The Success Factors Influencing AI Ecosystems and AI Startups: A Multi-Level Analysis

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A THESIS

Submitted to

HEC MONTREAL

In Partial Fulfillment of the Requirements for a Masters of
Science in Administration (M.Sc.)

June 2020

Abstract

The thesis aims to investigate the success factors influencing Artificial Intelligence ecosystems, including the success factors influencing Artificial Intelligence startup firms in Canada. The primary objective of the research was to identify the ingredients, pattern, linkage, and relationship with the growth of both AI ecosystems and AI startups. First, a theoretical framework was constructed based on insights from the literature review. Then, the framework was validated with the interviews and empirical analysis where the framework was later refined in the discussion and findings section of the thesis.

The research involves a mix-method approach including a mixture of both quantitative and qualitative methods to assess the research questions which included interviews and secondary data analysis. A pilot study was done using interviews (AI startup firms). Three (3) AI firms were interviewed to validate the interview instrument to be used by other participants. Seventeen (17) subsequent artificial intelligence firms then participated in the study. Data were then used to analyze and compare where the results were collected to determine the factors influencing growth for AI ecosystems and AI startup firms. The study was further used to adjust the theoretical framework based on the interviews and findings in order to validate and gain precise factors/ingredients that influence growth in both AI ecosystems and AI startup firms.

The findings of the thesis demonstrate some agreement in the empirical analysis surrounding Artificial Intelligence trends, AI ecosystems & AI startups growth and sustainability factors. The results contribute to the existing literature in Artificial Intelligence, startups and ecosystems. Furthermore, the result bridges the gap between AI and ecosystems, startups in AI and provides an analytical view of AI from the macro, meso, and micro levels. The Theoretical Framework

and result will benefit AI stakeholders, government agencies, startup founders, and key decision-makers inside and outside AI firms and ecosystems ways in stabilizing AI growth.

Acknowledgments

I would like to thank:

- My Thesis supervisor Ekaterina Turkina for all her guidance, support, teaching, advice, and professional approach before and during the process.
- All the AI firms participants and co-founders which made this thesis possible
- HEC staff members and Faculty. And my colleagues, including Abdoulaye Diop and Madeline Belanger-Trottier, for all the support, motivation, and consistent partnership during the process.
- Last but not least, the support of my mother, Sharon Powell, who helped in all possible ways with my school, relocation, emotionally and financially. She dropped out of school to take care of her family, yet is one of the most intelligent individuals I have grown to be inspired from. This is for her because she gave up so much at the hardest time in her life just to give me an opportunity. It did not go unnoticed nor was unappreciated.

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Chapter One

Introduction

1.1 What is AI

What is Artificial Intelligence (AI)? Artificial intelligence can be traced back to the 1950s when Alan Turing asked the question, 'can machines think?' Later, the definition of AI became more streamline when Anderson described that AI is a machine with the ability to solve problems that humans usually solve with their natural intelligence (Clark, 2015). In other terms, AI is machines designed to mimic the human brain to undertake similar tasks efficiently that normally the human intelligence can conceive. In recent times, AI has developed from an idea to a concept and now, into production globally; and cross over in just about every sector and industry. AI can be broken down into three main categories, which are Artificial Narrow Intelligence (Kurzwel, 2005); the second is Artificial General Intelligence (Carroco, 2018); and the third is Artificial Super-Intelligence (Bostrom, 2006). Below, the three main categories of AI are described in further detail. The adoption and full acceptance of Artificial Intelligence are on the rise inside virtually all leading industries, solving a variety of business, social, and economic problems as the world steadily shifts.

