the parameters of when and for what purpose meetings, events and “free hours” are encouraged can have a significant impact on when and how people make the time to work together to develop new ideas.

Finally, there needs to be explicit consideration of and communication about the values that are supported and promoted within the ecosystem. It is with these values that the DNA of any and all innovations that are developed will be encoded. The values of the ecosystem give specific purpose, focus and boundaries around which potential innovations can arise.

Ultimately, the better and more well defined the design of the ecosystem is around these three factors, the more opportunity there will be for innovation to thrive.

Interview with Adil Dhalla, CEO of Centre for Social Innovation

Q: What was the purpose behind creating CSI [Centre for Social Innovation]?

A: Fundamentally, like most good products or services, it was solving a problem. The problem being that access to office space and amenities around that are expensive, especially for early stage organizations, small organizations, and non-profit organizations. So the motivation to start CSI was based on this idea of sharing. If we shared workspace and all the things surrounding it, fundamentally we could solve people's problem of not being able to afford office space in downtown Toronto.

On a more philosophical basis there was this other problem around how do we get people to share ideas, opportunities, and networks? With the premise being that in order for us to truly make meaningful, systemic large-scale change and impact, we need to figure out ways to work together.

So in addition to the idea of sharing space, there was this other idea about sharing our work, with the hope being that the diversity of experiences coming together in the space would create new and innovative ideas to really tackle the world's problems.

Q: So it's interesting you talk about it being initially conceived as a co-working space, but now there is this community aspect to it, which is more than people just sharing some of the physical space. Can you tell a little more about how the community has evolved and what kinds of things the community participates in to promote those key interactions?

A: When CSI started, our identity was more just around co-working and very physically rooted in space. Today at least half of our members now actually do not access space from us. They are virtual members. That means for the most part they see value in being part of the community. I think that's also really important because as we evolve our own thinking, we ask ourselves why do we exist. And fundamentally we exist to help people change the world, and space is just a tactic of that—so are programs, so are services, and so are people in specific positions. And so you ask about community—I think one of the tactics that we have used to enable change is through investing and animating community. Our community has grown from twelve founding members to now over a thousand. We cross every sector, we're small, we're medium, we're large. Some of us are incorporated, some of us are not. Some of us are non-profit, some of us are for-profits. Collectively we have succeeded because everyone started out with a common purpose which is that we wanted to make the world a better place, and we curate our community that way.

Q: What specific types of businesses are represented in the community?

A: We have many sectors from people working in Environment to Education to Civil Liberties, Civil Rights, Social Justice, Socio-Tech, consulting, various professional service providers, and many more. And that diversity is important, one, from just a perspective of inclusivity, and two, because it's actually these different experiences that tend to, when coming together, create new ideas. We do not have a specific mold as to 'this is the type of thing you should be' in order to be a CSI member. We actually really pride ourselves on the fact that we don't have a lot of consistency in that regard.

One of the advantages to the rise of urbanism and the increasing density of cities, is that there's more people in the same space. This provides benefit in a number of ways including our opportunity to connect with one and other and for different experiences to happen—in that way CSI is very similar to a public space in a city like a park or a square. Where I'm interested to see cities go more, if I were to take a page out of CSI, is bringing intentionality to the interactions that happen within that space. Fundamentally, the strength of a city hinges on how connected its people are. Cities are growing and becoming more dense but their success hinges on the ability of their people to be connected and work together, so there has to be that layer of intentionality for that to happen. Without that, we're just a bunch of strangers occupying space together.

Q: What are the different ways you achieve that intentionality at CSI?

A: We invest in people. Specifically, we have community animators whose job it is to weave together the connections with the needs and asks of the community. We invest in space design, and we put intentionality around how we can design for serendipity within our spaces. The third thing we do is create programs and events which also have a role in connecting people together. All of

these can exist or are possible when you think in the scale of cities. If you can imagine from the example of one public space—what kind of supports, or infrastructure, or investments are needed in order to realize how space, people, and programming all reinforce a mutually understood idea about making connections?

Q: You talked about intentionally designing for serendipity. What are you referring to?

A: Imagine the potential of all the untapped connections we don't instinctively make. That's why the notion of serendipity is so fascinating because you create the conditions for these unexpected moments that though you can't predict, you can foster in some way.

Q: We know that innovation can often happen when you're out of your comfort zone in some ways, not in the same routines, not talking to the same people. And I think there's no question that CSI fosters that kind of environment for innovation. It's certainly one of the qualities that has drawn GO Productivity to the community. But there is also something else there. There's the old adage: "You get what you put in." The values that people come to the table with create an environment where people are ready to connect with and engage with others, even if that sometimes means doing something for free. Can you speak to collaboration as a key value that members bring to the table at CSI?

A: I think you need to have a culture of collaboration, which also sounds like the type of thing you would say and everyone would agree "Yes of course!" But how do you actually invest in that happening? The first you have to do is identify is your values. Values are the DNA or playbook, to how people think or act in a certain way. To be clear, here at CSI people can opt-in or opt-out. And that's totally okay because you can't be something to everyone. But CSI's culture and the values which define it speak a lot to the importance of collaboration. All great communities

are like great pot-lucks: They only work when everyone brings something to the table. From the very beginning, we incept, imbed, communicate, share this concept that your role in being here is to contribute. And it comes back to you in various ways. But yes, anyone who chooses to be a part of CSI, as a consequence is buying into the social contract that asks them right from the beginning, "What are you bringing to the table?"

Q: Can you talk specifically about the business model of CSI and how people participate?

A: We are property managers first. We buy and rent buildings and lease space to others. We also have a tiered membership model for people who don't want space but want to leverage our services or be a part of the community. We also work via various partnerships and grants.

Q: What does a city need to have in place to embrace this model/approach?

A: I think the idea of shared space can work everywhere. I think that some helpful assets would include low-cost real estate, access to transit, and diversity.

Q: ...and having the right kind of space, with the right design or opportunity for design?

A: For sure. We [humans] really appreciate beauty. There is a huge correlation between our uptake and how it looks. Beauty is certainly part of it, and so the design of the space is important.

About the Author

Mr. Ron Subramanian is the National Director of GO Productivity.

GO Productivity is a Canadian not-for-profit organization that helps businesses become more innovative and productive. We work directly with small-medium size enterprises on an advisory, coaching, and training basis. Through a highly customized and facilitative approach, we partner with key stakeholders across Canada to build leadership and innovation capacity at the regional and firm level. We continually strive to inform and update our services with the most up-to-date thought leadership in order to position Canadian industry for higher levels of competitiveness and growth.

Portions of this case study are based on "Leading Growth Firm Report #24: Return on Culture", prepared for the Ontario Government by GO Productivity in Spring 2016.

CANADA

GEDI: A University-Led Model to Accelerate innovation, Enhance industry Competitiveness and Drive Regional Economic Growth

Synopsis

Universities undertake a wide range of fund-amental research that can change how things are done. Some research may generate transferrable use immediately, some may have to wait for decades and some may never find any use. Regardless, a great number of discoveries with high potential fail to reach the marketplace. Global Entrepreneurship and Disruptive Innovation (GEDI) is a first-of-its-kind initiative, led by the University of Waterloo, designed to systematically accelerate the transition of on-campus research to industry, creating regional economic opportunities and positioning Canada for global success.



UNIVERSITY OF
WATERLOO

1.69 percent of GDP, compared to the OECD average of 2.4 percent (McKenna). According to the Globe and Mail, Canada is the only developed country that purchases more intellectual property than it sells (McKenna), while relatively high barriers to foreign direct investment also stymie growth (OECD, 47). Perhaps not surprisingly, the Conference Board of Canada gave the country a “C” for innovation in its 2015 report (“Innovation Provincial Rankings—How Canada Performs”).

Chief among the reasons for Canada’s subpar performance is an underinvestment in research and development on the part of business. Although government support for innovation is relatively strong, private sector investment in R&D has steadily declined for more than a decade, and Canada currently ranks 26th among OECD countries (Lynch). In part, this is due to the fact that Canada’s business landscape is dominated by small and medium-sized companies that lack the resources for extensive R&D. Also, most large-scale multinational corporations carry out R&D outside of Canada.

Although there exists strong university-based research and innovation capacity in Canada, too much university research fails to get translated into industry, in part due to the reasons noted above. As outlined in the federal government’s

The National Challenge: Canada Needs Innovation

“The countries most likely to succeed are those that understand that business innovation holds the key to rising living standards.”

— Innovation Canada: A Call to Action, 2011

On paper, Canada has all the conditions for innovation excellence. Among advanced democracies, this G7 member enjoyed the fastest recovery from the 2008 recession (Grant). It boasts conservative debt-to-GDP ratios (The Canadian Press) and world-leading post-secondary education rates, while the government offers one of the most accommodating research and development tax structures within the OECD (State of the Nation 2010).

Despite these factors, Canada continues to lag most advanced economies on key measures of innovation. Spending on R&D now stands at just

2016 innovation strategy discussion paper, “Canada has strong research capabilities yet needs to improve in transforming ideas into marketable products, services and business models” (Government of Canada).

Today, innovation in fields such as advanced manufacturing, transportation, clean technologies, information and communications technologies and digital media is disrupting products, processes and sectors around the world. These changes are creating seismic shifts in traditional business models and shaking up established industries both domestically and abroad.

To stay competitive, Canadian businesses must anticipate and adapt to those changes. To thrive, they need to position themselves on the leading edge. They need to recognize that universities have a crucial role to play in making that possible, by pushing the boundaries of discovery to create new knowledge, preparing emerging talent to be leaders of the future and creating all-important ways to connect those discoveries and that talent with industry to drive positive disruption.

The Local Challenge: Building the Toronto-Waterloo Innovation Corridor

“We need to connect people and their ideas. These clusters are where innovation will happen – innovation that will ensure Canada is at the forefront of technological advancement in the 21st Century.”

– Canadian Finance Minister Bill Morneau, 2016

Around the world, innovation clusters are driving discoveries and economies. They include Britain's London-Cambridge innovation cluster, the concentration of Israeli high-tech firms between Haifa and Tel-Aviv and, of course, California's Silicon Valley. Now a similar concentration of cutting-edge activity is taking shape in Canada: the Toronto-Waterloo Innovation Corridor.

Anchoring one end of the corridor is Waterloo, a city Inc. magazine ranked at the top of its 2016 list of emerging startup hubs to watch (Zoe). Dubbed “Silicon Valley North,” its assets include world-class research institutes, universities and colleges; incubator and accelerator centres that facilitate growth and commercialization; and one of the highest densities of startups in the world.

Just over a hundred kilometres away lies Toronto: Canada's corporate headquarters and its centre of finance, industry-led R&D, health and life sciences, and venture capital. According to Berry Vrbanovic, Mayor of the City of Kitchener, “If you look at us as a corridor and the potential for growing it, there's so much opportunity that exists here, and the fact that we have such different sized communities on either end of the corridor gives people more choices of where they can live, work and play. And that's an asset.”

Altogether, the Toronto-Waterloo corridor includes 16 post-secondary institutions, 15,000 tech companies, 5,200 startups and six million people speaking 150 different languages.

According to a 2015 Compass report, increased connection and integration between Toronto and Waterloo is key to the future growth of Canada's leading innovation ecosystem. “These improvements could attract international entrepreneurs,

capital, and other resources needed to accelerate the combined ecosystem's growth rate," the report states. "More importantly, it would propel the region to become an even bigger engine of economic growth and job creation" ("Waterloo, The David vs. Goliath of Startup Ecosystems").

Now, a collection of regional mayors, technology accelerators and economic development organizations are working together to create a cohesive Toronto-Waterloo Innovation Corridor: North America's second-largest technology cluster.

The Solution: GEDI

"The University of Waterloo will transform how we collaborate with industry and government."

— Feridun Hamdullahpur, President, University of Waterloo

To open new horizons for innovation and progress, we need to deepen our understanding of the world around us, to undertake fundamental, discovery-oriented research. And that is where universities excel. But how do we transform the insights made on campus into world-changing innovation?

That question prompted the University of Waterloo to launch the Global Entrepreneurship and Disruptive Innovation (GEDI) Initiative on September 15, 2016.

GEDI's vision is to create a dynamic link between research, industry and disruptive startups, unlocking the University of Waterloo's talent, insight and invention to more fully realize the economic benefits for Canadians. We want to create a nexus of innovation: a physical space where business leaders, entrepreneurs and academic researchers can connect and collaborate resulting in a continuous and escalating feedback loop.

The GEDI initiative provides a concierge-based service that helps industry tackle their toughest problems, commercialize disruptive technologies and position themselves for global success. It serves as a laboratory for innovation, an educa-

tion platform for change agents in business and industry, a testing ground for ambitious and entrepreneurial students, and a hatchery for solutions to the world's most pressing problems.

GEDI aims to:

- Break down existing barriers to unleash the full potential of industry, academia and government to bridge the innovation gap and jump-start the knowledge economy
- Open the door to stronger collaboration through the full innovation spectrum, from ideas and insights, discovery and invention to the talent needed to deliver solutions
- Connect, integrate and accelerate innovation by connecting a diverse range of resources and experts to solve industry problems
- Play to Canada's greatest economic strengths, focusing on strategic sectors of the knowledge economy
- Create a space where businesses can reinvent themselves, accessing the talent, research, skills and connections they need to create disruptive innovation
- Support the next generation of globally leading companies

Housed on the University of Waterloo campus, we will start building this initiative with a base of more than 100 affiliated faculty, lecturers, researchers and staff, as well as connections to more than 200 local startups. Our clients range from individuals with a disruptive idea to executive teams from major corporations examining future possibilities for their industry.

To our knowledge, no other university in Canada has undertaken anything of this scope.

While most universities—including University of Waterloo—have startup incubator programs and commercialization offices, GEDI is the first initiative designed to systematically unlock and combine all innovation enablers on campus together in a physical space or network—effectively moving research out of the lab and into the marketplace.

To enhance industry-research collaboration, we provide four key services.

Research and development partnerships

The University of Waterloo is a leader in impact-driven research, particularly in key frontier disciplines that hold the potential to disrupt and invent whole new industries — disciplines such as quantum and nano-technology, additive manufacturing and robotics. GEDI connects industry partners with that expertise, giving companies the chance to collaborate on highly focused research or take part in more exploratory projects.

Access to talent and discoveries

GEDI helps businesses tap into a deep pool of innovators within the university, from graduate students to faculty to undergraduates within Waterloo's world-leading co-op program. We also connect industry with the growing and diverse pool of technology-enabled and socially driven startup companies that make up the region's entrepreneurial ecosystem.

Insights and diagnostics

GEDI provides assessment services that help enterprises determine how well their internal systems foster innovation and how ready they are for the next disruptive technology.

Leadership development in technology, innovation and intrapreneurship

To empower business leaders to create a culture of innovation, we provide a suite of development opportunities and resources. These include executive-level education, a master's degree in innovation, and innovation coaching. We also disseminate the latest in innovation research through white papers and conferences.

