Analysis of BIoT-based energy business in city of Montreal

Lessons learned from broader market

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1. ABSTRACT

The Internet of Things (IoT) is considered one of the fastest-growing topics attracting the attention of the technological world. Building Internet of Things (BIoT) focusses on the IP-marked components of a building, connected to the network (internet), generating and collecting data, or executing orders autonomously and sim-autonomously. BIoT encompasses various classes of applications including energy, water, building automation, security and fire protection. The success of BIoT solutions, however, relies highly on the business outcomes expected from implementing them. The present study focuses on building energy solutions (and the associated building automation applications). In an attempt to formulate a high-level and generic business model, this paper uses Osterwalder business canvas as a framework, and compiles extensive number of case studies in the city of Montréal, Qc. Experts opinions are sought through survey questionnaires to enhance, validate, and verify the model, and provide an overview of the BIoT market in Montreal. Our model provides an opportunity to explore other classes of BIoT and move towards formulating generic business model canvas for IoT in building sector.

2. INTRODUCTION

IoT is one of the emerging technologies, expanding in many areas including smart cities, intelligent transportation systems and smart building solutions. One of the reasons IoT solutions have become viable is the recent developments in fields such as cost-effective wireless sensors, communication technologies and internet protocols. IoT solutions are not limited to smart mechanical appliances like thermostats, lighting and wireless sensors; they are moving towards applications which connect the physical objects (the things) together to support intelligent decision making (of different types) in the built environment.

Our IOT world is growing at a breath-taking pace, from 2 billion objects in 2006 to a projected 200 billion by 2020. That will be around 26 smart objects for every human being on Earth. "With connected items, the enterprise must do more than provide an innovative product. In addition to the amazing physical product, IOT service, or solution offered, the marketing team must also engineer an excellent connected experience that is also meaningful or purposeful. Successful IOT products and services will clearly outline distinctive features, value to customers and business, and the means of integrating into the larger ecosystem" [16]. It is one of the emerging fields and is expanding in many areas like smart cities, intelligent transportation system and smart building solutions. One of the reasons IoT solutions became viable is because of the latest developments in fields like cost-effective wireless smart sensors, communication technologies & internet protocols. IoT solutions does not limit themselves with smart mechanical appliances like thermostats, lighting and wireless sensors, However, they are moving towards applications connecting to "physical objects together in support of Intelligent decision making" [5].

BIoT takes the concept of IoT solutions and applies it to buildings, aiming to make them more efficient and offering the occupants higher levels of comfort, convenience and a healthy environment in their surroundings." $349 billion of total Value at Stake on Smart buildings" [4] comprise of an intelligent and converged IP network of electronic devices that monitor and control facilities services, including mechanical, electronics, HVAC, and lighting systems in a building to achieve greater

energy efficiencies. Due to the ever-growing stake of investments in BIoT industry, and the high rate of associated entrepreneurships (in Canada and elsewhere), there is a need for developing new and efficient business models. There is a possibility that BIoT-based solutions can upgrade the traditional building industry business models (of physical asset, i.e. buildings and the services supply) and accommodate the advent of the additional layer of data and digitalization introduced by the IoT. Our study focusses on BIoT solutions for energy and building automation applications, and we have scoped the Montreal market (one of the smart city cores of Canada).

In an attempt to study business models in BIoT for Montreal market, we started with understanding the market trends on global, national and regional levels, which will help us in determining the progressive growth of demand in our region, compared to other regions and provinces, as well as at national level. We then studied different classes of BIoT solutions offered in the market of Montreal, with proper understanding of issues and threats associated with them. In order to structure our study, we used the well-known/traditional business model canvas as a framework, aiming to test the limitations and potentials of such models in the high-tech BIoT business, as a side product of the study. To this aim, we validated the canvas through studying different case studies, as well as taking experts' opinions, to provide value to the vendors involved (or planning to be involved) in energy-based BIoT solutions.

3.   LITERATURE REVIEW

3.1 MARKET VIABILITY

The revenue opportunities available for products and services in smart building market are estimated to grow convincingly at a compound annual growth rate of 34% globally; however, Canada is still at the emerging phase of BIoT solutions market. While the studies suggest that majority of Canadians are interested in smart home technologies and the addressable market will hold at $6.5 Billion dollar by the end of 2018; currently "only 12% of Canadians actually own smart home device [10]. The latest advances in the field of wireless sensors, when connected to the internet, help to formulate new models for home energy management. This has been recently leading the emergence of BIoT solutions market in Montreal (as a city with cold climate). Montreal is also emerging in the field of smart thermostats, home automation and smart water metering system, with the strong presence of different Montreal-based companies which provide solutions for energy and water efficient systems. The companies have provided solutions to condos, townhouses and penthouses; however commercial buildings, residential buildings, university, school, government and public infrastructure facilities can be a potential market in the city of Montreal.

In smart building sector, Energy, Economic and environmental condition is one of the main issues which not only affect the assets and resources pertaining to construction, operational and mainataince of the building but also increase the overall cost of the building throughout its life cycle for instance in the area of energy optimization: sensors deployed across the electricity grid can help utilities remotely monitor energy usage and adjust generation and distribution flows to account for peak times and downtimes.

Offices and commercial spaces are undergoing a smart transformation connecting and linking HVAC, lighting, environmental sensors, and security and safety equipment, along with external inputs such as the smart grid and weather. User-driven and automated business processes can now leverage real-time IOT information from people, systems and devices to maximize resource efficiency, reduce cost and risk, and increase visibility across all operations.

The IoT Platform can help you:

Easily collect and manage data from people, sensors, connected equipment and existing enterprise systems and external system information.

•Quickly build and bring to market new innovative IoT applications at 10 times the speed of other approaches with our rapid application development environment and drag and drop mash up builder.

•Utilize big data and analytics to provide new insights and recommendations to drive better decisions.

•Provide facility managers and real estate executives role based access to easily visualize data, receive alert notifications and take action on insights and recommendations across all relevant building operations.

3.2 MARKET SIZE- IoT BASED SOLUTIONS

Total market size is observed in 3 levels which are:

A.   Total Available Market (TAM)
B.   Serviceable Available Market (SAM)
C.   Serviceable obtainable Market (SOM)

A.   Total Available Market (TAM):

TAM is the total market demand for a product or service whereas SAM is the segment or subset of TAM targeted by products or services which is within the geographic reach. SOM is a portion of SAM that you can capture and attain desired solutions pertaining to the result which needs to be obtained.

The advent of Internet of Things (IoT) is also affecting the way green and smart buildings are getting connected with various stakeholders throughout the world. IoT for buildings can be imagined as a network for buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data. In 2016 and beyond, building owners and key decision makers will invest in an array of smart building solutions that embody the technology foundation of Internet of Things (IoT) and cloud computing to validate the growth of the industry.

Smart buildings: $349 billion of total Value at Stake Smart buildings comprise an intelligent and converged IP network of electronic devices that monitor and control

facilities services, including mechanical, electronics, HVAC, and lighting systems in a building, to achieve greater energy efficiencies and cost savings, along with an improved experience for occupants. IoE allows buildings to create value by bringing together operations that are currently into a single IP-based platform. IoE reduces waste (energy) by greatly increasing the efficiency of building management (HVAC, lighting, safety). Smart buildings also make more efficient use of available space by maximizing occupancy. For example," Cisco estimates that IoE can reduce space requirements for the same number of employees by 40 percent" [4].

"It is being estimated that $19 trillion will be invested in IOT application as it has been found that buildings currently account for 49 per cent of total energy consumption, which is more than transportation and industry combined and 50 per cent of the energy used in buildings is wasted with lights being on without anyone in those room" [10].

$14.4 and $4.4 trillion dollar will be invested in private and public sector respectively where as $ 3.9 trillion dollar will be invested only in manufacturing sector where as total share of Canada would be $ 660 billion.