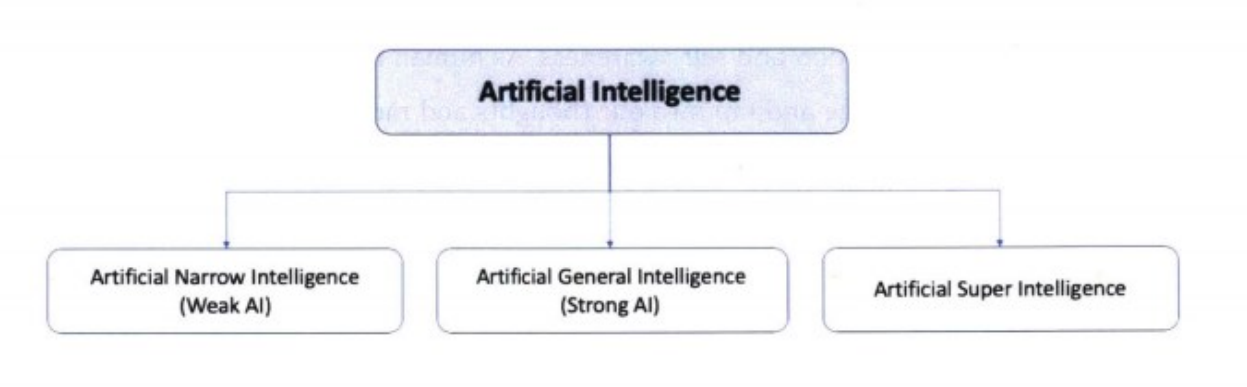


Figure 1: Categories within Artificial Intelligence (Source: Barua, 2019)

Artificial Narrow Intelligence can be described as machine learning and deep learning tools that undertake a specific task. For example, this type of AI was used in Chess games, Jeopardy, and Go masters (Hassabis, 2016). More recognizable, Artificial Narrow Intelligence is currently used in the popular Google search engine; however, there are limitations to Artificial Narrow Intelligence. For instance, it can answer questions such as the distance from point A to point B that is difficult to answer by humans. Yet, cannot answer if dogs can drive cars or not.

Artificial General Intelligence that can be described as AI machine learning at the human level. According to Osborne, (2019), this level of AI is smart as humans across the board to perform any task under normal circumstances to where AI can apply intelligence to any problem and not the specific task. An example of this would be the robots in the Sci-Fi movie iRobot.

Artificial Super Intelligence can be described as AI that is more intelligent than the smartest minds today or ever existed such as Steve Jobs and Einstein. They are more intelligent in every field, including creativity, social skills, conventional wisdom, and scientific (in science?)(Xinhua, 2016). You can see an example of this type of AI from movies, including Johnny Depp in Transcendence and Skynet in Terminator.

It is important to note that machine learning and deep learning are terms often used to describe a sub-concept of Artificial Intelligence. Figure 2 below illustrates the types of a subset of artificial intelligence.