Initially, we have chosen to focus our work on targeted areas that reflect both Waterloo's particular research strengths and the greatest potential for global impact. These include technology platforms and disruptive sources such as:

- Quantum technologies
- Nanotechnology
- Cybersecurity
- The Internet of Things
- Machine learning
- Data science and visualization
- Autonomous systems
- Connected systems, including robotics
- Additive manufacturing and 3D printing

Our focus also includes a number of strategic industry sectors:

- Financial
- Health and medical
- Automotive
- Agriculture and food
- Energy
- Clean energy, including alternative fuels
- Environment, including water

Our strength lies in our power to create connections, amplify existing partnerships and spawn new collaborations within the Toronto-Waterloo Innovation Corridor and beyond.

The Leaders and Stakeholders

"...a new generation of entrepreneurs is rising out of the Waterloo region. At its centre is an indispensable institution, talented inventors and a dedicated group of community leaders co-operating to support the hub's ambition to become a world-class technology centre."

— Shane Dingman, The Globe and Mail

GEDI is led by the University of Waterloo and personally championed by the university's president, Feridun Hamdullahpur. The initiative is governed by a committee of internal stakeholders at the University, which includes the Office of Research,

the Accelerator Centre, Co-operative Education and Career Action, the Office of Advancement, University Relations and the Provost Office.

The University of Waterloo is uniquely positioned to conceive and drive this groundbreaking endeavor. Its success, however, depends on engaging with a number of external partners, as discussed below.

The University of Waterloo

As Canada's top innovation university and the engine of the country's leading technology and talent cluster, Waterloo is a magnet that can attract established industries looking for help in creating and harnessing the power of disruptive innovation. That makes us the ideal location to establish a central conduit between industry and academia.

Our world-leading co-operative education program forges strong connections to businesses in Canada and around the world, and produces graduates with extensive industry knowledge. Meanwhile, an emphasis on impact-driven research encourages collaborations between faculty and industry.

Our longstanding creator-owned intellectual property policy has helped foster a strong entrepreneurial culture among faculty and students, and spawned a thriving startup ecosystem second only to Silicon Valley in its density. An impressive infrastructure of support for fledgling entrepreneurs bolsters this ecosystem. We run the largest free startup incubator on any campus in the world, helping Waterloo students establish 120 companies to date which, in turn, have created more than 800 jobs.

The University's commercialization office helps innovations get to market sooner, conducting patent searches, assessing markets and identifying competing technology. Meanwhile, the Conrad Centre provides an academic hub for entrepreneurship on campus—a place to learn essential

skills for every stage of business development, from idea generation to venture creation to commercialization and growth.

Waterloo also has earned a reputation as a world-leading research institution, home to more than 40 centres and institutes, and 65 Canada Research Chairs, not to mention Canada's largest school of engineering and its largest academic concentration of computer science researchers. In 2015-16, the University attracted more than \$182 million from public and private sources to fund research across a spectrum of challenges, from nanotechnology to cybersecurity to green energy. For the eighth year in a row, Research Infosource Inc. named Waterloo the "Research University of the Year" among Canadian comprehensive universities ("Canada's Top 50 Research Universities List").

Industry leaders

Currently, GEDI is in discussion with several potential industry partners who recognize that Canada's future—and their own—lie in creating transformative change. In doing so, we are building on a long tradition of collaboration with industry that includes The Mike and Ophelia Lazaridis Quantum Nano Centre, the Advanced Manufacturing Consortium, the Waterloo Centre for Automotive Research, the Southern Ontario Water Consortium and the UW-Schlegel Research Institute for Aging.

Regional innovation partners

GEDI is reaching out to local technology accelerators, research institutes and post-secondary institutions, as well as more than 200 startups that contribute to Waterloo's thriving entrepreneurial ecosystem. We complement the valuable services they provide by connecting industry partners with sources of innovation found on campus and across the region, unlocking additional economic potential.

We also leverage and increase the impacts of the work done through the Ontario Centres of Excellence and the Ontario Network of Entrepreneurs, opening the door to more collaborations.

Government

GEDI's goals align with federal government priorities. The Government of Canada recently earmarked \$800 million for innovation networks and clustering as part of its innovation strategy. Meanwhile, the mayors from communities within the Toronto-Waterloo Innovation Corridor have been discussing ways to attract business, boost growth and unlock the potential of this innovation cluster. GEDI feeds directly into those ambitions.

The Barriers

Carving a new path inevitably involves overcoming obstacles. For GEDI, a key challenge was clearly articulating to external stakeholders how our mission and services complement, rather than duplicate, the work of existing technology accelerators and innovation hubs within the Toronto-Waterloo Innovation Corridor.

Other challenges included finding ways to align industry needs with the other research demands placed on our faculty, and align industry timelines with academic schedules. On this latter front, Waterloo has the advantage that our co-op students are available to work throughout the year, while our faculty are not necessarily tied to eight-month teaching schedules.

Finally, like almost any new initiative, we faced the challenge of financing GEDI. We are currently working to secure industry investment and government funding, as detailed in the following section.

The Investment

Work on GEDI began in earnest in February 2016, when University President Feridun Hamdullahpur presented the idea to the Board of Governors. To transform the initial vision into reality, the University of Waterloo invested staff time and resources, together valued at approximately CAD\$500,000.

GEDI officially launched on September 15, 2016. Moving forward, the projected budget for 2017-18 will be CAD\$13 million, funded by the University of Waterloo, government and industry partners. By 2020-21, we expect the budget to grow to CAD\$32.5 million.

The Results

"We are determined to make access to disruptive innovation faster and easier."

— Feridun Hamdullahpur, President, University of Waterloo

Successful innovation clusters create value greater than the sum of their parts. Locally, GEDI will amplify existing partnerships and create new collaborations within the Toronto-Waterloo Innovation Corridor, creating new jobs and economic opportunities.

Nor do the benefits end there. Because GEDI is strategically focused on high-potential growth sectors, we will accelerate disruptive innovation, increase foreign direct investment in Canadian research and help Canadian companies succeed on the world stage. As a result, we will directly contribute to national job growth and economic prosperity.

Each year, we anticipate that GEDI will attract more than 10,000 visitors, keen to connect with our partners, develop collaborations and learn from this first-of-its-kind initiative.

What Comes Next: A Scalable, Replicable Model

GEDI provides a model that can be readily scaled up within the Toronto-Waterloo Innovation Corridor—a region that is home to 16 post-secondary institutions. Expanding GEDI to include other universities, colleges and research institutes would open the door to a number of high-potential collaborations.

Even more significant, this is a model that can be widely replicated. Universities lie at the core of most great innovation systems. By pioneering a model for translating more on-campus discoveries into real-world innovation and accelerating the pace of innovation, GEDI can help drive positive disruption on a global scale.

About the University of Waterloo

Unwavering commitment to innovation in research, learning and experiential education makes University of Waterloo a celebrated source of talent and new ventures. A research powerhouse and the engine of one of the world's top-25 startup ecosystems, Waterloo offers the world's largest co-operative education program, a uniquely entrepreneurial culture and a dynamic learning environment for 36,500 undergraduate and graduate students. Championing innovation and collaboration, Waterloo builds a better future for Canada and the world.

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ECUADOR

Public-Private Dialogue as Catalyst for Competitiveness and Sustainability in Quito

One of the challenges that the cities of Latin America face is creating the conditions that make a city competitive, inclusive and sustainable. Striving to balance these economic, social and environmental goals is a public policy challenge. However, none of these objectives can be achieved without a constant dialogue between the public sector and the private sector.

Recognizing the need for public-private sector collaboration, Quito presented a new agenda for shaping the future of the city towards 2040, after several months of deliberation with experts in different fields, taking into account the needs of entrepreneurs, urban planners, students, universities, cultural actors and citizens. The results of this work were presented at HABITAT III, the United Nations Conference on Housing and Sustainable Development, recently convened in Quito to reinvigorate the global commitment to sustainable urbanization, and to discuss the urban agenda for cities in their role as drivers of national economic and social development. In this context, Quito is developing plans to achieve orderly and sustainable growth, guided by the following vision:

This Vision sees Quito in the year 2040 as a modern and livable city whose citizens feel that they belong and where they can live in dignity. It is a resilient city that successfully addresses its challenges. Cultural diversity is considered its greatest asset, keeping its historical heritage alive. It promotes the full exercise of human rights within a democratic and free environment. We want the city to have a design that serves life and respects the environment. We want it to be inclusive,

foster private enterprise and be open to the world. Quito in 2040 must be a city that protects its natural heritage, prioritizes the pedestrian, has quality public spaces and a sustainable and efficient transportation system.

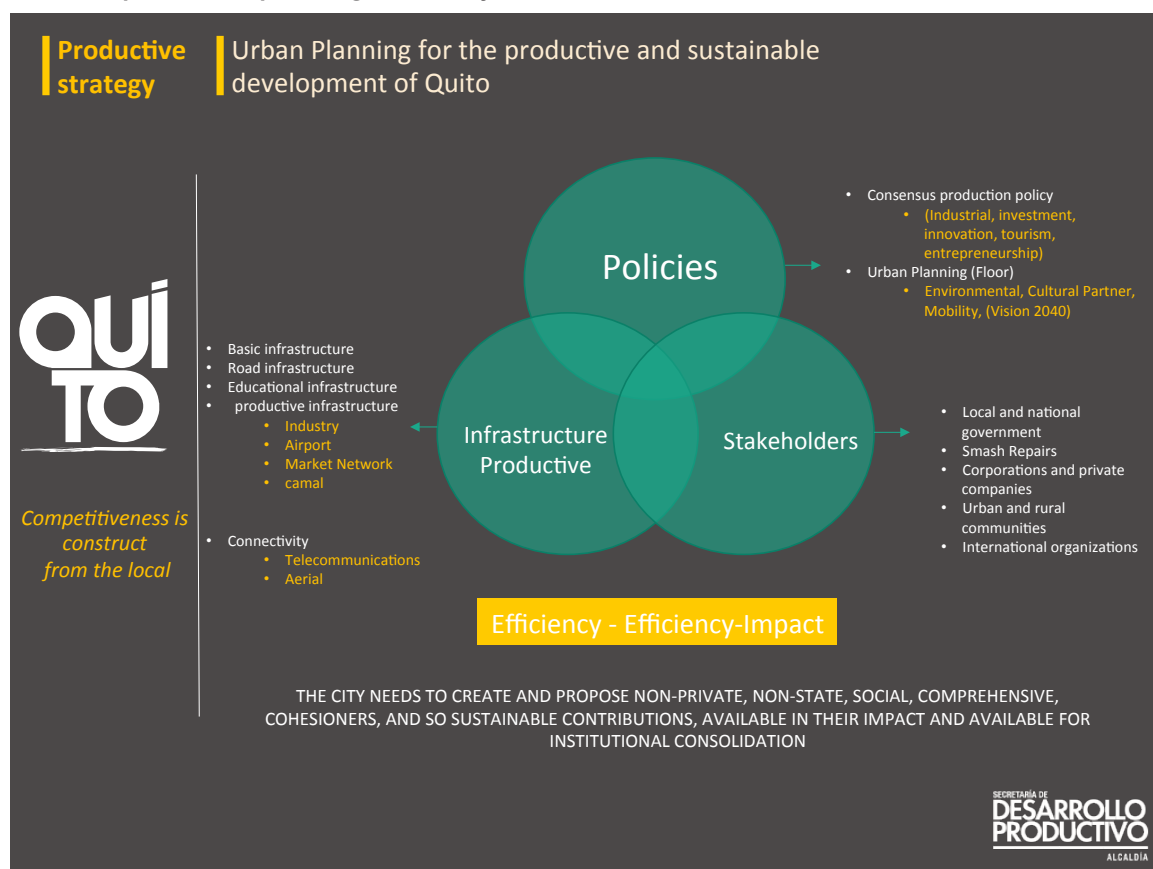
The economic component is fundamental, and the first step for urban planning has been to establish the basis for balanced economic development. The City of Quito accounts for 10 percent of Ecuador's population, 27 percent of the country's GDP, and 20 percent of its non-oil exports. Quito's productive structure is dominated by professional activities, manufacturing, construction and commerce that account for 62 percent of its economy. However, the growth of the productive sector has been largely spontaneous and unplanned. The location and design of industrial spaces, and land use have not been optimal and, at present, many industrial enterprises are located in urban areas of the city, generating, in many cases, increased social pressure. In response, territorial production planning needs to focus on creating synergy and balance in the use of space and land to achieve economic, social and environmental goals. Three areas of policy and planning are crucial.

The first is public policy, including the rules that govern and promote urban growth, land management, environmental policy, investment, innovation, mobility, culture and social development. The second area involves accommodating the needs and interests of stakeholders. On the public side, this includes the local government or mayoralty, the national government and multilateral agen-

cies. On the private side, this includes production and trade chambers, urban and rural communities, corporations and private companies, universities and citizens. The third area of planning involves physical spaces and productive infrastructure such as the airport, wholesale and retail markets, the slaughter center, the city's road network, digital network, etc. The ability to integrate these

three elements is fundamental to the development of the city's competitiveness. Thus, the city needs to create a non-private, non-state competitiveness agenda and strategy that address these three areas in an integrated and sustainable way, and develop a plan of action that includes objectives measurable in their impact and identifies the role key institutions play.

Focus of productive planning of the city



In February 2016, the productive development secretary of the municipality of Quito formed Quito's competitiveness council. The Council's role is to focus on and coordinate work between the public sector, private sector and academia in developing a competitiveness agenda for the city. Chaired by the Mayor of the city, the Council has 15 members representing the economic sectors of the city, including:

- Chamber of Industries
- Chamber of Commerce
- Chamber of Agriculture
- Chamber of Tourism
- Stock Exchange
- Association of Banks
- Association of Exporters
- Construction Chamber
- Federation of Chambers (Mining, flowers, banks, textiles, metalworking, etc.)
- Three representatives of the main universities

General guidelines were established at the Council's first executive meeting:

1. The council will dedicate itself exclusively to addressing structural issues of the city, developing by year's end a ten-year competitiveness agenda.