"Investment in smart buildings solutions is expected to grow at 27 per cent to $18 billion, according to IDC. The world building stock growth is 23 per cent from 2013 to 2021 to 2 trillion scale feet". [10]

The factors that fuel the IOT sector on global level

- Asset utilization (reduced costs) of $2.5 trillion.
- Employee productivity (greater labour efficiencies) of $2.5 trillion.
- Supply chain and logistics (eliminating waste) of $2.7 trillion.
- Customer experience (addition of more customers) of $3.7 trillion.
- Innovation (reducing time to market) of $3.0 trillion.

B.   SERVICEABLE AVAILBALE MARKET

Countless reports and studies project connected devices will be the next multi-billion-dollar market. This technology hasn't made a very big splash in Canada yet, though. Only "12 per cent of us actually own a smart-home device [10], despite more

than a third of Canadians being interested in the technology, according to an Ipsos poll. Cost is listed as the primary barrier to more widespread adoption". [22]

Of course, most people in Canada don't own homes worth nearly that much, if they own homes at all. According to Statistics Canada's 2011 National Household Survey, one-eighth of Canadians actually live in condos, and a quarter of those condo dwellers living in Canada's 10 biggest cities were renters. Home automation isn't just for million-dollar mansions, though.

Canadians earning an average salary — whether they're owners or tenants — can affordably introduce elements of automation to their homes. In Tagliani's case, his high-end audiovisual equipment and custom blinds were the priciest parts of his home's automation. People of lesser means (and with smaller homes) can opt for cheaper solutions. "IDC estimates the Canadian IoT addressable market will be worth more than $6.5 billion by 2018". [23]

Growth on connection of IOT with smart buildings in Canada

- 4.8 million Homes and commercial facilities in Ontario have been outfitted with smart meters in Ontario.

- 60% of Ontario homes and small business are green button standard enabled.

- 84% of Ontarian's have internet connectivity as do 83% of Canadians.

- Globally Canada rank 8 in terms of connectivity.

- IOT application reduce energy cost and lowers almost 30% of the operating cost on average by $25,000 per year for each $50,000 square feet of office space.

- In Canada, 42% increase in home power bills by 2018 with increase reaching 68% by 2032.
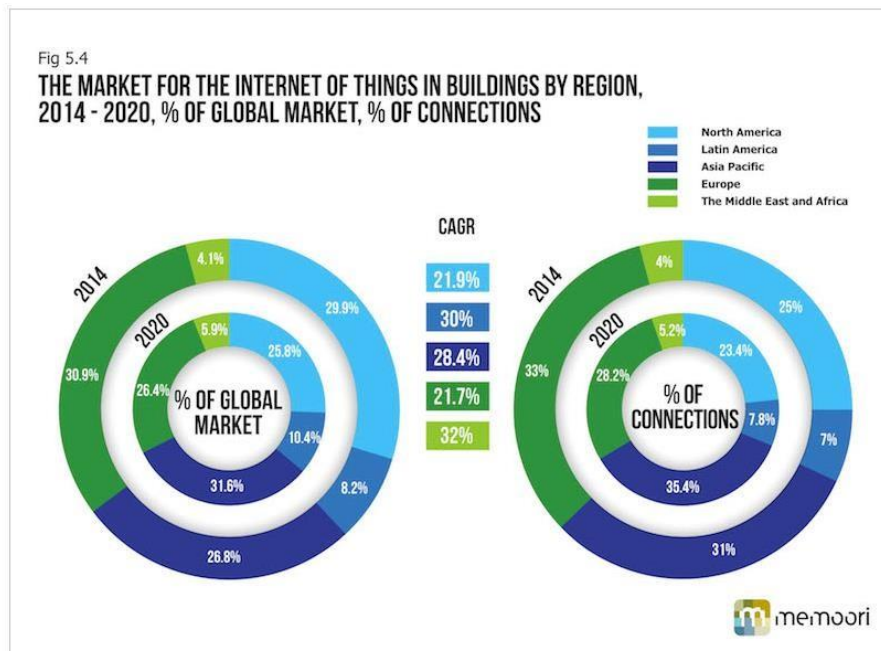
C.   SERVICABLE OBTAINABLE MARKET (SOM)

Montreal currently does not have much advancement in IOT application for smart buildings as compared to Ontario. However it is strongly emerging in this particular field. Montreal is emerging in the field of wireless sensor which helps in formulating the model for energy saving techniques which when connected with Internet would lead to strong emergence of Montreal market in IOT.

At the Microtechnology and Microsystems Laboratory of UQAM, Professor Frédéric Nabki has fostered a particular interest in manufacturing MEMS and integrated circuits. More specifically, he is involved in some 15 patent applications in the area of sensors and wireless communications. In collaboration with Professor Dominic Deslandes (UQAM), Prof. Nabki has developed a wireless transmitter-receiver that uses the least amount of energy possible to provide information for sensor applications dedicated to the Internet of Things. Sensors equipped with this technology can transmit their data for several years using miniature batteries. This innovation will benefit several industries, notably those in smart building, wearable technology, smart transportation or smart cities (e.g., smart lampposts).

Not only in wireless sensor, Montreal is also emerging in the fields of smart thermostats, home automation to reduce energy and water management solutions. Our underlying market figures indicate that the overall market for systems in buildings will grow from $110.9Bn in 2014 to $181.1Bn in 2020, with Physical Security, Lighting Control and Fire Detection & Safety representing the 3 largest segments. To calculate the technical market potential for the BIoT we have assessed the additional cost requirement of adding connectivity through sensors to existing or newly installed building systems, as well as projecting the growth in related network hardware and IoT data services that the BIoT would enable to generate. We therefore project that "the global market for the Internet of Things in Buildings (BIoT) will rise from $22.93Bn in 2014 to over $85Bn in 2020" [12].

According to research by ON World, wireless sensor network technologies, a newer staple in smart building technologies, will enable "50 million smart homes and buildings worldwide by 2018" [23]. Smart thermostats are one of the fastest growing smart energy markets, currently used by"15% of the broadband and smartphone/tablet users surveyed by ON World, up from 9% in 2010. Annual shipments of wireless sensor network devices are expected to increase by more than 600% within the next five years, with the top three markets in energy management, smart lighting, and safety/security" [19]. This echoes the report from IDC Energy Insights, which also forecasts an uptick in areas including lighting, plug load, equipment maintenance, plumbing, and security, significantly expanding the smart building technology market.

Fig 5.4
THE MARKET FOR THE INTERNET OF THINGS IN BUILDINGS BY REGION, 2014 - 2020, % OF GLOBAL MARKET, % OF CONNECTIONS

http://www.memoori.com/portfolio/internet-things-smart-buildings-2014-2020/

3.3 CUSTOMER DISCOVERY & VALIDATION

Until recently, the lack of a cost-effective solution has kept ODMs, OEMs, and systems integrators from being able to deliver affordable smart building management systems (BMS) to market. A lower cost alternative is to instrument a building using Internet of Things (IoT) technologies, including low-cost sensors, on-premises gateways, distributed control, and cloud analytics. BMS on a piecemeal basis to automate individual tasks such as elevator or lighting control, owners then must collect and aggregate data from various places. Partially integrated BMS Realizes the limitations of individual BMS, combining automation of a few activities with a common focus, such as energy management systems. Compared with individual BMS, these systems are more integrated, require less manual intervention, and enable faster decision making. Fully integrated, IoT-enabled BMS: In sharp contrast, IoT-enabled systems can be fully integrated BMS, allowing higher-order cost, productivity, and revenue benefits with a deep customer and data focus. It can leverage one infrastructure to operate all building management solutions and require minimal to no manual involvement. Internet protocol or IP-enabled devices can facilitate intelligent