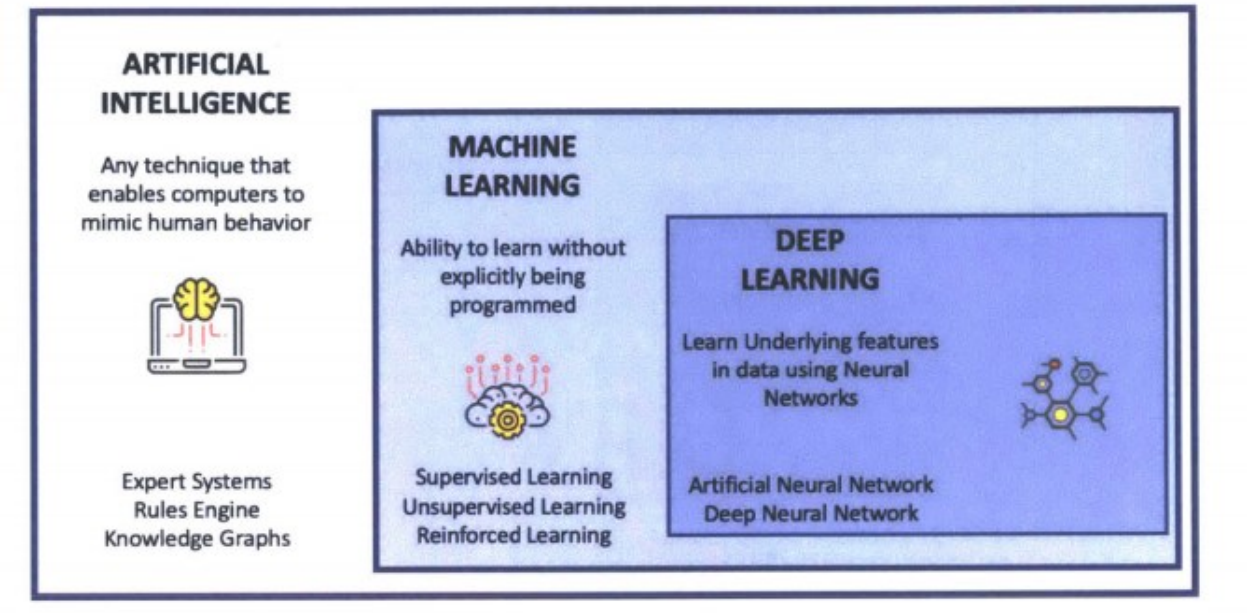


Figure 2: The Different Types of Artificial Intelligence (Source: Barua, 2019)

Moreover, deep learning can be described as a subset of machine learning where deep learning algorithms are said to be championed by the information process patterns found in the human brain. Just as the as the human brain can be trained, the deep learning algorithm can be trained to accomplish a specific task for machines. Deep learning further follows a multi-layered ANN (Artificial Neural Networks) in which aims at delivering exceptionally high accuracy in a task (Russell and Norvig, 2016). Below, figure 3 from Barua (2019), illustrate the subfields of artificial intelligence research and further map machining learning sub-layers.