2. There are three technical working groups:

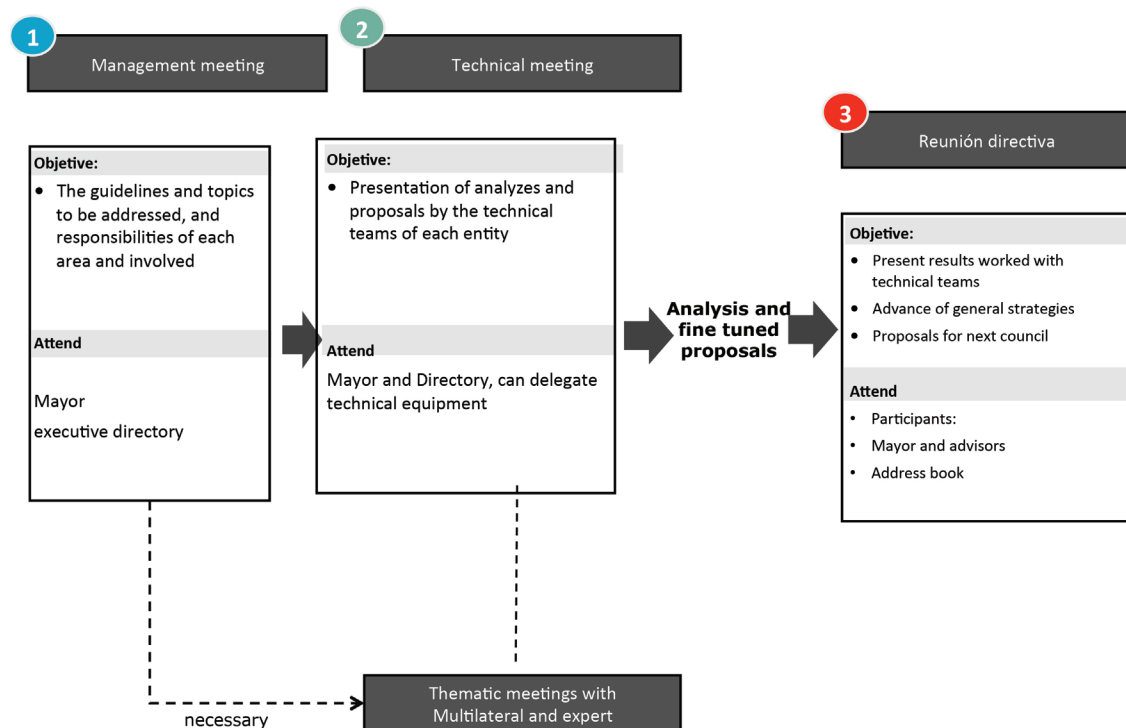
- Productive development table
- "Tramitology" table (cutting red tape and streamlining permitting)
- Business climate table

3. Methodology of operation

The tables already have had important results:

The first "Quito Invest" is an initiative to encourage the participation of the private sector in projects identified as a priority for the city: projects for mobility, sustainability and tourism. Up to \$3 billion could be invested in these projects. Also, the investment board is working to develop other key tools to improve the business climate as a fast track mechanism for investments, sector incentives and the formation of Quito's investment agency. The table of productive development has been more complicated because the city's industries are currently focused on the short-term and day-to-day issues, not by explicit decision but rather because the country's changing tax and commercial policy has created an environment of uncertainty and indecision. For this table, we are increasing the level of work and seeking input from academia and the productive sector on stimulating industry cluster development. This includes, first, identifying who is in the city, which are the most dynamic sectors and, of those sectors, which generate the most jobs and are the most competitive. Once this information is gathered and a plan developed, we will focus the entire productive ecosystem to make these sectors more competitive. The table of procedures ("tramitology") is perhaps the most complex and challenging. Here we have set forth an objective and methodology, aligned with the World Bank's Doing Business framework and indicators, focused on improving the ease of doing business in the areas of regulation for which the municipality has responsibility: starting a business, dealing with construction permits and registering property.

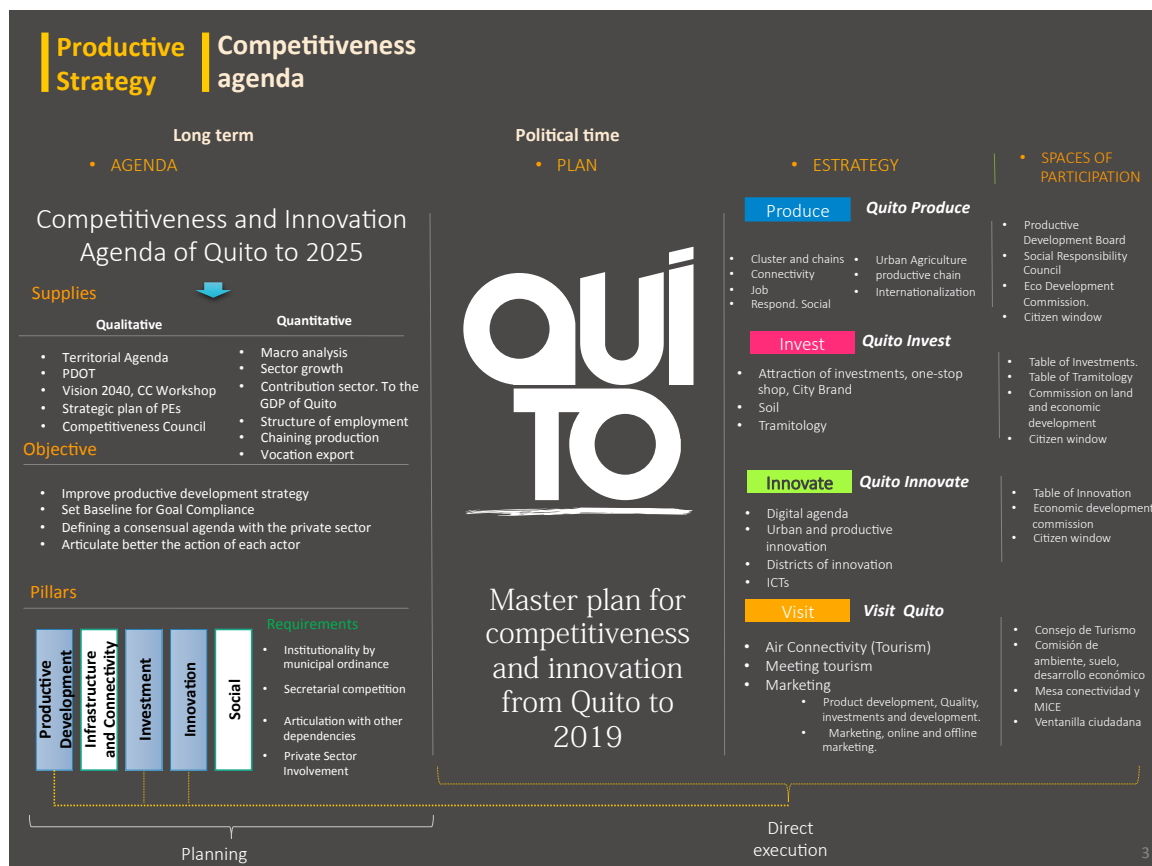
Components of the Competitiveness Agenda of Quito



The discussion generated within the Council and its sectoral panels has led to the development of the Competitiveness Agenda of Quito, an essential instrument for productive medium- and long-term planning and a consensus roadmap for improving the city's competitiveness. Quito's competitiveness agenda has five general pillars: productive development, infrastructure and connectivity, innovation, investment and social development. At the operational level, this agenda has four strategies, promoted directly by the Competitiveness Council, and that involve respon-

sibilities of both public and private stakeholders, setting objectives and goals, and establishing programs that enhance competitiveness. While, undoubtedly, managing a long-term agenda is complicated, made even more so when the political times create an uncertain environment, setting and institutionalizing a balanced and integrated economic, social and environmental strategy are fundamental steps for creating a competitive and sustainable city.

Components of the Competitiveness Agenda of Quito



Quito, Competitive and Global City

The vision of the competitiveness of the city could be defined as follows: A city open to the world that, due to its geographic location, becomes the capital of regional integration and promotes entrepreneurship and private investment. Dynamic in nature, the city is connected to the rest of the country and the world. It has an international orientation and takes advantage of opportunities.

About the Author

Mr. Alvaro Maldonado is currently the Secretary of Productive Development and Competitiveness of the Metropolitan District of Quito where he proposes and dictates public policy that aims to enhance the city's business climate, investment attraction and overall productivity for economic development.

GLOBAL

Sustaining Cities by Connecting People: Global Public Purpose Partnered with Private Investment

Webster University can be and has been described in many ways. Founded in 1915 in St. Louis, Missouri, United States, Webster is a Tier 1 nonprofit private university currently serving nearly 17,000 students studying at campus locations in North America, Europe, Asia, and Africa, and in a robust learning environment online. Fully accredited by the Higher Learning Commission of the North Central Association, Webster's mission is to ensure high quality learning experiences that transform students for individual excellence and global citizenship. At the time of its founding by the Roman Catholic Sisters of Loretto, Webster was one of the first colleges west of the Mississippi River to provide bachelor's degrees for women. From those beginnings, Webster evolved to welcome an ever more inclusive community. In the 1960s, Webster welcomed male students and transferred the college to a lay governing board, leaving the identity of a Catholic women's college for independence with no religious affiliation. Student profiles expanded to include those on military bases, working adults and, in the 1970s, students in Europe as Webster opened residential campuses in the cities of Geneva and Vienna, followed by Leiden and London. Today, campus locations also include Athens, Greece; Accra, Ghana; Bangkok and Cha-am, Thailand; and joint degrees are offered in partnership with three Chinese institutions in Beijing, Chengdu and Shanghai.

While Webster's history and global diversity are distinctive, what sets the university apart is its entrepreneurial approach to taking education to our students, enabling us to meet the unmet needs of our students and the communities they



call home. Using the language of entrepreneurship, we can think of our founding as a "start up" created by women for women, who then accelerated the institution's growth at a phenomenal pace through focused strategy and considerable risk taking. The gazelle-like Sisters of Loretto put in motion an institution willing to embrace an increasingly diverse and inclusive sense of community, including the decision by the Sisters to launch the institution to private and independent status at its first half-century mark. Just as Webster pioneered in offering programs for working adults, for those in military service and their dependents, and creating fully online courses and programs, the institution's first creation of an international residential campus in an important city of the world marked a mission-defining strategy that persists to this day.

The Challenge: Optimizing and Integrating Private Assets for Global Public Purpose

Webster's global character is rooted in its history, dating to at least 1919 when the college welcomed two French students as part of the war relief effort. In 1925, Webster created its first scholarship to study abroad and, in 1931, students from other countries began completing

their studies at the Webster Groves campus. During the next 20 years, 200 faculty members and students went abroad or came to Webster. In the 1970s, the university took the significant step of establishing a residential campus in Geneva, Switzerland, soon followed by Vienna, Austria and Leiden in the Netherlands.

From enterprising beginnings in three European cities, the Webster University network of global campuses now extends to cities on four continents, educating thousands of students across the world. Webster's campuses in Europe and Africa are fully residential campuses with full degree programs, educating primarily students native to countries in the region of each campus—Leiden, Athens, Geneva, Vienna, Accra, and from the Middle East, Asia, and Africa. Thailand is the location for two campuses—graduate students in Bangkok and undergraduates in Cha-am. In China, graduate students complete joint degrees at Chinese partner institutions. At the European campuses, generally, the student population is 15 percent local, 15 percent from the United States and 70 percent from the rest of the world.

Study abroad students from Webster campuses and from its U.S. affiliate partners can spend a term, a semester, or a year at other Webster campuses, as well as through arrangements with partner institutions around the world. Our network of campus locations and partnerships means that Webster students can choose to complete an entire degree program outside their home country or can seamlessly transfer credits among campus locations. The curriculum is centrally coordinated, taught in English, and Webster programs are accredited by the Higher Learning Commission

wherever they are located. Faculty at international campuses are globally diverse; at the European campuses, 90-95 percent are local residents in the country or region, but not necessarily native to the country or region. They are complemented by those on assignment from other Webster campuses. Because of the longstanding presence of campuses in their communities and the residential nature of faculty, the embedded connections to each city location are culturally acute. In many cases, programs enjoy country accreditation, adding value to a Webster degree achieved in that country.

Yet, the considerable assets of these campuses and the cities they call home have not yet been optimized for the benefit of the whole university nor of each individual campus [and city] in advancing the university's mission of transforming learners for individual excellence and global citizenship. Generally, people are not inclined to work together across communities because of the lack of contact and communication, limiting any sense of shared purpose. Established structures, geographic isolation, leadership orientations, limited communication infrastructure, and unique characteristics of a specific location—such as culture, economics, politics, and regulations—are barriers to successful integration. Absent this integration, local realities and self-interest take precedence when a global view, locally expressed and manifested, can bring new talent and innovative solutions to bear on the issues facing the world's population living in cities.

The focus of this case is the strategy needed to catalyze and strengthen the connected ecosystem of a university's global network. The neces-

sity that demands integrating the university's network for global impact is linked directly to the necessity of connecting people across city and country boundaries for the benefit of the cities where Webster is located as well as for the world. Framing the need for entrepreneurship globally, United Nations Secretary Ban Ki-Moon explains, "Entrepreneurship is about innovating, breaking down barriers, taking risks and showing that new business models can tackle long-standing problems" (United Nations Foundation: Entrepreneurs are the Spark for Global Change). The enduring problems that the United Nations, its foundation, its partners, and leaders in communities worldwide are tackling are many and varied: public health, hunger and poverty, education, empowerment of girls and women, security, sustainable development, technology, energy, and communications. The need for innovators with a passion for humanitarian causes crosses the borders of communities and countries. Leadership across new borders demands a global mindset that embraces the interdependence of the world—its challenges and its opportunities (Gundling, et al. 1-2, 35-37). While the challenges to cities in the continents Webster students call home—North America, Europe, Asia, and Africa—vary, the need for human connections, innovative leadership, entrepreneurial approaches, and a global mindset persists.

The need is acute for collective will and concerted action that is entrepreneurial and informed by a global perspective and mindset which can address the challenges facing people living and working in the world's cities. To greater and lesser degrees, St. Louis, Shanghai, Vienna, Leiden, Athens, and Accra face issues of hunger and poverty, gender equality and women's empowerment, health and disease, environmental sustainability, income inequality, racism, security, violence, and improved educational access and outcomes, among many others. Building on the successes of the Millen-

nium Development Goals (MDGs), the United Nations recently launched a set of 17 Sustainable Development Goals (SDGs), calling out the worldwide need for improved industry, innovation, and infrastructure; sustainable cities and communities; and decent work and economic growth.

Meeting the Challenge: Connecting People Through Strategy, Leadership, Programs, and Infrastructure

As Webster University anticipated its second century, the institution's strategic plan had largely been accomplished, and university leadership embarked on a strategic planning process to establish the goals and metrics for building, from the institution's entrepreneurial successes, a sustainable enterprise for Webster's next century. The new strategic plan, *Global Impact for the Next Century* (2015-2020), is organized around four themes:

- Global innovation through inclusive leadership
- A global, student-centered experience
- A network of academic and operational excellence
- Strategic and sustainable development

Informed and shaped by hundreds of members of the Webster University community—faculty, staff, students, administrators, trustees, and alumni worldwide—the plan was endorsed by Webster's Board of Trustees to place priority on integrating, articulating, and leveraging Webster's global assets in a sustainable way. The plan commits Webster to enhance student support systems and embed experiences across the network that enable and cause students to put values into action to enhance their learning, with a focus on the values of global citizenship and diversity. As a worldwide institution, Webster will educate a diverse population locally, nationally, and internationally, and strengthen the communities it serves.