decision making by automating point decisions and enhancing strategic insights; this allows data to automatically flow all the way around the Information Value Loop without manual interaction, enabling quick action on the data and creating new value for companies. BMS monitors and controls various building systems, such as heating, ventilation, air conditioning (HVAC), and lighting with additional and often separate systems to control elevators, fire, safety, security, and access controls. The BMS supports a user interface (UI) that allows operators to program and maintain set-points, generate alerts on abnormal conditions, and execute scripts similar to a programmable logic controller (PLC).Intel and other providers of IoT technology are helping solution providers design building management systems at a fraction of the cost, which is expected to significantly expand the market. Intel is working with industry leaders to enable complete, secure solutions at lower cost than what is currently available. Connected buildings can drive meticulous tracking of information on sustainability initiatives related to energy, water, and waste management and boost efforts to reduce the impact of climate change. Further, "sustainability analytics can help companies decrease their carbon footprint, have more sustainable properties in their portfolio, and eventually differentiate themselves in the marketplace" [3]. "The U.S. Environmental Protection Agency estimates a 10 to 30 percent increase in building energy efficiency could be achieved with low-cost energy efficiency measures and operational adjustments" [1].

Smart building technology investments typically pay for themselves within one or two years by delivering energy savings and maintenance efficiencies. IoT system architecture can be worked

With internet enabled and non-internet enabled devices. Internet-enabled devices, like the electric use sensor directly connect to energy web services, whereas non-Internet-enabled devices send data to the cloud via a gateway. Once the data is in the cloud, there is a wide assortment of tools and products available to process, visualize, and act upon the information.

In buildings that do not have centralized automation systems, the availability of affordable wireless sensors combined with this new smart building technology makes

it possible to deploy a building automation system without the expense of hard-wiring," according to Dan Probst, chairman of energy and sustainability services at Jones Lang LaSalle" [17]. "Smart commercial buildings will be the highest user of Internet of Things (IoT) until 2017, after which smart homes will take the lead with just over 1 billion connected things in 2018. CRE companies may find it most relevant to understand how various types of sensors can track features such as motion, air pressure, light, temperature, and water flow and then— with the Internet backbone— enable the BMS to autonomously sense, communicate, analyze, and act or react to people or other machines in a nonintrusive manner.

Information in real-time about building energy consumption has been largely invisible to millions of users, who had to settle with traditional energy bills. In this, there is a huge opportunity to improve the offer of cost-effective, user-friendly, healthy and safe products for smart buildings, which provide users with increased awareness (mainly concerning the energy they consume), and permit them to be an input of the underlying processes of the system.

Therefore, an essential part of any intelligent management system is user's involvement, through their interactions and their associated data (identity, location and activity), so that customized services can be provided.

3.4 CLASSIFICATION OF BIoT SOLUTIONS

IoT solutions are dynamic in nature and include a wide range of applications in which physical objects and virtual "things" such as smart sensors and devices communicate and share information among each other. BIoT solutions include energy, water, building automation, security, video surveillance and fire protection. Energy sector includes HVAC, lighting, thermostats, building automation, smart grids, energy monitoring systems and other mechanical appliances which can make necessary adjustments in ventilation and other space conditioning to provide healthier and comfortable environment for the occupants. When combined with wireless sensor technology, video surveillance can attain real time notifications from devices such as smoke detectors, gas sensors, security access controls and fire detection alarm systems to better sense the hazard and danger. Water metering solutions can be used to optimize

resource usage and improve the building occupants' comfort. All these classes are developed with the existence of machine to machine (M2M) information exchange (smart devices or objects require less manual intervention to operate). "Monitoring systems and software also made a huge impact on the BIoT solutions. They usually consist of a user interface (UI) that helps to set light and/or temperature points; and generate alert on abnormal condition" [6]. The latter can lead to intelligent decision making and quick action to resolve the issue.

BIoT solutions are classified in terms of:

A. **GLOBAL LEVEL**

Initially it was decided to classify in terms of building type on the global market but then later observed that data would be huge and difficult to interpret the needs of IOT based application, Moreover it is difficult to rectify the issues and scope of improvement on that perimeter as every country or even area possess different condition and challenges. Later they adopt to classify in terms of demands and supply of technology trends offered on a global level and certain regions.

By Building Automation Software
- ➢ Intelligent security system
- o Video surveillance system
- o Access control system
- o Emergency management system
- ➢ Building energy management   system

- o Energy Management Platform
- o HVAC control system
- o Lighting control system

- ➢ Infrastructure management

   - o Parking management system
   - o Smart water management
   - o Elevators and escalators management system
   - ➢ Network and communication management systems

B. **CANADIAN MARKET**

The Internet of Things Alliance for Canada (IoTA CAN) has formed to accelerate the creation and rapid adoption of IOT innovation by building a new, vibrant and competitive wireless ecosystem. IoTA CAN's mission is to sustainably drive benefits for Canadians by enhancing awareness, providing education and expertise while operating as a single point-of-presence for IOT resources and connections within Canadian and global markets.

The organization uses a dual pronged approach to achieve this goal through supply and demand creation. Supply creation is facilitated by accessing resources through a common point while demand is created by providing a central resource and reference library for best-in-class IOT solutions.

IoTA CAN members have the ability to mitigate risk for product sourcing and project implementation because they are already working together in such areas as:

- Smart Cities and Smart Buildings – Improved operational issues from waste management, parking, energy conservation, connected learning and healthcare.

- Employee productivity – Improved labour efficiency and mobility through the use of Wearable Technology.

- Supply chain logistics and efficiency – Fine tune processes that reduce supply chain waste via the use of asset tracking.

- Predictive analytics – Glean actionable intelligence based on historical data through the benefits of 'big data' and cloud-based analytics.

- Organizational efficiencies – Cost of goods reduction from improved business execution through better real-time access to critical key performance indicators.

- Faster time-to-market innovation – Improved research, development and engineering due to a common goal of increasing productivity for all Canadian enterprises.

- Customer Experience – Improved customer lifetime value through connected marketing and education via immediate feedback gleaned from retail solutions and dedicated application software on portable devices.

IOTA CAN had done the classification on the basis of services offered different building type like commercial, industrial, health care and universities.

C. MONTREAL MARKET

On Contrary to global market, it is useful to classify in terms of building type as it is easier to interpret the data at this level and obtain the results which will help in advancement of technology and rectify the issue in different types of building.

By Building Type

- Residential buildings

- Commercial buildings

- University, school campuses, and hospital buildings

- Government and public infrastructure facilities

- Industrial Buildings

3.5 GROWTH PROJECTION

The target customers for IOT based application for smart building market are:

- System design and development vendors

- System integrators/migration service providers

- Consultants/consultancies/advisory firms

- Support and maintenance service providers

- Network service providers

- Smart building products and solutions provider companies

- Academic and research institutes

- Government associations

"The smart building market is estimated to grow from USD 5.73 Billion in 2016 to USD 24.73 Billion by 2021, at a Compound Annual Growth Rate (CAGR) of 34.0% during 2016–2021. The base year considered for the study is 2015 and the market size forecast is from 2016 to 2021" [16]. The smart building market ecosystem include technology vendors such as ABB, Siemens, Schneider Electric, IBM, BuildingIQ, and UTC, among others which provide numerous IT and non-IT components required for smart building solution deployment whereas companies such as Accenture, TCS, Wipro, HP, and Capgemini are the market players providing

assessment, consulting, system integration, and support services to smart building solutions.

- •"Overall connectivity penetration rates across all building systems are at only around 16%" [21]. "This connectivity penetration rate will rise steadily over the coming years, but mainstream penetration, i.e. 50% of all building systems devices connected, is unlikely to be achieved before 2025" [18].