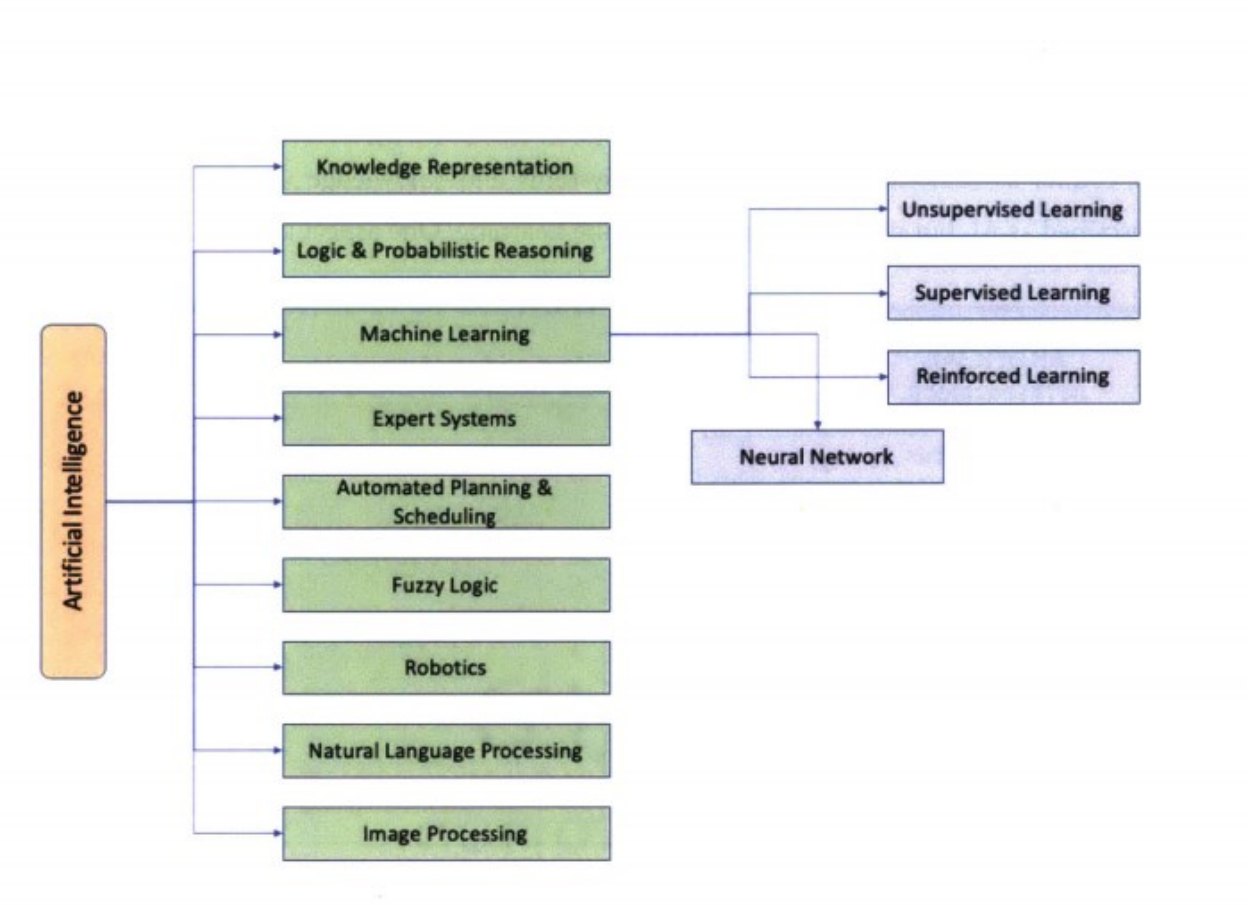


Figure 3: Sub-Layers of Artificial Intelligence Research

1.2 The Phenomenon of Startups in AI

Shaw and Allen (2018), argue that new startups are experimenting with new business models daily while old firms are experiencing new ways to utilize their data in the new data-product (data product) and service of things. With the shift into the age of expectation, and technological advancement, firms need to improve their understanding of what is happening and their predictions of ways that produce design, consumer's trend, regulatory decisions (data and privacy), and partnership between firms will go (Wang and Fang, 2012). Startups that focus on

the development of AI application as its core offering must have an innovative process and culture. The concept of innovation is generally defined as the introduction of a new method or thing with the focus of an application and commercial of inventions or ideas (Zhao and Zeng, 2014). Within the same context, innovation can also be viewed as a process of translating new ideas into tangible products or services, the successful exploration of new ideas and the change which creates a new dimension of performance, and when a creative idea is realized. Other exploration of innovation can be defined in literature as the following:

The innovation system is defined by Cook (2007) as an essential political, economic, organization, social and institutional factors which influence the diffusion, development, and use of innovation.

The National Innovation system is defined by Grandstramd and Holgerson (2019) as an infrastructure that supports innovation within a production structure of a region.

A sectorial Innovation system is defined by Ojaghi et al. (2019) as a system (group) of firms that participate in the making and development of a sector's products and utilizing and generating sector technologies including a system of firms. This occurs in two ways, through processes of competition and selection in the market and innovative activities and processes of cooperation and interaction in artifact-technology development.

Corporate Innovation System is defined by Spigel (2019) as a set of institutions, actors, resources, activities, and the healthy interrelation for the innovative performance of a firm. Or group of collaboration firms and other actions, including agencies and universities.