Several areas of strategic focus illustrate the means by which Webster seeks to be globally impactful through systemically integrating programs, services, scholarship, student and employee talent, operations, and engagement among and with members of a global community. To achieve connections among members of the Webster University community and their city homes, we have focused on:

- Leadership development for faculty, staff, and students
- Academic program development
- Infrastructure investments

1. Leadership Development for Faculty, Staff, and Students

Two innovative initiatives have increased the commitment, talent, and capacity of faculty, staff, and students across the Webster Global Network to lead in connected ways: the Global Leadership Academy and the Global Student Leadership Summit.

Created by President Stroble and Provost Schuster, the Global Leadership Academy is an innovative leadership development program designed to enhance Webster's institutional capacity for global work by virtue of the program's impact on faculty and staff leadership. The three goals of the year-long Academy are developing and enhancing faculty and staff leadership skills, providing a comprehensive and grounded understanding of Webster's complexity, and creating ambassadors to the communities Webster serves. Since its inception in 2013, the Academy has achieved these strategic results:

- Meaningful interactions among faculty and staff from 15 Webster University campuses, including 4 international campuses and 9 metropolitan campuses outside the home campus in St. Louis, Missouri.

- Increased faculty and staff global mobility by providing the first international travel experience for approximately 18 percent of participants.
- Increased participants' grounded understanding of Webster University's complexity, developed and enhanced participants' leadership skills, and created ambassadors to the communities Webster serves. Notable gains appear in participants' 1) establishing relationships across the Webster network and leveraging them to resolve institutional challenges and 2) recommending innovative and creative solutions to institutional challenges.
- Leadership accomplishments within the project-based framework of the Academy as well as in participants' current roles and new roles as a result of promotions within Webster or at other institutions.
- Key initiatives in the institution's strategic plan advanced by participants in areas such as leading major curriculum revisions, developing talent and improved culture within units, building student community, and advancing major facilities and information technology projects. Academy participants have extended Webster's global impact through new partnerships, faculty scholarship, and campus locations or study abroad initiatives that facilitate greater mobility.

The Global Student Leadership Summit, held in 2015 and planned again for 2017, first convened 29 students of 20 nationalities from 8 campuses across Webster's worldwide network at the St. Louis, Missouri campus to discuss leadership and advocacy. They built their knowledge and skills, developed relationships with peers across the network, enhanced their intercultural competence, and gained a better understanding of the impact that student involvement has on students and Webster University worldwide. Prior to the week's summit, the students met in an online course to develop their leadership competencies and to

study the new strategic plan. At the conclusion of the summit, teams made formal presentations of six proposed actions to advance the four themes of the strategic plan. For Global Student Leadership Summit 2017, to be held at the Webster Vienna campus, a cohort group of 26 student leaders will be recruited from the St. Louis, Geneva, Vienna, Leiden, Thailand, and Ghana campuses within the University's international network, and selected through an application process that includes a review of leadership involvement and work experience. The program goal is that student participants return to their home campus and implement the skills and knowledge acquired to improve student life throughout the Webster University network.

2. Academic Program Development

Ensuring all students have an experience that builds their global perspective requires a global feature in every academic program. A quick survey of Webster's certificate, undergraduate, master's and doctoral program titles finds at least thirty specific global/international programs spanning all five colleges. Schools and colleges are engaged in incorporating specific curricular content and/or experiential components such as study abroad opportunities as an aspect of comprehensive internationalization. This work continues and is designed to extend the foundation created by faculty in the form of a new general studies program, called the Global Citizenship Program (GCP). The Global Citizenship Program, recently recognized by the Association of General and Liberal Studies as an exemplary program, is a set of undergraduate degree requirements

building students' knowledge in these topic areas: roots of cultures, social systems and human behavior, physical and natural world, global understanding, arts appreciation, and quantitative literacy. Skills requirements occur in courses coded for: written communication, oral communication, critical thinking, intercultural competence, and ethical reasoning. Aligned with high impact teaching practices and 21st century knowledge and skills identified by the Association of American Colleges and Universities, the GCP is the basis of every Webster undergraduate degree. This foundation builds students' global perspectives and mindset, and enhances student mobility through the presence of GCP course offerings across campus locations.

The examples of programs with a global feature are long standing at Webster, including the innovative Global M.A. in International, offered since 2006. Cohorts of 8-12 students complete their degrees in five terms at five different locations. In the summer of 2016, 18 students completed their Global MA programs, having studied in Geneva, Vienna, Leiden, Bangkok, Beijing, London, Washington DC, and Havana. Newly created certificate and degree programs, and programs of research and community engagement often address global challenges linked in specific ways to the cities where Webster campuses are located. Examples include academic programs, scholarship, and community outreach focused on cyber security, teaching English as a second language, international NGOs, entrepreneurship, sustainability, human trafficking, refugees and asylum seekers, public health, national security, the political economy, human rights, gender empowerment, and transnational politics, to name a few. These areas

of focus are central to academic study as well as conferences and summits offered on our campuses in partnership with members of the local and global communities. The focus and needs of the cities we inhabit inform our scholarly work and our larger purpose of meeting needs where they are, whether global entrepreneurship in Vienna, or status and needs of refugees and asylum seekers in Geneva and Athens, or victims of human trafficking in Leiden and St. Louis, or leadership for young Africans in Accra.

3. Infrastructure Investments

Human connections and collaborative work across Webster's network of global campuses in global cities depend upon an infrastructure that increases our connectivity across the network and within each community. To that end, Webster created a Global Marketing and Communications Unit that provides coordination and necessary support for globally distributed university community members, prospective students, alumni, and media outlets. Both academic and operational functions rely on the quality and strength of Webster's global information technology network. Recent partnership strategies have replicated those typically employed by multinational corporations, establishing a global wide area network.

Webster's Global Wide Area Network, established in partnership with AT&T, means one telecommunication network connects all Webster campuses across the globe, creating consistent and reliable service for all constituents at higher speeds and greater bandwidth across the network. The new platform has enabled video conferencing across the network, invaluable as a substitute for costly

travel for operational purposes. In the 1990s, Webster was an early adopter of online courses and programs, provided asynchronously via the web due to vast time zone differences among campuses. Our recent strategic focus on "European alignment" seeks to coordinate academic and operational activities among Webster's European campuses. The installation of video-enabled classrooms enhances our ability to coordinate course offerings in synchronous modes. Courses can now originate at any of the European campuses and be delivered to students at each of the other campuses, thus optimizing enrollments and faculty expertise while diversifying the enrollments in such courses. The connections among campuses—faculty, staff, and students—are enhanced by video conferencing as well as regularly scheduled events that bring members of the community in contact with each other. Across the European campuses, students compete in Webster's Got Talent competitions, play football tournaments, and attend leadership development workshops. Student government leaders collaborate to advance improvements within their campus communities and to lead across the network. Academic conferences and summits hosted by each campus on topics as varied as born global entrepreneurship, humanitarian rights, global communications trends, the Eurozone, Asian regional cooperation, and women's empowerment draw members of the university community who attend in person as well as virtually.

Location matters, and it begins with St. Louis, Missouri, United States, Webster's home for 101 years. While our home campus is located in Webster Groves, a charming suburban town 15 miles from the St. Louis city center, we serve an urban

population with a campus located in the heart of the city. For more than 40 years, we have offered degree programs for those who live, work, and play in downtown St. Louis; in two of those campus sites, Webster led the way in the restoration and reopening of historic buildings long in disuse. We opened our current location for the downtown Gateway Campus in 2015, complete with an art museum, auditorium, dedicated classrooms, conference room space, computer laboratories, video-enhanced facilities for synchronous distance delivery, and shared space with partners such as the World Affairs Council. Webster's success in engaging and serving the community as an anchor institution depends upon the centrality of our location and our committed partnership with government, community agencies and organizations, and the growing start-up community present in downtown St. Louis.

The intention to serve as an anchor in the community has driven decisions about locations of the campuses in Vienna, Austria; Accra, Ghana; Athens, Greece; Bangkok, Thailand; Leiden and Amsterdam in the Netherlands; and all three Chinese locations—Beijing, Shanghai, and Chengdu. Investments in facilities central to cities and with residential facilities support desired mobility among campuses, providing opportunity for academic study and cultural immersion. Proximity to potential students within the community is the primary factor for these campus location decisions, but the proximity to partners who provide internships, onsite locations for classes and programs, and available professionals who bring expertise to our classrooms as instructors and speakers are important factors for the quality of programs that intentionally link theory and practice. As

Kleiman and Poethig state in regard to U.S. cities, “just as much as cities need anchor institutions, anchors need cities.” Yet, the awareness of interdependence between anchors and cities too often takes the form of partnerships on specific projects or programs rather than “the kind of intentional and strategic planning that is found in the private sector” (Kleiman and Poethig). Transactional relationships and one-off engagements typify city-anchor relationships, while the truly impactful partnerships that function at systemic and strategic levels are the ideal for a private university serving a public and global purpose.

Lessons Learned and Next Steps.

The challenge of galvanizing shared commitments across individuals with diverse interests is a universal circumstance best addressed by bringing people in contact with each other to discover shared interests and the benefit of working together to solve shared problems. Engaging with others whose lived experiences are not our own enables us to grow in our connection with the human community and to act in ways that surpass self. Sheer lack of mobility among cities and communities limits our knowledge of each other and each other's needs. As humans, we are prone to positive biases about the value of what we know and negative biases about the value of what we do not know. This is why increased contact among people—whether in person or virtually—is essential to transcending self-interest and inadequate knowledge of ourselves and each other.

The ubiquitous nature of this challenge means that solving the problems of creating adequate infrastructure, optimizing talent and technology for economic growth, and improving urban living in sustainable and equitable ways will require bringing

people together in connection with one another. As diverse communities learn from one another, partner in leadership, and share experiences and perspectives to identify innovative solutions to their cities' most persistent problems, cities will prosper in a globally competitive environment.

As Webster University's president, I know from direct experience that the challenge of unifying our diverse constituencies of faculty, staff, students, alumni, and community members across our global network is daunting indeed. Through the solutions to connect people described in this paper, we not only seek to embed even more fully our presence in local communities and cities campus by campus, but also to build a global community.

Adopting mission-focused strategies for meeting the needs of those we educate and the communities we serve relies upon a global mindset that welcomes immersion in new ways of living and thinking. This mindset contrasts our mission-based, need-meeting premise of global education with a "missionary" viewpoint, that of exporting an American worldview or an "imperial" perspective that aims to plant the institutional flag at international branches for the benefit of the home campus. To be successful as a private, global serving university requires a systemic integration and linkage of individuals and communities using levers of connection such as leadership development initiatives, academic programs, and key infrastructure investments. To be competitive as a global city requires the building of mutual interests among disparate populations, using levers of connection that build global mindsets, entrepreneurial talent, and innovative solutions. For both cities and university, we have witnessed the positive impact of a private university partnering for a public, global purpose.

About the Author

Dr. Elizabeth (Beth) J. Stroble is the president of Webster University, a top tier private nonprofit university serving nearly 17,000 students in 8 countries on 4 continents. Her leadership has strengthened Webster's academic profile and global outreach. Previously she served as senior vice president and provost, chief operating officer at the University of Akron and held administrative and faculty positions at University of Louisville and Northern Arizona University.

Notes

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KOREA

Smart Cities in Korea

Urbanization in Korea

Economic Growth and Urbanization of Korea

The “miracle of the Han river” gained strong momentum as early as the 1960s, along with HCI (Heavy Chemical Industry) nurturing plan by means of the “Five-Year Economic Development Plan.” As a result, Korea has become the 6th largest trading country in the world (WTO) and, consequently, “urbanization” has been an inevitable outcome. By 2010, the urban population in Korea had tripled compared to the 1970s and the proportion of “urbanization” had reached 90.9 percent (Figure.1), especially in the capital area. As more weight is put on the city level, the “competitiveness of cities” has become the core factor for the competitiveness of nations.

Visible Problems as a Consequence of Rapid “Urbanization”

Infrastructure

As cities in Korea outgrew available infrastructure, the pace of establishing new infrastructure could not keep up with the fundamental needs of the urban population. OECD estimates that USD 53 trillion is needed by 2030, equivalent to an annual 2.5 percent of global GDP, to meet the growing demand for infrastructure globally and, although it has not been specified, Korea will also need to make a significant investment.

High Population Density

Mass migration to urban areas is often driven by unbalanced economic development. For example, in Korea, people tend to find better opportunities in urban rather than in rural areas. This tendency, however, can cause the problem of high population density, which can further exacerbate housing, pollution, traffic, living cost and sanitation problems.



Others

Other possible problems of rapid urbanization could be an unbalanced growth among cities, various social problems such as a NIMBY Syndrome, as people will need to keep more of their own properties.

Enhancing its “City Competitiveness” is the Key Factor

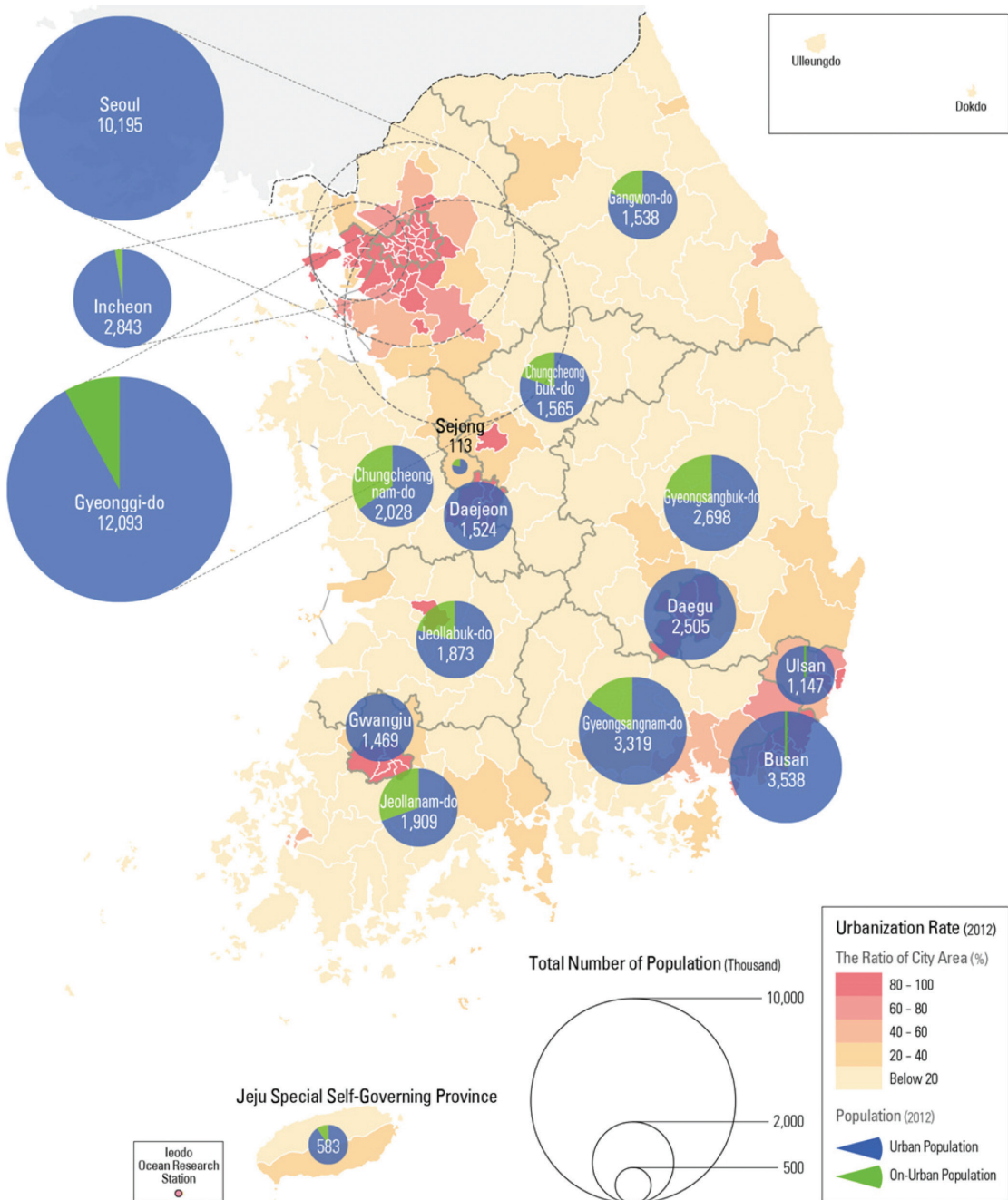
To solve these problems, effective means to enhance city competitiveness must be a high priority, and only fundamental solutions can alleviate these problems. If we regard the city as one whole organic system, such problems undermine its optimal function, so an immediate cure is needed. Thus, to address such concerns, the Korean government established an “integrated master plan for cities,” as a next generation model of cities, and “U-City plan” was its starting point.