- "The networking and related services segment of the market will show a steady growth of 22.6% rising from $9.53Bn in 2014 to $32.43Bn in 2020 which represents 37% of overall revenues by 2020" [24]. Similar to the market for connectivity hardware, effective network deployment to keep up with the rising bandwidth demands of the BIoT will be crucial to the effective delivery of services and the management of data flows.

- "Over the course of the last 4 years it has been tracked a total of 23 acquisitions in the BIoT sphere of influence, ranging in value from $3.7 million to over $3Bn" [7].

- Since 2010, it is tracked a total of "114 investment deals relating to the BIoT with funding rounds ranging in value from $1 million to over $126 million" [14].

3.6 POSITIVE ASPECT OF IoT SOLUTIONS

The potential impact of IoT applications is hardly limited to machines—it can also track and help to improve employee and occupant health and productivity. In addition to enabling predictive maintenance, wearables such as smart glasses can combine IoT technology with augmented reality to provide prompt information and guidance to workers in the field, particularly during the construction stage. Combining BMS-captured environmental data (temperature and air quality) with movement data from motion sensors and other sources could allow companies to understand the optimal ventilation and temperature levels for a specific day. "The buildings HVAC and lighting systems can make necessary adjustments in ventilation and space conditioning and provide a healthier environment for occupants" [2]. Basically, we can say that the data captured from connected buildings can be used to enhance building performance, optimize resource usage, target service delivery and also improve the employee experience in the workplace. Intelligence, "Business Insider's premium research service, expects the number of smart home devices shipped will grow from 83 million

in 2015 to 193 million in 2020" [11]. This includes all smart appliances (washers, dryers, refrigerators, etc.), smart home safety and security systems (sensors, monitors, cameras, and alarm systems), and smart home energy equipment, like smart thermostats and smart lighting. The first and most obvious benefit to smart homes is convenience, as more connected devices can handle more operations (lighting, temperature, etc.) and frees up the resident to perform other tasks. [8]

3.7 NEGATIVE ASPECT OF IoT SOLUTIONS

One of the main hindrances in the development of BIoT solutions is the cyber security and cyber threats. All the devices will be connected to the internet and if that IP address is not secure enough then it encompasses large amount of risk in applying the technology as the system can be hacked thus allowing criminals to gain access to the buildings. As of now we still don't have any international standard for compatibility or applicability for monitoring equipments. Moreover, it also lacks the standards for communication, data, service which can provide authentication to BIoT application services or products. Any failure or bug in the software or hardware appliances could lead to serious consequences as BIoT solutions appliances have high reliability and usages on daily basis. There is a possibility that wireless signals can be interrupted by other household electronic appliances thus could lead to the effectiveness of your smart products. There is a high reliability on internet connections so if connection drops it could lead to discomfort for the occupants.

The Internet of Things is challenging application developers, vendors, and business decision makers to transform existing business processes or technologies. However, the application ecosystem is still extremely nascent as the IoT really opens up endless opportunities to create solutions to connect "things" and change business processes or consumer behavior. If the IoT is ever going to truly take off, this needs to be the first problem that manufacturers address. "The 2015 control State of the Smart Home study found that 44% of all Americans were very concerned about the possibility of their information getting stolen from their smart home, and 27% were somewhat concerned" [13]. With that level of worry, consumers would hesitate to purchase connected devices, Also Researchers have been able to hack into real, on-the-market devices with enough time and energy, which means hackers would likely be able to replicate their efforts [13].

AT&T's Cybersecurity Insights Report surveyed more than 5,000 enterprises around the world and found that 85% of enterprises are in the process of or intend to deploy IoT devices. Companies also need to build security into software applications and network connections that link to those devices".

According to a recent IDC survey of U.S. technology decision makers, the top hindrances they see to IoT growth are security and privacy concerns. IDC sees the ecosystem embracing the need for connectivity standards, but not close to raising and embracing the issue of privacy. "With the amount of data and contextual input expected from sensors and other parts of the IoT solution, this is a challenge that will have to be overcome over the forecast period" [15]. The sheer amount of data that IoT devices can generate is staggering. A Federal Trade Commission report entitled "Internet of Things: Privacy & Security in a Connected World" found that fewer than 10,000 households can generate 150 million discrete data points every day" [24]. This creates more entry points for hackers and leaves sensitive information vulnerable. **COMPANIES INVOLVED IN BIoT SOLUTIONS**

1. **APPLE**

    Apple slices into the connected home market with Homekit in June 2014, Apple released Homekit—a home automation platform that allows a variety of smart home vendor technologies to be managed through one application on one of Apple's devices. This is part of a broader strategy for Apple to enter into the IoT and connected home markets. Apple has a history of success in harnessing entrepreneurs to bring value to the devices it seeks to sell. Homekit could be Apple's attempt to recreate their success with the Apple Store, and apply that model to the IoT.

2. **SAMSUNG**

    Samsung's Smart Home platform takes aim at the connected home similarly, in January 2014, Samsung, the global electronics giant, unveiled its Smart Home platform. This platform lets users connect and control their home using their Samsung devices through one app via their Samsung Smart TV or their smart phone.

"The company claimed it will 'collaborate with third-party partners to make the Smart Home service extendible to their products and services,' but it will doubtfully support its competitors' products.

3. GOOGLE

Google lays a Nest Egg as of October 2014, Google did not yet have a competing platform (like Homekit), but with the acquisition of Nest, it has positioned itself as a key contender like Apple in the smart phone market, Google has shown its ability to harness the crowd as well as developers' ingenuity to create a multitude of apps and devices. Nest has partnered with Airbnb, providing users with free access to MyEnergy, its energy monitoring service in 2013.

4. RAINFOREST AUTOMATION

The company makes products that enable utilities and their customers to manage real-time energy use. Its home area network (HAN) devices, software products and services enable energy efficiency and demand response programs for utilities, and provide automation convenience and reduced energy costs for residential and commercial consumers.

5. MMB NETWORKS

It enables consumer electronics manufacturers to rapidly add ZigBee connectivity to their products with automated interoperability across major connected-home platforms. Embedded software, Rapid Connect, implements and automates ZigBee Smart Energy or Home Automation standards in a robust way.

6. ECOBEE

Eco bee makes Wi-Fi connected thermostats that control your heating and cooling system. The thermostat connects to the Internet and, once connected, it can be controlled through a smart phone or a tablet.

7. VALTA

Company plans to incorporate a sensor to the lighting system that will be able to measure ambient light, motion and air quality. In addition to that, we enable

connected devices to achieve something tangible, that of energy savings.

8. ENERGENT

Energent Inc. provides state-of-the-art energy management information system solutions, or "in- depth energy Informatics. The Company collects all energy data associated with a site, either through electronic transfer, on-site integration to control systems, or metering infrastructure.

Then, through mathematical models that incorporate a wide range of variables such as weather, occupancy levels, production and facility operations, Energent baselines the energy profile, providing a reference point for continuous improvement.

9. STELPRO

A leading Canadian manufacturer of integrated heating solutions, has teamed up with three Internet of Things (IoT) partners to develop and bring to market **Maestro** – Smart Thermostats, a game changing Smart Home solution for electric heat that enables users to easily customize their home comfort experience while reducing heating expenses. "The company announced the partnership agreement with Ayla Networks, Mirego and Mnubo during the international AHR Expo being held in Las Vegas, Nevada" [24]. Ayla Networks which supports the IoT cloud service connectivity, Montreal-based Mirego which developed the mobile application and user interface, while Mnubo, also from Montreal, will look after the data analytic and strategic insight components. Smart Thermostats can replace any existing line-voltage thermostat installation and its communication protocol is compatible with other smart home solutions.