1.3 AI Startup vs. SME

It is essential to distinguish the difference between an SME (Small and Medium Enterprise) and a startup. One of the main differences is that a startup has no customers in the beginning, and cannot apply any pre-designed business model (Berger, 2019). With today's ever-changing condition, startups are becoming more relevant due to the openness in innovation, technology, and globalization, which creates a much lower entry for new entrepreneurs and corporations. The need for physical proximity had reduced due to new age technology and innovation that makes the availability of resources virtual. Moreover, the primary objective for startups is to search for their genesis where survival is their only priority and goal (Littunen and Nittukangas, 2013). For SME's, survival is often not the primary objective but more for growth and sustainability. Startups further establish under multiple risks and extreme uncertainty, making it difficult for attracting necessary resources for survival. While SME's are frequently quite versed in business, they lack the technology aspect. Where startups often lack management and business accruement, they excel in technology and innovation in high-tech industries (Oparoacha, 2015). This notion is even more visible in the AI industry where startups have the innovation, design, and ideas but lack business acurment and prudent resources (Ojagi et al., 2019). Startups are essentials parts of AI ecosystems. They are drivers of innovation in the ecosystems due to their firms' size, which allows them to be more flexible, adaptive, and risk-seeking in developing innovation, compared to more established firms (Audretsch and Belitisk, 2016). Although 95% of startups do not get past the first five years of business operation, the entire ecosystem of innovation that these startups are part of benefit from them (Littunen and Nittukangas, 2013). Furthermore, the ecosystem also creates innovation through acquisition or human capital and knowledge transferred from one industry to the next (Brown et al., 2019). Speaking on the idea

of innovation and startups, Charles-Edouard Bouee, former CEO of Roland Berger, claimed that the next wave of trillion-dollar companies would come from AI startup companies worldwide at the 2018 Rise of AI conference.

1.4 Motivation

Artificial Intelligence is at the brinks of a technological turning point with a more significant impact compared to when the world first welcomed the internet. With any radical change comes great opportunities and obvious risks in business, academic, and social light. With the fast pace of AI, innovation is excelling beyond reasonable expectations, which will disrupt our coexistence and way of life. With that, the AI industry is shifting towards building smart ecosystems to better educate us about technology advancement and their related benefits. AI adoption will accelerate information sharing and decision making and improve the everyday lives of people and businesses. If used wisely, Artificial Intelligence can solve the majority of the world's crises and problems that the world struggles to solve. Some of these problems are world pandemics (COVID-19), rapid vaccines and cures for sick patients; racial discrimination and injustice of people of black people and people of colour; the world hunger crisis, and poverty. For example, AI can provide the optimal solution in growing food more efficiently with minimal resources/cost, provide an efficient supply chain to make products and services more affordable and locally available, and detect and understand viruses at a more accurate and faster rate to produce vaccines to protect human life [see chart 9.1 for selected AI startups providing solutions and expertise for monitoring and tracking COVID-19]. These are just some of the things Artificial Intelligence will be able to do.

The world is just starting to understand the great benefits of Artificial Intelligence and the different levels of Artificial Intelligence and how it is advancing over time. However, to maintain the momentum of Artificial Intelligence, necessary steps and resources need to be set in place to ensure Artificial Intelligence can strive, innovate and grow to solve the changing world problems on a global scale.

The literature review outlines the overview of the Artificial Intelligence ecosystems and looks at some of the seminal work that is contributed in the area of ecosystems, startups, and Artificial Intelligence. These observations underpin the requirement that provide an understanding of growth factors influencing Artificial Intelligence within ecosystems and startups, as well as a framework which startups' founders and decision-makers can use, and AI ecosystems' stakeholders can benefit from.

1.5 Research Question and Objectives

The thesis is framed part of an exploratory study and consequently adopted the use of exploratory methods by way of interviews. With such, the thesis showcases an overview of Artificial Intelligence, the AI ecosystem's challenges, and growth factors from a business and theoretical perspective. Moreover, the thesis aims at providing a framework to guide Artificial Intelligence startup's founders and decision-makers as well as a framework designed to guide stakeholders of Artificial Intelligence ecosystems. The framework takes a holistic approach to guiding AI startups on necessary factors that are required to grow and sustain AI startups. Furthermore, the framework help guides stakeholders within AI ecosystems on the necessary ingredients that are influencing growth and sustainability.