Overview of Korea’s Countermeasures

In December 2006, the Ministry of Information and Communication announced “The Plan for Activation of U-City Construction.” In November 2009, the Ministry of Land, Transport and Maritime Affairs announced the first “Comprehensive Plan for U-City (09~13)” and, in October 2013, the second “Comprehensive Plan for U-City (14~18)” was announced.

Figure 1: Total Population & Urbanization Rate of Korea

Source: Korea Land & Housing Corporation



Note 1: The Ratio of City Area is the ratio of land in Urban Planning Area defined by Urban Planning Law.
 Note 2: Urban Population indicates people in Urban Planning Area.

Korea Land & Housing Corporation (2012)

The notion of “U-City” has evolved—to the “Smart City”—and Korea’s “Smart City” project is building on the foundation of the former “U-City Project.” With the aid of existing U-City infrastructure, the Korean government is developing various smart city projects. The “Smart City” plan in Korea is focusing more on “industrial competitiveness” of cities. Therefore, the government’s plan is designed to generate positive outcomes such as encouraging both domestic and foreign investment, promoting the growth of domestic SMEs and IT start-ups, and providing jobs for local citizens.

As Korea gained status as a top global competitor in the telecommunication industry, thanks to its cutting-edge technology, the strategic development plan of “Smart City” has long been promoted. Nevertheless, due to dispersed efforts on the U-City project—Smart Water Grid by Ministry of Land, Infrastructure and Transport; IoT business of “Smart City” by the Ministry of Science, ICT and Future Planning; and the “Smart Grid” project by the Ministry of Trade, Industry and Energy—the project’s actual outcome has been less than optimal. Thus, a major concern of the Korean government and other institutions is to generate the synergistic effect, which can further contribute to the success of the “Smart City” project.

The “U-City” Plan

By definition, “U-City” is the city, equipped with cutting-edge IT technologies that provide “Ubiquitous” access to vast information on transportation, weather and even crime. (Figure2)

Initiated in 2003, the Hwasung and Sunnam areas were selected for the “new city” plan. In 2006, the Ministry of Information and Communication—currently the Ministry of Science, ICT and Future Planning—announced its “Basic Plan for Active Establishment of U-City.” Later, the Ministry of Land, Transport and Maritime Affairs announced the 1st and 2nd comprehensive plans for U-City.

The first plan was designed primarily for developing the basic infrastructure, including application of core technologies, as this basic infrastructure could be leveraged to support further development of other areas. In contrast, the second plan was devised to expand “U-City” projects all over the nation, as well as to penetrate foreign markets. With some degree of variations, the two comprehensive plans aimed to enhance the competitiveness of cities, especially metro areas, and ultimately expand the development scheme to achieve harmonized growth all over the nation. Along with 49 local institutions, the government initiated its 1st plan, which targeted 55 percent of metropolitan areas and 23 percent of rural cities. The Ministry of Information and Communication provided a total of 145 billion Won over 5 years, 46 billion for the U-City Plan and 990 billion for the u-Eco city by means of R&D.

Case Study—The 1st Comprehensive Plan

Challenges & Evaluation

Although the government tried to disperse initiatives evenly over the nation, the U-City plan was mostly confined to metropolitan areas. Only some rural institutions were involved as to undergird its development. For the 1st plan, for which the central government was mostly responsible, there had been a visible limitation on effective, timely development, especially for harmonizing roles with local governments. In addition, gaps in implementation developed between cities that initiated the U-City plan simultaneously because some of the local governments did not have an adequate budget. Moreover, as the real-estate market deteriorated during the implementation, some of the U-City plans had to be abolished.

Also, as it lacked an objective institution that could evaluate progress without politics, the most effective tools and/or methods to achieve further development could not be pinpointed in a timely manner.

Figure 2: Korea's U-City

Source: UBICOM Report (Citing Korea Ubiquitous City Association)

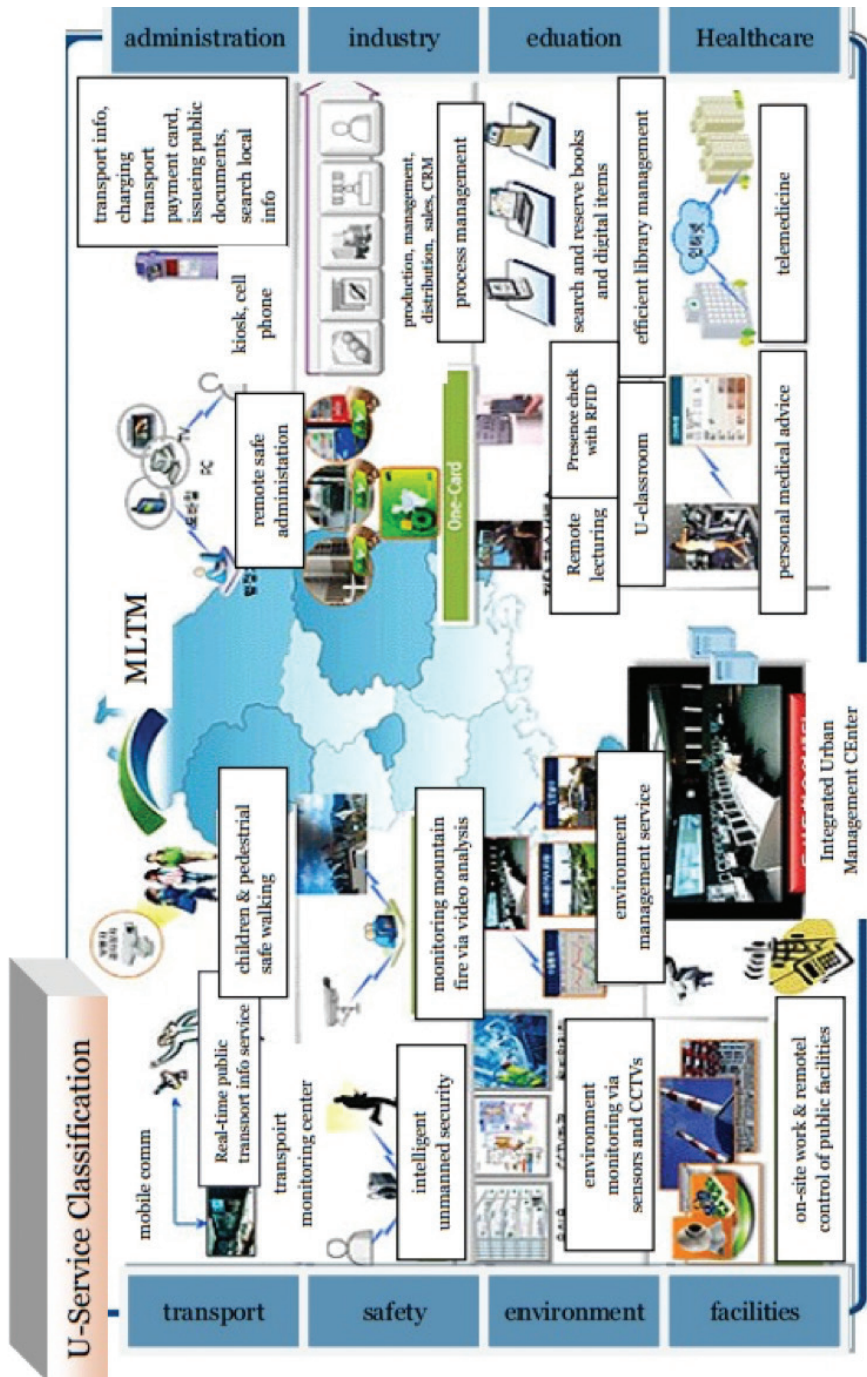


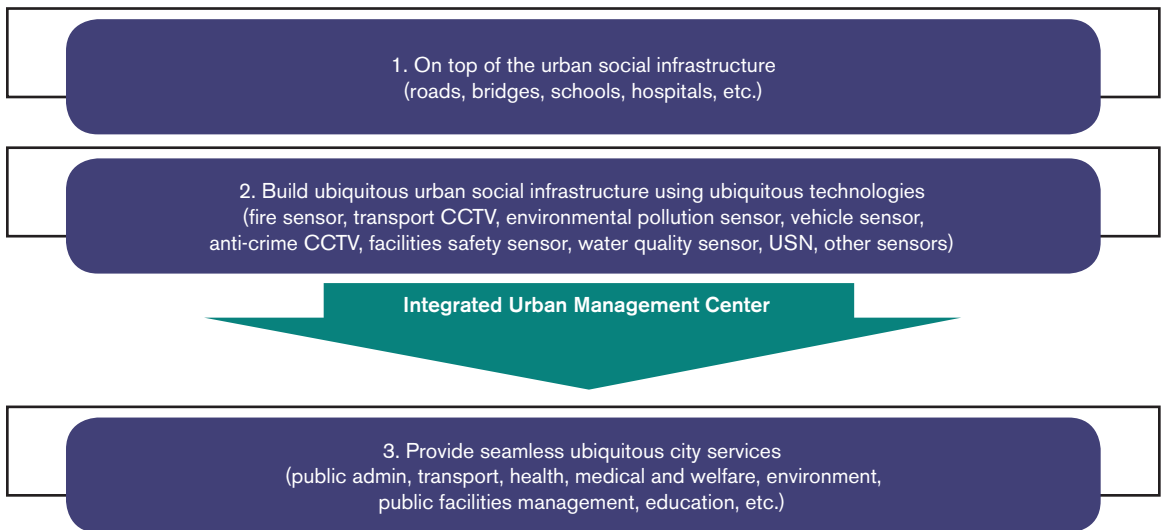
Table 1: Results of the 1st U-City Plan

Initiation Year	Target Location	Result
2009	Songdo	Devised a new model for an effective U-City infrastructure that became a standard for other plans.
	Busan	Provided the service, which encouraged citizen participation, maximizing the promotion effect for "U-City Plans." Also, as it built up the integrated service, including the past U-City infrastructure, it reduced the total cost of development.
	Mapo District (Seoul)	Accumulated cutting-edge IT technology, contributing to further expansion of U-City projects in other cities. By harmonizing with other city systems, it created an integrated and comprehensive system able to provide affordable and efficient services.
2010	Songdo	Established a standardized model for U-City.
	Busan	Reduced costs by maximizing use of existing infrastructure. Increased the community's satisfaction level as it promoted citizen participation.
	Mapo District (Seoul)	Mainly expanded the service and infrastructure for vulnerable citizens such as children, seniors and the disabled.
	Yeosu	Encouraged the use of bicycles to reduce its carbon emissions, forming a "growing green U-City."
	Gangreung	Invented an effective city administration method and low-carbon smart service, and developed a sustainable "growing green U-City."

Initiation Year	Target Location	Result
2011	Eunpyong District (Seoul)	Provided various safety services and integrated with existing disaster management system, developing an upgraded model for a safer city.
	Songdo	Utilized CCTV installation to secure safety of citizens. Combined both wired and wireless services, reducing administration cost for the telecommunication system.
	Ansan (Gyeonggi Province)	Increased the utilization rate of public assets and provided practical services that could enhance the daily life of citizens. Established the basis for providing integrated service by developing the integrated platform system.
	Namyang	By bringing successful expansion of small-mid u-cities to other areas, it was designated as the "exemplar" for the other cities. Increased the work efficiency of public servants, further reducing the administration cost.
	Naju	Equipped with the vision of "Green Energypia," it is expected to save about 4.8 billion won in annual energy administration cost. Estimated to bring a profit of 1.8 billion won solely for carbon emission control. As operated under the eco-friendly scheme, it is expected to contribute to the expansion of "green growth."
	Yeosu	Expanded its standardized model of "U-traditional market service" which led other cities to follow. By improving the traditional market structure, it recovered the old business model, boosting economic growth of local areas.
	Busan	Established a flooding information at the existing U-City service, reducing costs for further development.
2012	Jeonju	Built the "safe living place," improving the overall satisfaction of citizens. Provided the specific U-City service considering the "aging society," improving the overall welfare of citizens.
	Yeongju	Provided a "rejuvenating city safety service," enhancing the prevention of fire and alleviating citizens' concerns regarding natural disaster.
	Yangsan	By recovering its old city infrastructure, it provided a rejuvenated traditional market service. Provided the service focusing on the "Human" itself, increasing citizen's satisfaction level.

Figure 3: 1st Comprehensive Plan

Source: UBICOM Report ("The 1st Ubiquitous City Master Plan (2009-2013)" by Ministry of Land, Transport, and Maritime Affairs, Nov.2, 2009)



Therefore, several issues must be considered to help ensure an optimal level of success in the development of the U-City Plan: proper collaboration between the central and local government, more practical approaches to building additional U-City projects that take into account the status of a deteriorating economy, and establishing an institution to evaluate the project objectively.

The “Smart City” Plan-An Extended Initiative of “U-City” Plan

The Smart City is a city where various ICT technologies are integrated by maximizing the function of a city as a “Platform.” In Korea’s case, “U-City plan” was proposed prior to that of the

“Smart City” plan, and both plans were aimed at enhancing “city competitiveness” by adopting cutting-edge technologies, but the latter put more weight on IoT and eco-friendly technologies.

In June 2015 the Ministry of Science, ICT and Future Planning proposed a plan for making “City Complex for Demonstration.”