10. AYLA NETWORKS

Ayla Networks empowers leading manufacturers by simplifying the inherent complexity of Internet of Things (IoT), enabling them to turn their products into smart connected Systems and transform their businesses to compete in the game-changing world of Connectivity.

11. MNUBO

Mnubo extracts business value from IoT data by delivering out of-the-box insights and advanced IoT data science. It offers a SaaS solution to connected product manufacturers so that they can ingest, enrich and analyze their object data.

12. MIREGO

Mirego plans, conceptualizes and develops breakthrough digital products for clients such as Bell, Aldo, Bombardier, Familiprix and Rona. Its team of over 90 experts based in Montreal, Québec City and Toronto is one of the most experienced in Canada in terms of strategy, user experience and mobile app development with nearly 200 applications and transactional websites in assets since 2007.

3.9 VALUE PROPOSITION

"Value proposition is basically defined as the collection of products; services or benefits that a company or a business offers to meet its customers' needs" [10]. Given the availability of strict norms and regulations regarding energy conservation, a high demand is created in the building sector for solutions with higher levels of energy efficiency. This demand has created a market opportunity for many vendors. As a result, some of the offered solutions, beyond responding to that demand, have led to the emergence of smart and innovative devices/solutions which also take into consideration the convenience and comfort of the occupants. While some of these solutions are completely new, others add attributes or features to the conventional solutions. In our study, we divided the value propositions under two major categories of *demand pull* (responding to the existing needs), and *technology push* (offering new solutions to increase the "utility" of the end users). However, in both cases the value proposition is the same. Table 1 summarizes the view on market drivers and barriers for BIoT-based solutions which companies take into consideration before investing in a new project.

Value Proposition- Market status

Market Drivers	Market Barriers
Expanded Internet Connectivity	Security Concerns
High Mobile Adoption	Privacy Concerns
Low Cost Sensors	Implementation Problems
Large IoT Investment	Technological Fragments

TABLE 1

Managing the IoT ecosystem, the myriad technologies that underlie it, and the data it generates not to mention developing use cases to improve business – will require organizations to hire, recruit and train skilled talent, which is in short supply. Because IoT ecosystems comprise numerous technologies and devices running on different networks, organizations will need to partner with third-party specialists to complement their in-house capabilities. These partner

Organizations should be evaluated on their strength of expertise, industry knowledge and ability to address the complexity of connecting a wide array of technologies and platforms on which the devices will run.

The smart home is likely the most popular IoT application at the moment because it is the one that is most affordable and readily available to consumers. From the Amazon Echo to the Nest Thermostat, there are hundreds of products on the market that users can control with their voices to make their lives more connected than ever. "Amazon Echo - Smart Home works through its voice assistant, Alexa, which users can talk to in order to perform a variety of functions. Users can tell Alexa to play music, provide a weather report, and get sports scores, order an Uber, and more". [9]

The advent of Internet of Things (IoT) is also affecting the way green and smart buildings are getting connected with various stakeholders throughout the world. IoT for buildings can be imagined as a network for buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data. In 2016 and beyond, building owners and key decision makers will invest in an array of smart building solutions that embody the technology foundation of Internet of Things (IoT) and cloud computing to validate the growth of the industry.

4. BUSINES MODEL DEVELOPMENT

Business model is considered as a focal point in the field of management, however in recent times researchers also put serious attention on these models as it is a good starting point for creating, marketing and delivering value in this competitive environment. Model can be used to describe unique value proposition in order to access the attractiveness of any opportunity or viability of a proposed new venture. Researchers can use the model as a source to create heuristic logic between technical and economic potential and propose their ideas to private investors, entrepreneurs who generally prefers business plans and models to justify the investment involved in any project. One can easily say it can act as a helper to line up "technological development and economic value creation" [11]. One of the most important aspects of the business model is the systematic overview that enables us to apply some logic to various perspectives. Knowledge management, revenue stream, vision and value creation is one of the important components of any business model.

One must also be aware of the language before presenting any business model which should be globally understandable and acceptable and have common base of work which can be easily managed, facilitates description and discussion. It should develop a logic which motivates other researchers and users to give their inputs or to develop alternative models for other classification of BIoT solutions. In our study Osterwalder business model canvas certain attributes are taken into consideration to develop BIoT- based business model for the city of Montreal.

4.1 BUSINESS MODEL REPRESENTATION: CANVAS

Osterwalder business model canvas **(see Figure 1)** is divided in four main areas of a business: Infrastructure, Value proposition, Customers and Financials, and infrastructure is divided into three main categories: Key Partners, Key Activities and Key Resources. The customer segment is also sub-divided in three main categories: Customer relations, Channels and Segments; financial category is also sub divided into two main categories: Cost Structure and Revenue Stream. All of the identified categories are govern by each other i.e. they are not mutually exclusive. In the followings paragraph each one of the segments and its categories are briefly explained.

A. Infrastructure:

1. **Key Partners:** Suppliers or partners getting together with a common goal creating alliance to improve their business model to reduce cost, risk and uncertainty to create a new business form a key partner theme. Different partners that work in conjunction are:

a. **Financial partners:** It provides the monetary support to the companies since every business needs investment in the beginning; it could be banks or county of SOM. Companies which provide financial services like end to end lending and leasing, enterprise asset planning and workforce management can be a financial partner of IoT companies.

b. **Technology partners:** Different IoT partners need to work in conjunction for IoT enabled smart buildings like smart sensor wireless companies to collect data, gateway vendor companies whose role is to receive the data and either can sent to data centre or can analyse by themselves to act upon it, data service provider company to integrate and manage the big data, application developer and system integrator company for automation of the building and connected to mobile application or other means for the convenience of the user or occupants and building management service provider companies which provide BMS who coordinates and monitors the proper functioning of the physical devices like HVAC, air monitoring equipment, lighting retrofits, fire alarm etc.

c. **Certification authority partner:** It is generally needed for security or threat Purposes associated with the IoT devices. "IoT manufacturers need to take an approval

from the certification authorities like ICON Labs for authentication of the products"
[10].

d. **Testing and validation partners:** Companies like Infosys helps in improving efficiency and deliver customer value across full range of consumer, end to end testing of IoT system across multiple subsystem, device, interface and application is done for proper validation.

2. **Key activities.** It emphasise on all the specific responsibility of all the key partners associated with it. It includes data service provider, management of infrastructure, operation and mainataince of infrastructure, certification authority.

3. **Key resources:** It is considered as essential assets to maintain and support the business which can be of different types like intellectual, financial, human or physical.

B. Value proposition

Value proposition area specifies the collection of products, services or benefits that the company can offer to meet customer needs. "It has been estimated that building currently account for 49% of the total energy consumption and 50 % of the energy used in the building is wasted with lights being on without anyone in the room" [18]. This had huge impact on the environment due to which government bodies has built strict norms when it comes to conserve energy. This has created high percentage of demand in energy for building sector of which many vendors have taken opportunity for business implication to supply the demand. Since the scope of domain is huge not only it lead to supply the demand but also lead to emergence of smart and innovative devices taken into consideration the convenience and comfort of the occupant. Some of the solutions were completely new whereas some had added attributes or features to the solution, however in both respect it enhances the value proposition of the company.

C. Customers:

No business can prevail without customer and therefore it is considered as the heart of the business model. Customer is subcategorised into:

1. **Customer segments:** it refers to the target consumer where it can be individual or in a group depending on the common behaviour, common needs or with other aspects.

2. **Customer channel:** it is medium between the company and the clients which should be properly defined for information about the product, service and company existence.

3. **Customer relationship:** it characterise the way a company interacts with the clients, the interaction could be an individual assistance or automated depending upon the approach taken by the company.

D. Financial Area:

It is subdivided into two themes:

1. Cost structure: It defines the cost inherent to the business which can be calculated after specifying key partners, key activities and key resource.