The main objective of the research was to identify any relationship, patterns, and linkage in the success factors influencing AI firms and their ecosystems. Moreover, the research further aims at finding the following:

- The success factors of AI ecosystems
- The success factors of AI startups
- The growth factors/ingredients for AI ecosystems
- The drivers and factors inside the value chain that affect the growth and sustainability of AI startups and AI ecosystems
- The type of Artificial Intelligence applications that drives growth

In order to answer the research questions, the thesis is structured in the following ways:

A. The thesis outlines an overview of Artificial Intelligence ecosystems from a macro, meso, and micro level.
B. Provide an overview of the technology perspective of AI by presenting the types of Artificial Intelligence.
C. Provide an analysis and an overview of growth factors influencing various ecosystems, including entrepreneurial, innovation, business, and high technological ecosystems.
D. Provide an overview and outline the frameworks around ecosystems and startups.
E. Formulate AI ecosystems and a framework for AI startups that will guide startup founders, decision-makers, and stakeholders of Artificial Intelligence.

To achieve these aims, the thesis had observed the relationship, pattern, and linkage in AI ecosystems and AI startups' success factors by answering the above research questions.

1.6 Key Findings and A Summary of The Contribution of This Research

The topic of Artificial Intelligence is broad with various approaches and publications on the subject. Nevertheless, this thesis aims to analyze the factors influencing growth and sustainability for both AI ecosystems and AI startups. Moreover, this research proposes a framework for AI ecosystems and AI startups and further provides empirical evidence around success factors that influence AI ecosystem and AI startups.

To the best of our knowledge, this is the very first study aiming at analyzing AI from a macro, meso, and micro level, studying the success factors for AI ecosystems and AI startup growth, and developing a framework. Thus, this thesis extends the empirical literature on ecosystems and startups framework.

The thesis contributes to the field of research by adding to existing research within Artificial Intelligence, ecosystems' formation, and startup framework. Thus, this research further builds on the ecosystem and AI literature by analyzing AI ecosystem's growth factors and AI firm's success and growth factors. Moreover, this research further analyzes the AI ecosystem from the macro, meso, and micro perspectives of Artificial Intelligence ecosystems at the firm level.

Next, the study also contributes to local and federal governments around the world, business decision-makers, and AI stakeholders globally. Our results show the necessary ingredients to grow the industry of Artificial Intelligence by enforcing necessary success factors to ensure AI startups and ecosystems not only survive but grow and sustain.

Lastly, due to the broad understanding and publication of Artificial Intelligence, the research collects and distributes data manually from multiple sources and the use of original primary data, creating a unique data-set on a global, regional, and firm level.

1.7 The Structure of The Research

The thesis consists of seven chapters that describe and outline the background, literature review, theoretical framework, contextual framework research, methodology, results and discussion of the research findings, a recommendation for further research and conclusion of the research questions. This section outlines the content of each chapter.

Chapter 2: review existing literature from articles, journals, reports, and books to gain an overview of ecosystems, frameworks, and startups.

Chapter 3: highlight the theoretical framework derived from the literature discussions which includes a framework addressing AI ecosystem and AI startup success factors.

Chapter 4: Provide a contextual framework by analyzing the AI ecosystem from a macro, meso, and micro level.

Chapter 5: describe the data sources, our sample information, and the research methodology used in this thesis, which explain the rationale of this thesis approach.

Chapter 6: analyze the data, interview and outline the results.

Chapter 7: examines the critical findings of the research and data, states and addresses limitations, further research, and conclusion.

Chapter Two

2.1 Introduction

This chapter highlights the critical, conventional understanding of development within theoretical paradigms to better contextualize the findings in the research. The thesis is therefore structured and framed by three focus areas, in which this chapter addresses the critical significance that aims at answering the research questions and helping to validate the research findings.

2.2 Ecosystems Growth Factors

According to Spiegel, (2019), an ecosystem is defined as a conceptual umbrella for the resources and benefits produced cohesively, naturally, by a community or region of entrepreneurs and their supporters, which propels growth ventures from the starting phase of survival to expansion. Accordingly, Bandera (2019), describes an innovative ecosystem as a set of the complicated relationship between actors whose sole objective is a technology development, and innovation in-terns create jobs and grow the economy. While there is an ample theme of existing literature of defining the necessary social and economic condition for growth ecosystems for entrepreneurs, Adner, (2017) suggested that for growth inside ecosystems to exist, it must have the characteristics that ensure entrepreneurs have the opportunity for untapped market niches and open access to financing, support, and resources to grow new ventures into a globally competitive company. Bongug (2019) argued that the need to explore a framework that capsulate entrepreneurs within an ecosystem needs to expanded on. Aldrich and Yang (2014) referred to