The demonstration plan consists of two major subcategories, “supporting center” and “smart service demonstration,” and the “supporting center” can be further subdivided into three sub-areas, “Platform,” “Supporting Center for SMEs,” and “Service Demonstration.”

“Platform” establishes and operates open IoT platforms based on international standards and, for “SMEs Supporting Center,” it supports and provides mentoring for firms which are trying to equip with state-of-the-art IT technologies. For “Service Demonstration,” Smart Home, Smart Parking and Connected Tourism Services are provided.

Along with currently adopted smart city technologies, Table 2. shows other feasible possibilities, some of which are already installed in other areas.

Case Study-Anyang

Anyang is the exemplar for other cases, which integrated successful smart city technology, and more than 60 nations are noticing its advancement.

Evaluation

Anyang has been acclaimed for its major success in the “Smart City” field. One of the major contributors to success was the willingness of the authority, and the provision of financial and technical support sufficient to meet the demand. However, although “Smart City” initiatives have been planned and implemented, the actual outcome in Anyang’s case is still unclear and it is unable to evaluate which initiatives have been the most successful. Thus, initial plans should include more thorough efforts to fulfill support requirements and proper means to gauge the degree of success.

Table 2: Feasible Components for further Smart City Project

Area	Name	Overview
Transportation	Smart Parking	Real-time availability of parking space is indicated and the automated payment of parking fee is allowed with the aid of smart phone application.
	Smart Crossroad	On the crossroad in front of the elementary school, Smart Bollard and safety fence are installed so that alarm will sound when cars violate the traffic law.
Energy	Smart Streetlamp	CCTV and WIFI function are added to the streetlamp to provide energy savings and prevent crimes.
	Smart Building	Monitors information on building management necessary to reduce energy consumption.
	Smart Management of Store	Provides real-time analysis of accumulated energy usage and status of all franchise stores to minimize energy consumption and provide an efficient store control system.
Living	Situation-Based Smart Home	Provide the safest escape point during a fire.
	Beacon-Based Marketing	For beverage and food sellers, it provides low-cost, highly effective marketing based on its “Beacon” Technology.

Table 3: Budget Outline

Source: IDB

Project	Cost (Million KRW)	Period	Main Operations
Crime Prevention CCTV Establishment	16,473	2008.08~2014.11	<ul style="list-style-type: none"> • Crime Prevention CCTV 3,476 cameras at 771 sites • Automatic Vehicle Identification (AVI) 114 AVI at 47 sites
Bus Information System (BIS)	4,740	2003.10~2014.11.	<ul style="list-style-type: none"> • 300 Bus Information Terminals • 140 Vehicle Information Devices
Intelligent Transport System (ITS)	14,315	2008.02~2014.04.	<ul style="list-style-type: none"> • Anyang Smart City Center Establishment • 119 CCTV, Fiber optical network established, etc.
Total	35,528		

Table 4: Major Service Areas

Source: IDB

Service Area	Services
Smart Traffic	<ul style="list-style-type: none"> • Real-time traffic information • Bus information terminals • Parking space information • Facility location and traffic use information • Traffic signal control
Smart Safety	<ul style="list-style-type: none"> • Smart phone safe helper • Intelligent crime prevention service
Smart Disaster Service	<ul style="list-style-type: none"> • Forest fire surveillance • Winter snow conditions surveillance

Concluding Remarks

Although the ambitious plans of the U-City and Smart City project have been initiated with much expectation, its actual outcome has not reached its optimal level yet. This is mainly because (1) too many institutions are involved, (2) harmonization between the central and local governments is lacking, (3) the government departments responsible for development are frequently changed and/or abolished, and (4) objective institutions for evaluation are lacking.

To be more successful, active participation from the local governments is necessary, while the central government could provide financial and technical support. Cities such as Seoul and Incheon, which have adequate financial and technical capabilities, are preparing their own “Smart City” plan, and more local “Smart City” plans are projected for the near future.

Also, more participation from the private sector should be encouraged to potentially maximize the efficiency of such plans. For example, in June 2015, the consortium between Busan city and SKT—the Korean Telecommunication Company—was selected as the trial “Smart City” business, aiming to raise 1,500 IoT professional workers, develop 150 creative enterprises and generate 15 globally competitive firms. Since many state-of-the-art technologies are developed by innovative firms, the government’s efforts should reach out to such companies as well.

Although it is not straightforward to carry out such initiatives, especially without any difficulty, the ‘Smart City’ project must be implemented because it is the only way to meet the increasing demand of citizens and to enhance “city competitiveness.”

Korea Economic Research Institute (KERI) is Korea’s leading nongovernmental research institute founded in 1981. Guided by founding principles of free market, free enterprise and free competition, KERI has successfully integrated research in both the entirety of the Korean economy and long-term and short-term prospects for corporate growth.

SAUDI ARABIA

Dhahran, Saudi Arabia: An Evolving City in Innovation*

Executive Summary

Innovative cities are a vital part of a country's economic strategy. Given an increasingly integrated global economy and rising competition, countries need to develop innovative cities to ensure being ahead in the race for economic sustainability and leadership. Cities that succeed at being innovative are often characterized by an innovation ecosystem, making the city a centre of wealth creation with links to local, regional, and global economies.

There are many paths along the way to innovative cities, ranging from cities where innovation is led by private sector stakeholders, to those led by national enterprise champions and everything in between. In many developing countries, often a state enterprise emerges that champions the cause of innovation in cities.

The city of Dhahran, located in the Eastern Province of Saudi Arabia, represents the potential for Saudi Arabia's innovation in the energy sector. Endowed with oil wealth, a national corporate champion, and one of the top science schools in the Kingdom, a growing innovation ecosystem is promising to put Dhahran on the path of most competitive cities in the energy and petrochemical industries. However, Dhahran was not a city



Saudi Arabian General Investment Authority

SAGIA

without challenges; these included a dearth of scientists, government red tape, and the need to develop a culture of innovation.

An important success factor for the city of Dhahran is the presence of an enterprise champion in Saudi Aramco which supports innovation in important ways. Saudi Aramco has helped build the capabilities of Dhahran Techno-Valley—an energy innovation hub—by providing investment capital, a pool of experienced technical talent, and business opportunities; it also provides interregional and international connections via its networks and value chains. It helps stimulate research and development (R&D) within hubs and academic institutions by facilitating knowledge creation and sharing. In addition, it helps other stakeholders within the hub to bridge the commercialization gap with their resources through collaboration or supplier relationships. All these support factors have brought about a wealthy city with strong infrastructure, research, and with corporate and social links that are propelling Dhahran to an energy innovation hub status.

*Some sections of this paper are adapted from the author's previous publications. See, for example, The Global Innovation Index 2013: The Role of Enterprise Champions in Strengthening Innovation Hubs; Coherent Linkages: How to foster innovation-based economies in the Gulf Cooperation Council (2012 Strategy & formerly Booz & Company); and Strengthening Innovation Hubs in the GCC: The Role of Enterprise Champions (2013 Strategy & formerly Booz & Company).

Innovative Cities: More than One Path to Success

The developmental paths of innovative cities vary. In some countries, such as the United States, innovative cities tend to form around research institutions that attract and support an entrepreneurial community. For example, San Diego, California has become an important city for innovation in the United States. Leading minds are attracted to the University of California-San Diego campus, as well as the presence of renowned research institutions such as the Scripps Institution of Oceanography, the Scripps Research Institute, the Salk Institute, and the Sanford-Burnham Medical Research Institute. In addition, San Diego hosts companies, such as Qualcomm, the telecommunication technology supplier, which provide funding and support for developing innovation. At the opposite end, in cities such as Singapore and the Republic of Korea, government-sponsored research programmes provide the seed for the innovation of cities.¹ Between these opposites, in cities such as London in the United Kingdom and Kerala in India, a range of innovation cities are based on different models that include varying degrees of involvement from government and academic institutions.

Although innovative cities develop in different ways, every successful innovation city is characterized by strong participation and involvement of large enterprises that serve as champions for innovation. Sometimes these champions are private enterprises, as they are in Silicon Valley in the United States, where companies—including

Hewlett-Packard, Lockheed, and Xerox—helped catalyse growth at various points in the city's history. More recently, chaebols (conglomerates)—including Samsung, LG, and SK Energy—have played this role in innovation cities in the Republic of Korea. Sometimes these champions are state-owned enterprises (SOEs). For example, the state-owned oil giant Saudi Aramco acts as a champion in the Dhahran Techno-Valley (DTV), an emerging innovation hub in Dhahran, Saudi Arabia.²

Enterprise champions support innovation cities in important ways. They help build capabilities by providing capital, a pool of experienced technical talent, and business opportunities; they also provide interregional and international connections via their networks and value chains. They stimulate research and development (R&D) by facilitating knowledge creation and sharing. In addition, they help other stakeholders bridge the commercialization gap with their resources through collaboration or supplier relationships. All these support factors enable cities to become innovative and wealth generating.

Dhahran's Challenges

Dhahran is a major administrative center for the Saudi oil industry. Together with the nearby cities of Al Dammam and Al Khobar, Dhahran forms part of the Dammam Metropolitan Area, which is commonly known as greater Dammam and has a population of more than four million inhabitants. Large oil reserves were first identified in the Dhahran area in 1931 and in 1935 when Stan-

1 Samman et al, 2013. The Role of Enterprise Champions in Strengthening Innovation Hubs.

2 Ibid.

Standard Oil drilled the first commercially viable oil well. Standard Oil later established a subsidiary in Saudi Arabia called the Arabian American Oil Company (ARAMCO), now fully owned by the Saudi government and known as Saudi Aramco.

In one regard, Dhahran has a major advantage over other cities attempting to spur innovation—it has large cash reserves from its oil wealth, at a time of economic crisis around much of the world. Such resources have been used to support the transfer of not only physical but also human capital from other countries. Establishing satellite R&D in related strategic sectors around the world, with links to home-based R&D institutions and corporations, can help bridge that gap.

Additionally, acquisitions or joint ventures that allow for the establishment of R&D sites in Dhahran can help with the transfer of complex knowledge.³ Indeed, over the past four decades, two Dhahran-based giant companies, ARAMCO and SABIC, have cooperated with and acquired parts of MNCs and have attracted experts from around the world.

However, the city of Dhahran cannot simply import an innovation culture. Past experience with enterprise acquisitions shows little effect on any city's overall ability to innovate from within. This is because these cities lacked several requisite elements to support such knowledge transfer, such as a critical mass of local skills, widespread adoption of technology by public and private sectors, and the appropriate legal and cultural institutions.

The Dhahran Techno-Valley has helped overcome this by bringing together various stakeholders and facilities—universities, private sector institutions, MNCs, and the public sector, among others—in an effort to collaborate on research and leverage knowledge of the local markets. Yet, as with acquisitions, technology and research clusters have had mixed levels of success in creating a truly innovative culture, due to a fairly long list of challenges. Most notably, a critical lack of technical skills among the population means that foreigners largely staff such clusters.

At the corporate level, several executives at MNCs pointed to a persistently high cost of doing business in Dhahran, due to factors such as unwieldy immigration laws and visa restrictions. Copyright issues also present a major challenge to protecting intellectual property; the regulations that exist on paper are often not enforced in reality. With such perceived risk, few MNCs were willing to devote money and effort to R&D in Dhahran. Instead, much of their focus is on contract and service provisioning, which is not ideal for establishing knowledge-based economies in Dhahran.

In some cases, local bureaucracies got in the way of innovation efforts. The technology cluster is ultimately sponsored by the state, which creates challenges that manifest themselves in the budgeting process for city clusters and small-scale enterprises working on promising technology. Research budgets can be compromised due to the financial crisis or other factors. Some budgets

³ Complex Knowledge refers to knowledge that is embedded in a local context. To transfer this type of knowledge requires a level of 'seeing and doing' as it is very difficult to articulate. See *Innovation: Is Global the Way Forward?* A joint study by Booz Allen Hamilton and INSEAD, 2006.

for R&D institutions were cut and the lack of a vibrant private sector has led small companies to complain of insufficient funding sources.

Another crucial problem to address was the dearth of statistical data, which hampered efforts to understand market demands through research functions that are standard in other markets, such as financial feasibility studies for new products.

Finally, cultural attitudes often got in the way of innovation. Outsiders note a prevalent “why do we need this” sensibility, in which taking risks is not encouraged. Often people do not see the long-term value of research projects, particularly the kind of blue-sky research that sometimes leads to real breakthroughs. In addition, companies in technology clusters and parks point to the lack of accountability towards work.⁴ Given the high involvement of government and strict labor policies, it is often difficult to hold people accountable for their mistakes, to the frustration of MNCs trying to establish themselves in the city and region at large.

The Role of Saudi Aramco in Dhahran’s Innovation

Innovative cities often depend on some form of innovation hub to integrate scientific research with commercial application. These hubs serve as commercialization catalysts by transforming technological advances into marketable products and services. Accordingly, innovative cities must have the main innovation kernels of research, development, commercialization, and the production

and dissemination of new products and services. Enterprise champions such as Saudi Aramco support this value chain in three ways: by building hub capabilities, by supporting and developing hub R&D activities, and by enabling commercialization.

Building Dhahran’s Capabilities

Innovation development depends on the ability to generate and protect intellectual property (IP), and gain access to the capital and expertise needed to develop it commercially. Saudi Aramco has leveraged its financial resources and expansive networks to support these requirements by acting as service provider, investor, and customer. At the same time, it has attracted local and international companies such as Schlumberger, GE, Sipchem, Honeywell, Baker Hughes, and others, which co-located in Dhahran in order to do business with Saudi Aramco. In doing so, Saudi Aramco has been able to orchestrate the creation of a network of resources that can, for example, provide King Fahd University of Petroleum and Minerals (KFUPM) and its partners with access to top-notch commercial research.

Saudi Aramco has also created a sufficiently large talent pool—one on the scale needed to start and seed new businesses. Its established alliances and partnerships with local and global companies, as well as its acquisition of other companies, help secure the technologies and capabilities needed to strengthen the Dhahran innovation hub.

Finally, Saudi Aramco is helping to support and encourage the development of a strong IP protection system by filing its patents and licenses domestically and internationally, maintaining

⁴ Based on 2010 interviews conducted with several such parks in Dhahran and other GCC countries.

strong internal policies and processes for protecting their own IP and that of their partners, and advocating the enactment of comprehensive national IP policies.

Supporting and Developing Dhahran's R&D Activities

Once the major structural elements are in place, a self-sustaining R&D ecosystem is needed. To be successful, an R&D system requires capabilities that enable stakeholders to capture customer needs, conceive breakthrough ideas, and feed high-value concepts into the prototype development pipeline. This requires talent development within the hub, especially with regard to the staff and students of academic partners. Often this development is fueled by increased industry collaboration and financial support. Universities generate IP that is marketed to external users by university-owned companies, and local businesses produce products and services based on local IP. This requires finding specific beneficiaries with different objectives, including basic research, industry-driven commercial research, and technology development and commercialization.