2. Revenue stream: it represents the capability of generating money from the business.

Different revenue stream models for IoT Company

1. **Hardware premium:** It is the most basic form of monetization model. Here organisation adds connectivity option to an existing or new product and offer remote device management in the form of mobile apps. This basic level of connectivity and control enables organization to charge the premium for these products specially seen in the lighting industry.

2. **Service model:** It offers a recurring revenue stream model and more importantly creates the relationship with the customer long after they have purchased the product. Premium fee can be charged for different mechanical, electrical and plumbing devices (MEP) installed and are connected to BMS.

3. **Data generated model**: IoT device generate large amount of service data. Once the data has been aggregated, organisation can choose to sell it raw, package insights from it or monetize it during advertising.

4. **Platform promoter:** IoT thrives in connected ecosystem- the bigger the ecosystem the greater the value generated for stack holders. Platform promoter provides shared platform to other players in the ecosystem- hardware, manufacturers, software developers, service provider and makes money from both end customer as well as other platform users.

Following segments of Osterwalder business model canvas like technological partners, financial partners, key resources and revenue stream models are attempted to formulate the BIoT based business model for the city of Montreal.

Osterwalder Business Model Canvas
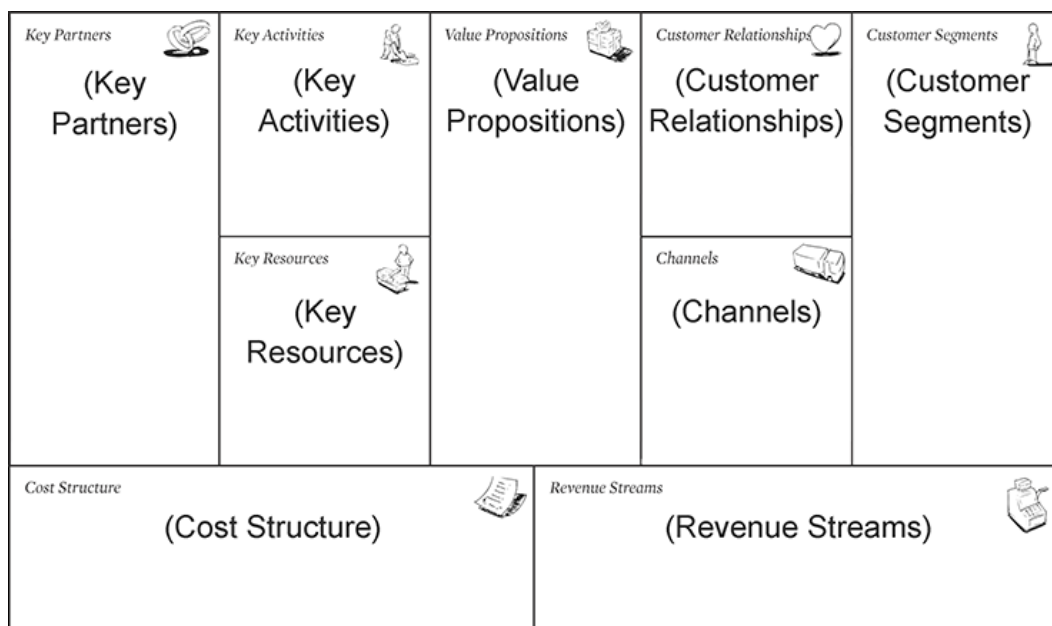
FIGURE 1

5. BUSINESS MODEL DEVELOPMENT PROCESS

We tried to develop the canvas by dividing our work in two different stages. First is the extensive study of various case studies the reason we studied these case studies is to validate Osterwalder business model canvas with BIoT based energy solutions projects and also to know about different partners available in the Montreal market. The source of obtaining these case studies were company's website and also by approaching them. We approached BIoT based energy companies like Ayla Networks, IBM, Thingworx which are recognized on North America Level have completed projects most of them being in commercial sector in Montreal region and also companies like Mnubo, SPM manufacturers, Home Sync. Which are Montreal based companies and successfully completed projects in BIoT based solutions for residential use. We tried to form a table **(See Table 2)** which consists of different segments and sub divisions of Osterwalder canvas model and also figuring out from the case studies the different partners involved in completion of the project. In most of the case studies we were able to find about technological partners, certification authority partners, key resources, revenue stream models, financial partners and value proposition.

CASE STUDY ANALYSED

Name of Case Study	Technological Partners	Certification Authority partner	Key Resources	Revenue Stream Model	Value Proposition	Customer Channel	Financial Partners
Condo-Montreal	SPM (*manufacturer*), Mnubo (*data analytics firm*)	Ayla Network	N.A.	Data generated	*Demand pull–* (system integration)	Website	N.A.
Data Driven Services-Commercial Office	Mnubo (*data analytics*), Ayla Network (*platform promoter*), Stelpro (*device management*)	Ayla Networks	University of Montreal, Parks Associates	Data generated	*Technology push–* Maestro (smart thermostat)	Door to door service	N.A.
Tyrens Stockholms headquarter	IBM (*platform*), Intel (*cloud computing*),	IBM Watson	IBM (Maximo) for asset	Service model	*Demand pull–* Wireless	N.A.	Tyrens

	Yanzi (*manufacturer*), SVSI (*business partner*)		managemen t		sensor system		
The Edge	IBM, Johnson Control (JCI)	IBM Watson	IBM – Building managemen t System	N.A.	*Technology push*– Light motion sensor	N.A.	SVSI
University of Montreal – Library	Schneider Electric (*manufacturer*), Accenture	Intel	N.A.	Hardware premium & service provision model	*Technology push*– Wireless Network System	N.A.	Accenture
Orbotech	ThingWorx (*platform promoter*), Sysmex (*device management & business partner*)	N.A.	University of California	Platform promoter	*Demand pull*– Lighting & HVAC System	N.A.	Sysmex
Montreal Gazzete – Smart Home	Home sync Inc. (*service provider & manufacturer*), Tagliani (*business partner*)	Via Consultants	Apples Home Kit	Data generated & service provision model	*Demand pull*– Building Automation	Door to door service	N.A.

The second stage is the expert opinion which was taken by conducting the survey. Various consultants, technicians, data analyst who work in BIoT based energy solutions and has significant amount of experience in BIoT industry from different Companies like consulting firms, contractors and vendors working in energy sector in Montreal were approached to participate as a respondent in survey **(See Figure 2)**. Total of 11 experts from 5 companies participated in the survey. The survey is conducted to get an insight about different financial partners, technological partners to understand which partner with in the technology sector drives the industry forward and various revenue stream models available in Montreal Market, survey also helped us in understanding the vendors perspective about growth of different BIoT solutions and where the industry wants researchers to focus. It also gave us an idea how fast Montreal market is growing with respect to another province in Canada.

(a) Companies' experience in BIoT industry

(b) Companies' roles

(c) Participants' profiles in the company
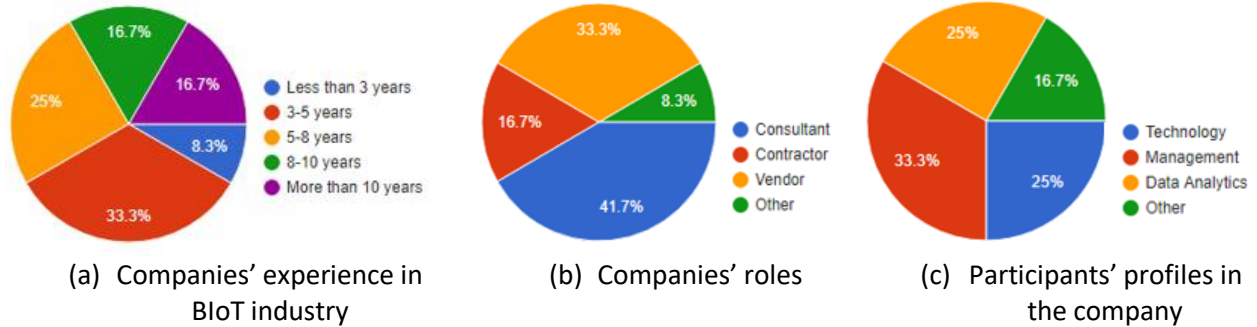
Figure 2. Survey participants' distribution

6. RESULTS

We aggregated the results of the case study analyses and survey response, and attempted to formulate the BIoT-based energy business for Montreal region within the framework of Osterwalder business model canvas (see figure 3). Case studies are analysed on North America region but only few companies are added in figure 3 as per our selected SOM. It also made us understand different key resources, revenue stream models and technological partners available in the market. Review of case studies helped in preparing framework for our survey form to validate certain aspects of case study analysis, Not only that it also helped us in gaining information about BIoT based solutions in Montreal region.