Saudi Aramco is playing an essential and critical role in achieving R&D goals in at least three distinct ways. First, Saudi Aramco is leveraging intellectual capital by encouraging knowledge sharing (through its collaboration with KFUPM researchers) and cross-pollination of ideas (for example, by organizing innovation forums). Second, through established R&D satellites across its international networks (e.g., in Houston, Texas, and other locations), Saudi Aramco is facilitating the transfer of complex knowledge and promoting Dhahran as a hot spot for innovation. Third, by utilizing its local and international links, Saudi Aramco is helping steer DTV in directions that better meet regional and international needs and, thus, help contribute to DTV's development and Dhahran's economic growth.

Enabling Commercialization

One of the challenges that DTV faced as a nascent hub was its ability to close the gap between R&D and commercialization. This was a result of several reasons including difficulties in attracting partners and investments in projects with high technical risk and long developmental time frames, the risk of losing grant funding as project scope expands beyond academic research, the lack of critical end market insight or access, and the lack of entrepreneurial culture within the research community. Saudi Aramco has helped bridge the commercialization gap, and reaped benefits in several ways:

- Through training and consulting, Saudi Aramco has helped its domestic suppliers enhance their capabilities—such as manufacturing quality and efficiency—that they need to successfully commercialize innovations. In turn, these enhanced capabilities helped Saudi Aramco improve the quality of its products and reduce waste. In addition, Saudi Aramco created opportunities for entrepreneurs to sell their products and services.
- Enterprise champions often employ highly talented people, but they do not always provide them with incentives to innovate. Saudi Aramco addressed this need by providing employees with opportunities to share their ideas with senior management and rewarding them when ideas are successfully implemented.
- Finally, Saudi Aramco is educating downstream companies about new domestic and international markets, and has acquired companies that can provide innovation capabilities with innovation ripple effect throughout the hub value chain.

Dhahran Innovation Push

Recent economic figures for the Eastern region⁵ show that it accounts for 60 percent of Saudi Arabia's GDP, emphasizing the importance of the Eastern Region and Dhahran to the Saudi economic landscape. Indeed, in a study by the SAGIA, modeled after the World Economic Forum's Global Competitiveness Report, the Eastern Region's score for "Capacity to Innovate," along with other important sub-factors, is higher than the country's average [Figure 1].⁶

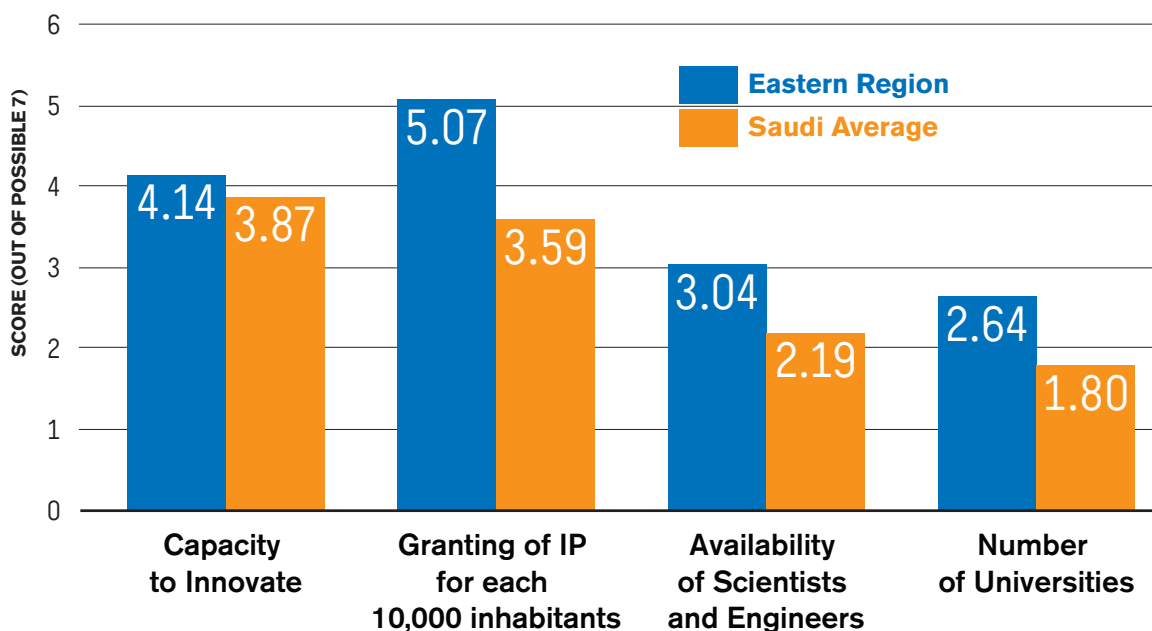
Other indicators of the innovation push in Dhahran include the progress KFUPM has achieved over the last decade in patent issuance. Over the period 2008 to 2015, the number of issued patents produced by KFUPM skyrocketed from three in 2008 to 126 in 2015—a 42-fold increase.

This has positioned KFUPM 13th worldwide in terms of the number of patents issued [Figure 2]. With the field of patenting activities connected to Saudi Aramco and other DTV stakeholders, the innovation linkage is established between KFUPM and DTV tenants. This explains, for example, why KFUPM patents are cited in patents of the world's top industrial organizations such as GE, Baker Hughes, Inc., and Schlumberger Technology Corporation [Figure 3], which contributes to the growth of the Dhahran innovation ecosystem.

Supportive Government Policies

The city of Dhahran and its path towards innovation is providing Saudi Arabia with useful lessons for expanding its model across the Kingdom, primarily by aligning national policies with the

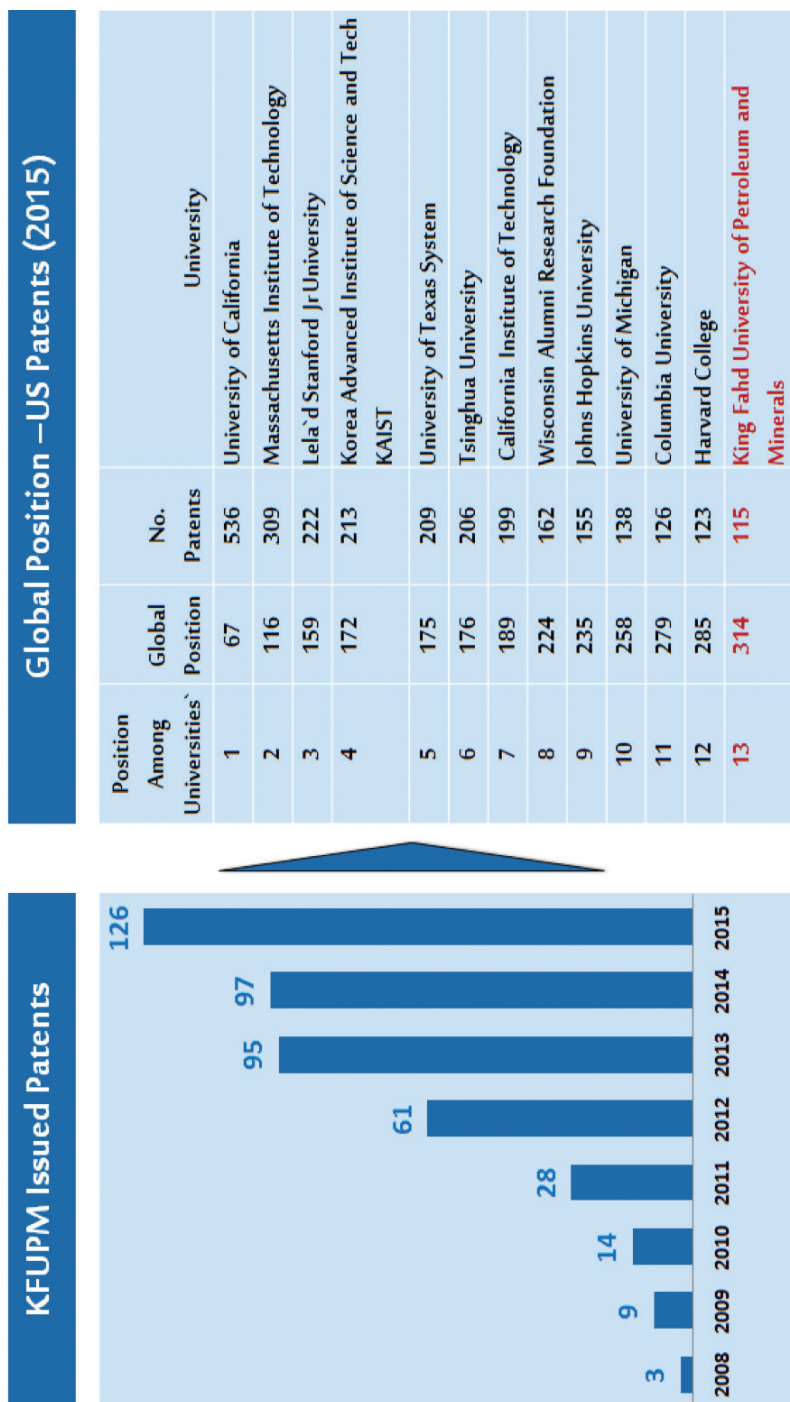
Figure 1: Capacity to Innovate



⁵ The Eastern region is the largest region in terms of area, which amounts to about 779,000 square kilometers, equaling 36 percent of the total areas of the Kingdom. The region is divided administratively into the principality of the eastern region and eleven governorates: Dammam, Al Khobar, Al-Ihssa, Jubail, Hafr al-Batin, Qatif, Al Khafji, Ras Tannura, Baqeeq, Al Nuairiya and Olaya Village.

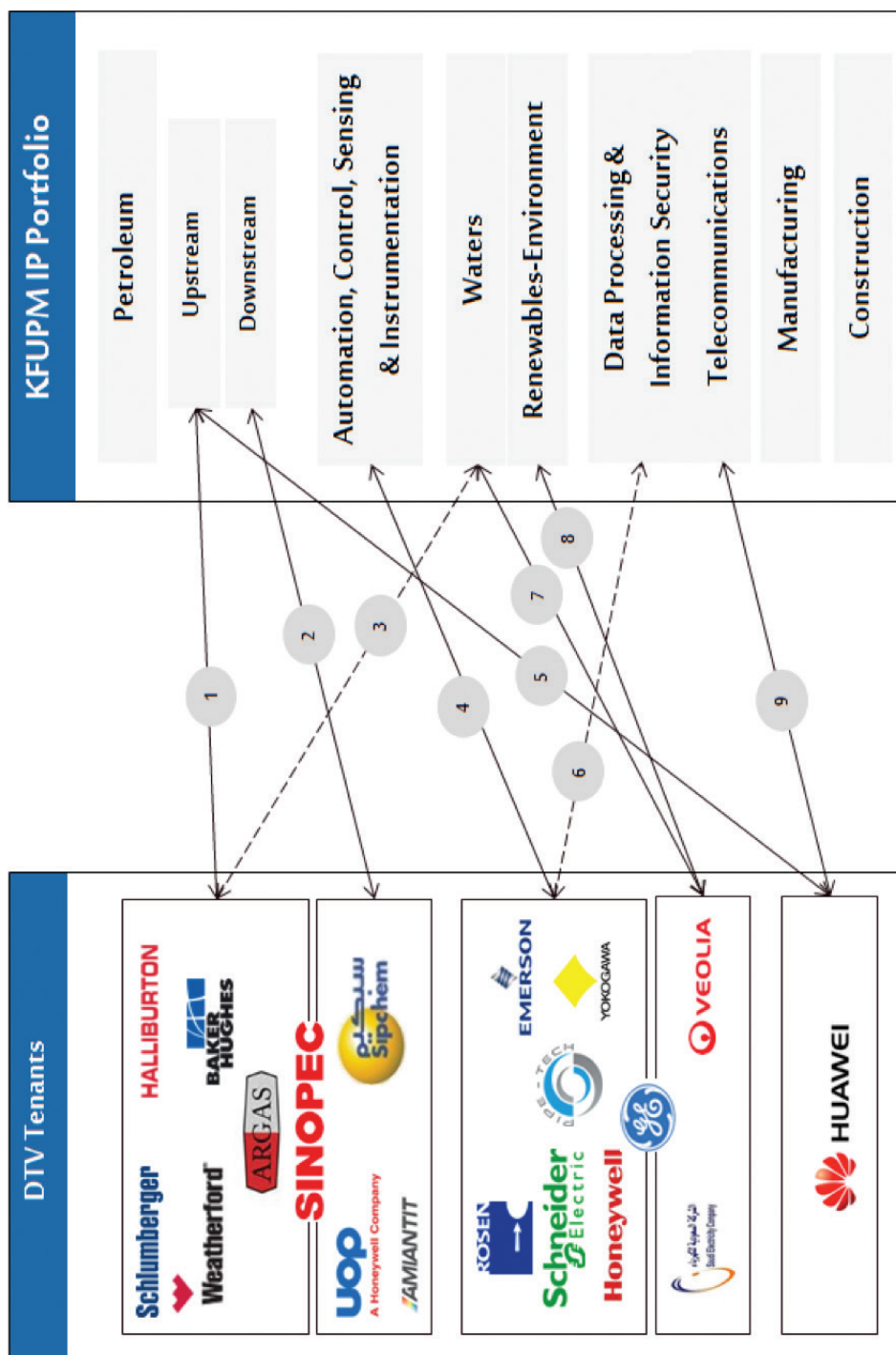
⁶ Source: SAGIA, Business Environment Indicator: Eastern Region (2010) in Arabic. Note: The score is out of a possible 7. The methodology for computing the scores is similar to that of the World Economic Forum's 2010 report.

Figure 2: KFUPM Issued Patents and World Ranking



Source: IFI CLAIMS® Top 1000 US Assignees for 2015

Figure 3: University-Industry Linkages



requirements for innovation cities to replicate the conditions necessary for the growth of innovation cities across Saudi Arabia.

Today, policies that the Saudi government is enacting to advance the Dhahran experience are reflected in the Vision2030 and the transformation programs. One example is the Competitive Acceleration Program, a cooperative strategy between SAGIA and relevant public and private-sector agencies, in which stakeholders committed to reaching set targets of competitive indicators to increase the ease of doing business and enhance Saudi Arabia's competitiveness. The program culminated in enacting policies for promoting a more efficient market and business environment for both local businesses and foreign investors. Indeed, this is now showing impressive results.

For example, the Dow Chemical Company recently became the first company to receive a trading license from the government of Saudi Arabia, allowing 100 percent ownership in the country's trading sector, and expanding Dow's long history of partnership and investment in the Kingdom. The trading license advances Dow's ability to deliver high-value, innovative products that will benefit Saudi Arabia in the areas of sustainable development, energy efficiency, oil and gas, alternative energy, and water. Other examples include 3M (an American materials manufacturer) and Huawei (a Chinese telecommunications company).