As per survey analysis Ontario is fastest growing province in Canada followed by Quebec and British Columbia. Commercial sector is growing progressively in Montreal region followed by institutional and residential sector. Private sector includes entrepreneurs, investors and multinational corporations are more motivated than banks and government in investing in IoT solutions for smart buildings but still most of the participants feel that cyber security is the biggest hindrance in the development of BIoT based solutions. Based on the literature review the most effective IoT application for smart building is energy saving mechanical appliances and building automation in North America region. This completely validates from our survey analysis for Montreal region as well. Review of Case studies shows (see Table 2) most of the companies are involved in manufacturing solutions and data generated model is most popular revenue stream model in market. This validates with our survey analysis as most of the participants consider device management and manufacturing solutions drives the growth of IoT Industry in Montreal region and data generated model is the most preferred model to generate income. However survey

analysis does not validate with our financial partners as participants were unaware about majority of partners listed on survey form.

TABLE 3. Aggregation of case study results in Osterwalder framework

List of Financial partner's companies		Device management & Manufacturing Companies	Data Analytics & Data service Companies	System Integration Companies	Monitoring Device & Solution Companies	Software Vendor & Visualization
• Capital Intelligent Mtl • Réseau Capital • Investissement Québec • Business development Bank of Canada • Société d'Investissement Jeunesse (SIJ) • Walter Capital partners • BMO capital partners • EY Montreal	**Technologic Partners**	Callisto Integration Soaz Aeponyx Inc. Schneider Electric	Mnubo Via Consultants Agile DSS Schneider Electric	Ayla Network Eridanis Home sync Schneider Electric	Sense Atek Monitoring & Control Solution Home Sync	Soljit Splunk Sensor Suite Thing Worx Schneider Electric

	Research	Management Consulting Firms	Certification authority partner
Key Resources	• Micro technology & Microsystem laboratory of UQAM • University of Montreal	• McKinsey & Company • BCG • Deloitte • Accenture	• Eradins • Via Consultants

	Platform promoter	Data generated model	Service Provision Model	Hardware Premium
Revenue Stream Models	• Soljit • Splunk • Ayla Networks • Thing Worx • Sensor Suite • Schneider Electric • Eridanis	• Mnubo • Agile DSS • Schneider Electric • Splunk • Ayla • Home Sync • Calisto integration	• Sensor Suite • Atek Monitoring & Custom model • Sense • Via Consultants • Eridanis • Thing Worx	• Home Sync Inc • Calisto Integration • Schneider electric • Thing Worx • Splunk • Agile DSS

7. CONCLUSION

Following the components of Osterwalder business model canvas, and synthesizing a number of business cases for BIoT-based energy solutions in Montreal market, we developed a framework to highlight the current situation of this mart. Our model perceives different aspects including infrastructure, value proposition, customers, and revenue streams within the broader context of Montreal market. In addition, it

addresses some options available for financial and technological partners within the Montréal market. The model took the perspective of vendors in the field of BIoT energy solutions and can help them to analyze the market trends within the specified domain and region to justify the investment involved in BIoT deployments. Moreover, other researchers and vendors can use this framework to formulate and evaluate their suggested models and expand beyond that to include other forms of BIoT applications.

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10. APPENDIX

Appendix 1

Survey Questions Time: 10 min

On a scale of 1 to 5 with 5 being the strongest influence, please rate the following questions for the study on Building-Internet of Things (BIoT) based energy business in the city of Montreal.

1. **1. How progressively each of these building sectors is moving towards IoT?**

   Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Commercial	◯	◯	◯	◯	◯	◯
Residential	◯	◯	◯	◯	◯	◯
Institutional & Educational	◯	◯	◯	◯	◯	◯
Industrial	◯	◯	◯	◯	◯	◯

2. **2. From customer point of view, how important in each of the following advantages of IoT in buildings?**

   Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Safety & Security	◯	◯	◯	◯	◯	◯
Health & Well being	◯	◯	◯	◯	◯	◯
Comfort & Convenience	◯	◯	◯	◯	◯	◯
Energy Saving	◯	◯	◯	◯	◯	◯

3. **3. From the perspective of vendors, how much must R&D focus on each of the following IoT related issues?**

   Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Cyber Security	◯	◯	◯	◯	◯	◯
Safety	◯	◯	◯	◯	◯	◯
Cost Effective Wireless Sensors	◯	◯	◯	◯	◯	◯
Cloud Storage Solutions	◯	◯	◯	◯	◯	◯

4. **4. How fast is each province is growing in IoT for smart buildings?**

   Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Ontario	◯	◯	◯	◯	◯	◯
Quebec	◯	◯	◯	◯	◯	◯
Alberta	◯	◯	◯	◯	◯	◯
British Columbia	◯	◯	◯	◯	◯	◯

5. **5. In the recent years, how much have IoT application grown in Montreal, in each of the following domains?**

Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Energy (Mechanical Appliances)	◯	◯	◯	◯	◯	◯
Video Surveillance	◯	◯	◯	◯	◯	◯
Water & Waste Management	◯	◯	◯	◯	◯	◯
Building Automation	◯	◯	◯	◯	◯	◯

6. **6. In your perspective which technological partners drive the growth of IoT industry?**

Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Device Management & Manufacturing Companies	◯	◯	◯	◯	◯	◯
Data Analytics & Data Service Companies	◯	◯	◯	◯	◯	◯
System Integration Companies	◯	◯	◯	◯	◯	◯
Monitoring Device & Solution Companies	◯	◯	◯	◯	◯	◯
Software Vendors & Visualization	◯	◯	◯	◯	◯	◯

7. **7. Which Sector is investing more in the IoT industry?**

Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Banking	◯	◯	◯	◯	◯	◯
Private Investors	◯	◯	◯	◯	◯	◯
Government	◯	◯	◯	◯	◯	◯
Multinational corporation	◯	◯	◯	◯	◯	◯

8. **8. Based on your knowledge and experience how actively each of the following financial partners in Montreal is involved with Vendors to support IoT solutions?**

Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Capital Intelligent Mtl	◯	◯	◯	◯	◯	◯
Reseau Capital	◯	◯	◯	◯	◯	◯
Investissement Quebec	◯	◯	◯	◯	◯	◯
Business Development Bank of Canada	◯	◯	◯	◯	◯	◯
MITACS	◯	◯	◯	◯	◯	◯
Walter Capital Partners	◯	◯	◯	◯	◯	◯
BMO Capital partners	◯	◯	◯	◯	◯	◯
EY Montreal	◯	◯	◯	◯	◯	◯

9. 9. **The main source of generating revenue for Montreal companies active in IoT are?**
Mark only one oval per row.

	1 (Not at all)	2	3 (Moderately)	4	5 (Extremely)	Don't Know
Platform	○	○	○	○	○	○
Data	○	○	○	○	○	○
Service	○	○	○	○	○	○
Hardware	○	○	○	○	○	○

General Information

10. 1. **How many years your company is working in BIoT industry?**
Mark only one oval.