Despite this, Dhahran's innovation system, like other cities in Saudi Arabia, would benefit from improvements made to government policies and regulations that would encourage key activities. For instance, revising policies to encourage talent recruitment in Saudi Arabia can help attract and retain specialized skills. Further improving regulations that restrict the import/export of specialized research laboratory equipment and material will also reduce delays, and allow universities and companies to conduct the required R&D activities. Finally, new financing models that allow small and medium-sized enterprises to pursue product engineering and development will enable the manufacturing of promising new technologies created within the techno-valleys across the Kingdom.

About the Author

Dr. Hatem Samman is Chief Economist and Economic Advisor at the Saudi Arabian General Investment Authority. Previously, he was Director and Lead Economist of the Ideation Center—Booz & Company's (now Strategy &) Middle East Think Tank, held the position of Vice President at a major Saudi Bank and was Director of Regulatory Affairs and Strategic Planning at a major regional telecommunications company. He was Senior Fellow at the University of Minnesota and Consultant at the World Bank, among other positions. Dr Samman holds a Bachelor's degree in Social Sciences from the University of California, San Diego and a PhD in Political Economy & Public Policy from the University of Southern California.

UNITED STATES

Sustainable Use of Water in Manufacturing in Milwaukee, Wisconsin

The Challenge

Water is integral to manufacturing operations. To gain a competitive advantage, companies must strategically manage water across their supply chains, innovate to improve efficiency, and ensure a robust talent pipeline and investment pool exists.

Renewal and replacement of aging water infrastructure is a top issue facing manufacturers and residential communities in the United States. The average age of water pipes in America is 47 years and, as a consequence, 1.7 trillion gallons of water are lost annually due to leaking pipes. Breakdown in supply, inadequate treatment, and loss of water and sewer capacity seriously disrupts industrial operations. Addressing U.S. water and sewer infrastructure needs could easily top \$2 trillion over the next 25 years.

Forty-six percent of water consumed in the United States is used in manufacturing processes. The need for an ample water supply, and efficient use and reuse of water for these processes creates significant demand for further development in water technology and water policy. As the call to reduce energy and water use in manufacturing grows, opportunities arise to develop and deploy new technologies at the nexus of water and energy.

The Solution: Expert Dialogue on Water and Manufacturing

In February 2016, as part of its Energy and Manufacturing Competitiveness Partnership, the U.S. Council on Competitiveness, along with partners Marquette University and A. O. Smith Corporation,



Compete.

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Competitiveness**

gathered more than 50 experts on water and manufacturing to identify and discuss common challenges and opportunities related to water, energy and manufacturing in the United States using the Milwaukee, Wisconsin region as a case study.

Participants in the dialogue spanned various private sector companies including IBM, Kohler, Rexnord, MillerCoors and Rockwell Automation; representatives from universities such as Michigan State University, Arizona State University and University of Wisconsin-Madison; national laboratory participants from Argonne National Laboratory, the National Renewable Energy Laboratory and Lawrence Livermore National Laboratory; and representatives from government and NGOs.

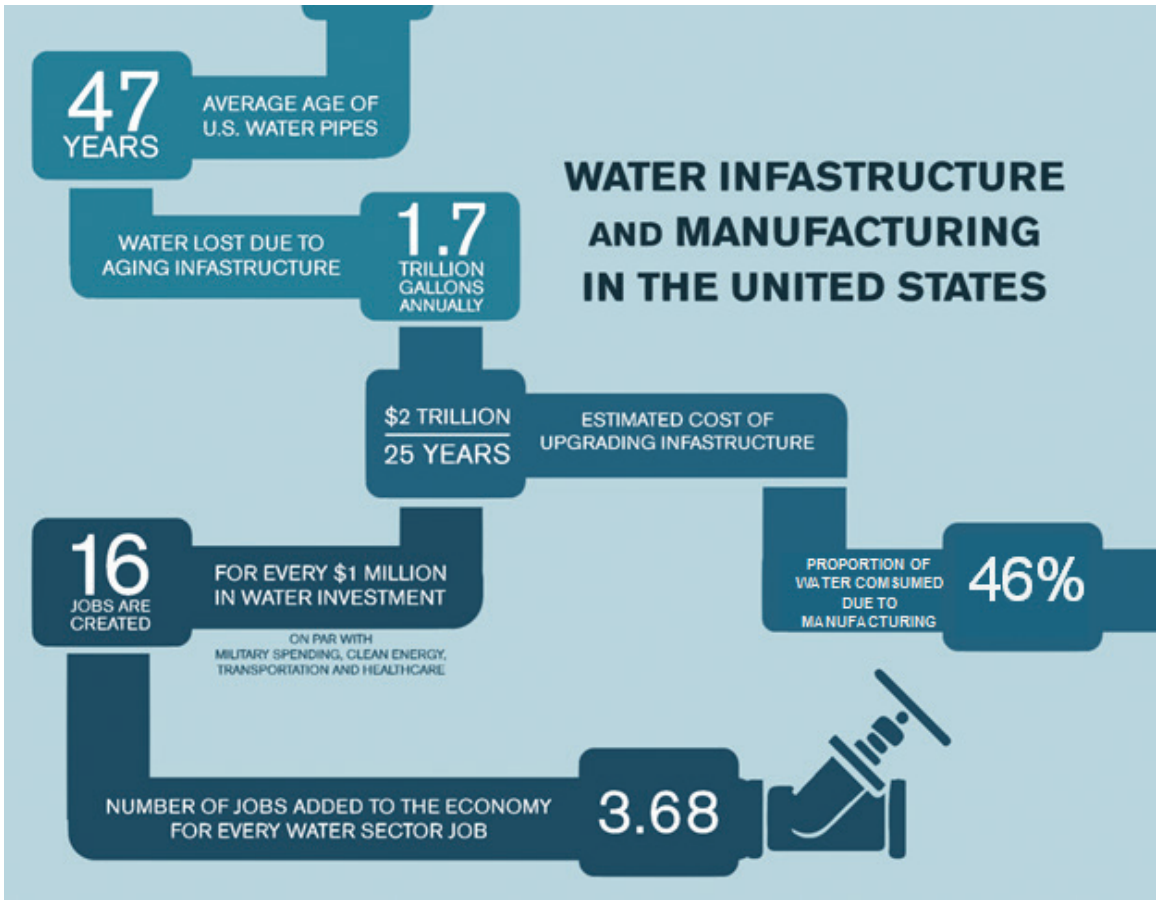
With 86 percent of the state of Wisconsin bordered by water, issues at the intersection of water and manufacturing are a priority. The state has more than 100 years of industrial experience, and Milwaukee's economy was founded on manufacturing industries that were highly dependent on

the abundance of fresh water, exemplifying and emphasizing the importance of access to and efficient use of water to manufacturers.

The City of Milwaukee has already taken numerous steps to improve its water stewardship. Among these efforts is the production of Milorganite, an organic nitrogen fertilizer created from solid waste collected from sewage treatment plants. Biogas—a gaseous fuel, such as methane, produced by the fermentation of organic matter—is also collected for future uses such as thermal energy. In addition, Milwaukee is integrating natural systems with the built environment in projects such as green roof installations, rain barrels and the Menomonee River Concrete Removal, which will allow game fish to travel an additional 17 miles north to Menomonee Falls River, creating a more natural ecosystem below the surface of the river.

Despite existing efforts, the dialogue participants identified other challenges around water use and re-use in manufacturing, water use-related risks, and opportunities for developing more efficient and productive use of water in the manufacturing sector. Specific recommendations included:

- Use a stewardship approach to water management in which laws and regulations surrounding water re-use support natural processes whenever possible and treat water as the limited resource it is rather than a limitless commodity.
- Integrate natural infrastructure, including green roof installations, rain barrels and constructed wetlands into water management approaches to improve energy efficiency and water quality, while reducing overall water infrastructure investment costs.
- Encourage development and deployment of technologies and microbiological barriers that increase overall water supply by diversifying sources, and improving quality and efficiency, such as desalinization, nutrient recovery and wastewater re-use.
- Promote the uptake of sensors and monitoring equipment, and the aggregation of big data across sectors and geographies to improve water management and increase information available on water quality and efficiency.
- Increase federal funding available for water technology test beds to accelerate development, and reduce cost and risk associated with deployment of advanced technologies for improving water quality and efficiency.
- Model water consumption and availability using high performance computing to address gaps in supply and demand, and reduce overall costs associated with managing water and energy systems.
- Engage government and private sector stakeholders in an enhanced public awareness campaign to address water conservation needs.
- Address the skills gap in the water and manufacturing sector by de-stigmatizing technical careers, reintroducing hands-on training in K-12, and encouraging cross-sector partnerships between industry and academia.



Dialogue participants made commitments related to the solutions proposed in order to demonstrate their validity and promote actionable steps. These commitments included:

- The Water Council, a Milwaukee-based non-profit that aligns the regional freshwater research community with water-related industries, launched a water innovation scouting program called PROOF, which is expected to connect emerging technologies from government laboratories, universities, entrepreneurs, etc. to commercialization across industry sectors.
- A. O. Smith Corporation, one of the world's leading manufacturers of residential and commercial water heaters and boilers is leading four specific projects. 1) A collaboration with The Water Council to sponsor the Business Research Entrepreneurship in Wisconsin (BREW) will promote start-up businesses in freshwater technology. A. O. Smith is also excited about becoming one of the Founding Members of a groundbreaking initiative by The Water Council to bridge the gap between research and industry. The ICE Institute will accelerate Innovation, Commercialization and Exchange (ICE). 2) A. O. Smith leverages the data and capabilities of their newest company, Aquasana, to identify regional water issues and develop approaches to address those issues. 3) A partnership with the Plumbing Heating-Cooling Contractors Educational Foundation supports an initiative for training outreach and recruitment of incoming talent, specifically in the plumbing field. 4) Along with other companies, A. O. Smith will provide support in a global outreach program that works to identify and broaden efforts to develop sensor technologies that can be employed to monitor fresh and wastewater usage.
- Marquette University, one of the nation's leading private universities, is collaborating with industry to develop cross-functional sensors that can be used in water monitoring equipment. Technologies under development include solid state and acoustic wave sensors, micro-electro-mechanical systems (MEMS) devices and sensors, optical waveguide-based sensors and smart sensor systems for water monitoring applications. Faculty from the Department of Mathematics, Statistics and Computer Sciences are involved in collaborative efforts at the Global Water Center to foster academic-industry partnerships on use of big data in the water sector.
- The Kohler Company is a leader in kitchen and bath plumbing fixtures, furniture and tile, engines and generators, and golf and resort. In the last 10 years, Kohler has helped U.S. consumers reduce water use by 110 billion gallons, saving \$1.3 billion in water, sewer and energy costs, which has extended water supplies in drought-affected areas. Kohler is committed to helping reduce another 100 billion gallons of water use in the next three years.

- MillerCoors, the second largest beer company in America, is implementing the Alliance for Water Stewardship (AWS) Global Standard at its Milwaukee brewery in collaboration with the North American Office of the AWS at the Global Water Center. The effort complements the brewery's successful work increasing the efficiency of water usage, and projects that enhance lake water quality and promote the enjoyment of Lake Michigan. Examples include: supporting Milwaukee County's effort to clean up Bradford and South Shore beaches, providing the Milwaukee Metropolitan Sewerage District with rain barrels, supporting the Milwaukee RiverKeepers' efforts, and showcasing green infrastructure (green roof and rain garden) to thousands of people who tour the brewery each year.

The U.S. Council on Competitiveness is a nonpartisan leadership group of CEOs, university presidents, labor leaders and national laboratory directors working to ensure U.S. prosperity.

The report on this water and manufacturing sector study dialogue—Leverage: Phase I Sector Study: Water & Manufacturing—can be reviewed at <http://www.compete.org/reports/all/3231>

GFCC

Foundational Global Competitiveness Principles

The GFCC developed a set of foundational *Global Competitiveness Principles*, supported by its network of more than 30 national competitiveness organizations and deemed essential for every country. First released in 2010 and finalized in 2012, these principles offer an overarching framework for national policies and programs aimed at fostering innovation, competitiveness and prosperity in the 21st century global economy.

They emphasize key drivers of competitiveness, such as investment in research and development, education and training for all citizens, sustainable and responsible development of natural resources, strong intellectual property rights, open trade and a stable, transparent, efficient and fair environment for business investment, formation and growth.

Pioneered by the GFCC, the *Global Competitiveness Principles* represent ideals that can serve as a beacon for economic progress around the world. They have been recognized as a best practice by other nations, adopted, emulated, promoted and/or referenced by organizations such as the Organization of American States and the World Economic Forum.

Each year, the GFCC revisits its foundational *Global Competitiveness Principles* and issues a new statement of *Competitiveness Principles* that emphasizes the topic highlighted by our organization in that year. In 2016, the GFCC is focusing on cities and sustainability, and we invite you to check and propagate the GFCC principles to support *Inclusiveness, Innovation, Sustainability and Resilience in the City Landscape*.

The Foundational Global Competitiveness Principles

- **Ensure Fiscally Responsible, Transparent and Ethical Governance.** National fiscal stability, discipline and certainty foster private sector and foreign direct investment, economic expansion, new business formation and job creation. Transparent regulations and tax rules enable market efficiency and reduce the cost of doing business. Government corruption reduces the productivity and performance improvements that come from fair and open competition.
- **Fulfill Human Potential.** All nations should educate and train their citizens without regard for gender, race, religion, age, ethnicity or economic status. Worker safety and international labor standards also are important underpinnings for individual and national success.
- **Invest in Research Technology and Innovation.** As the driving force of innovation, nations should increase investment in research and development, coupled with the domestic deployment of new technologies, to stimulate increased productivity, standards of living and leadership in global markets.
- **Ignite Entrepreneurship.** Supporting entrepreneurs—who are the source of new ideas, new products and services, new companies and new industries—is essential to economic vitality and improving productivity, competitiveness and economic performance.

- **Improve Infrastructure.** Investment in a modern, well-maintained resilient infrastructure—transportation, energy, digital networks and telecommunications—is critical to encourage domestic and foreign investment, support modern commerce and grow an economy.

Cybersecurity is essential to the performance and safety of all economic activity, consumer access to the marketplace and personal privacy protection.
- **Establish Public-Private Partnerships.** Collaboration between the public and private sectors is essential to drive innovation, economic growth and job creation. Private sector leadership is vital in developing national policy initiatives to address short- and long-term competitiveness challenges and opportunities.
- **Foster Regional and Metropolitan Centers of Innovation.** Regional clusters and metropolitan areas connect talent with science, technology, manufacturing and service resources, fostering the creativity, idea generation and innovation that drive competitiveness.
- **Encourage Sustainable Growth.** Sustainable growth and responsible development through increased natural resource productivity, energy efficiency, and access to or development of critical materials will foster innovation, increase standards of living, help ensure food security and access to clean water, improve health and enhance national security.
- **Protect Intellectual Property.** Strong intellectual property rights are a prerequisite to attract high-value investment and innovation in new technology, new product development and creative works such as software and entertainment.
- **Expand Access to Global Market Opportunities.** Open and transparent markets expand global trade and investment, and drive economic growth around the world. Protectionist policies hinder innovation, growth and business performance. Well-defined international standards are essential to facilitate global commerce.

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