- ○ Less than 3 years
- ○ 3-5 years
- ○ 5-8 years
- ○ 8-10 years
- ○ More than 10 years

11. 2. **What is the role of your organization in IoT industry?**
Mark only one oval.

- ○ Consultant
- ○ Contractor
- ○ Vendor
- ○ Other

12. 3. **What is your area of work in the Organization?**
Mark only one oval.

- ○ Technology
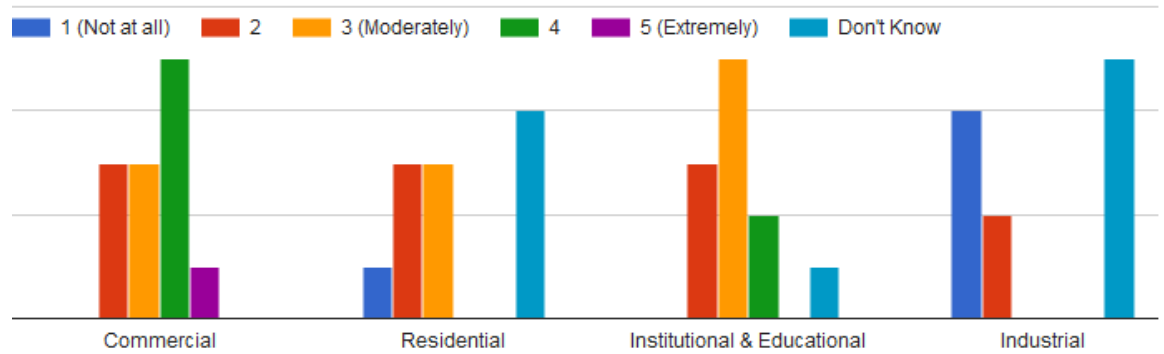- ○ Management
- ○ Data Analytics
- ○ Other

13. 4. **What is your role in your organization?**
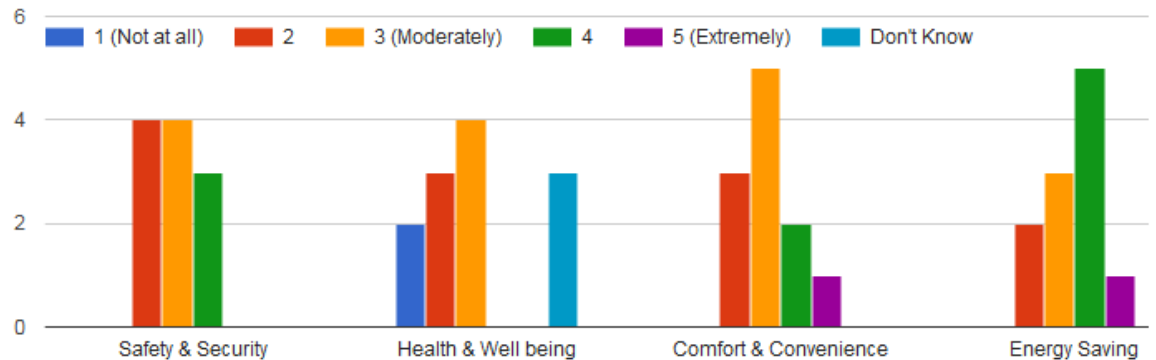*Mark only one oval.*

- ○ Analyst
- ○ Technician
- ○ Supervisor
- ○ Manager
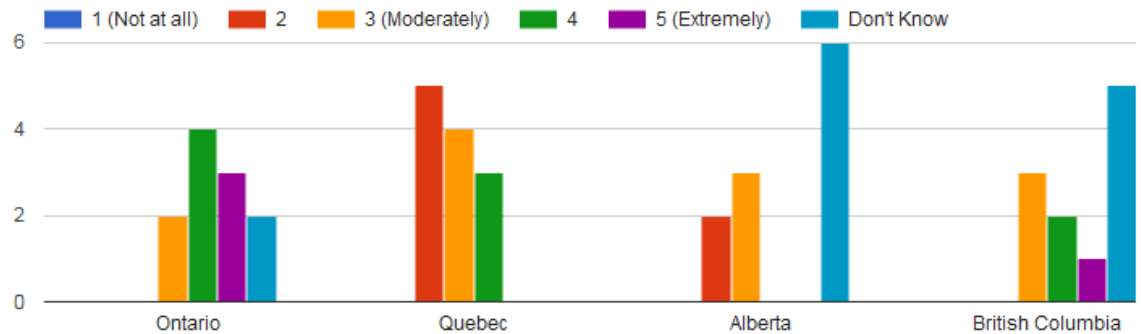- ○ Other

Appendix 2: Survey Results

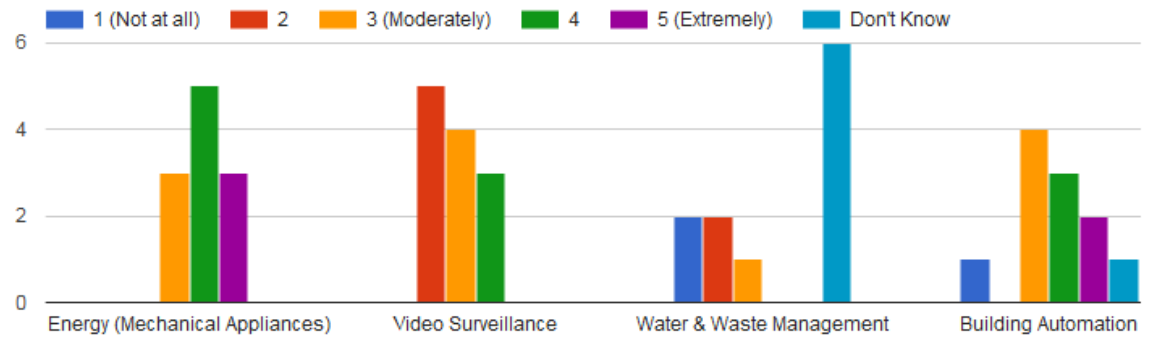**A. Different building sectors moving towards IoT**
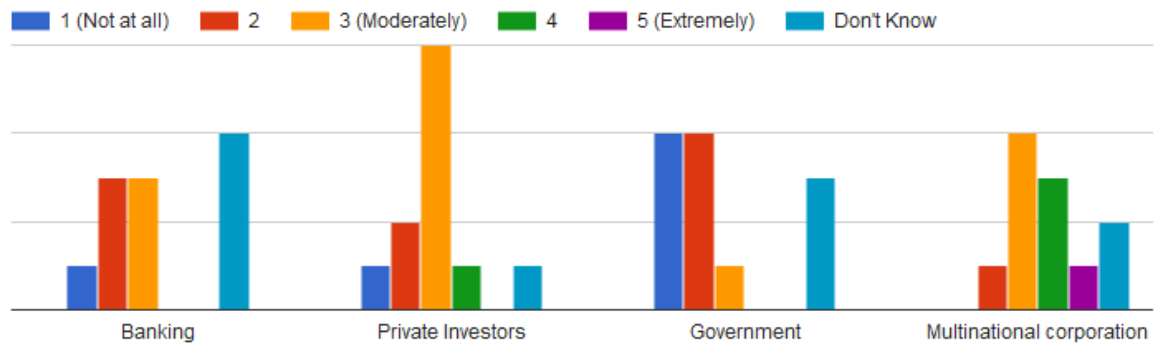

B. Advantages of BIoT solutions from customer perspective

C. Growth of each province for BIoT solutions

D. Growth of IoT Application for smart buildings

E. Investment of different sectors in IoT industry

F. Growth of revenue stream model