such a framework as an Entrepreneurial Ecosystem (EE) that expands on the Entrepreneurial Regional Innovation system (ERIS) from Cooke (2007) and Regional Innovation System (RIS). Audretsch and Belitski (2016) suggested that for entrepreneurs to grow in an innovative ecosystem, they must have culture and norms, physical infrastructure and amenities, information, demand and diversity.

Conversely, Rocha and Stemberg (2005) debated that entrepreneurial ecosystems are different from clusters and RIS where EE is built around its core, which is: resources, including knowledge of how to start and grow a business from the start, mentorship, financial capital, and skilled employees in the startup environments. Stam and Spigel (2016) further suggest the model needs to include the internet & connectivity for any innovation ecosystem.

Furthermore, Zhoa and Zeng (2014), suggested one characteristic of an innovative ecosystem's growth is the ability to have financial and research resources. Pucci (2018) further addresses the idea that entities within the ecosystem should be geographically localized and focused on a few and overlapping industries. Adner (2017) claims that those are the must-have to grow an entrepreneurial ecosystem successfully. Conversely, Shaw and Allen (2019), describe the ecosystem in the context of the flow of services to customers, and resources concerning customers that are recycled by business models directly aligned into pathways that are powered by bale co-creation for stakeholders. In doing so, innovation through a new business model reuses scarce resources for the customer in new ways that co-create value more directly (Kaiser and Landau, 2019).

Bandera (2019) argued that innovative ecosystem growth is a combination of startup incubators, regional clusters, and industrial parks that are a high density? Of firms in similar industries collocated in the same geographic location and are managed by provinces, municipalities or

universities to promote regional economic development. However, Kemp et al. (2019) claims (that social capital does not correlate with startup growth in an innovative ecosystem. Despite this claim, the author confirms that in high-tech firms, social capital and growth have a positive correlation. In such, proximity plays a large part in the exchange of information, and the sharing of scientific ideas as startup density and geographic clustering leads to performance benefits (Kapor and Lee, 2013). In summary, proximity is a driving factor of growth and its process because, for example, the density of startups improves the production of efficiency where the ease of resources in a highly competitive environment encourages startups to be quick and proactive in building necessary competencies, and knowledge flows are strong in the same geographic region (Littunen and Nittkangas, 2013). This means that, geographical concentration of interrelated startups compete, however, cooperate. Drawing the question of whether startups need to be born in global firms to grow in a given ecosystem. Turkina, E (2017) did a deep dive into one of Canada's largest, and by far, most successful AI firms headquartering out of the Montreal AI Ecosystem. The author approaches the importance of internal and external networks, which create open channels of necessary resources not only for the firm but for the ecosystem itself. This suggests that the fundamental factors that create successful AI firms are both the internal and external networks of actors. Conversely, Ojaghi et al., (2019) argued that the formation of a startup inside an innovative ecosystem is the interaction between actors that is critical for the growth of the ecosystem. The author further attests that other growth factors include the development of innovation culture, reducing bureaucracy, financial capacities, physical spaces, governance, training, and exclusive services.

Moreover, these actors are made up of incubators, universities, accelerators, and firms which contribute to the growth of an innovation ecosystem. Pan et al., (2010) further expand that three

primary mechanisms form an innovative ecosystem which consists of genesis mechanism that case the proliferation and variety of startups' growth, influence startup's survival; and include the development of innovation which is based on the encouragement of advancing customers' requirement and startup capabilities. On the other hand, Turkina, E (2017) suggested that born global AI firms like Element AI, see the world as their market place and not just a narrow focus on the domestic market. As many business practitioners and scholars before Turnkina, E (2017), would agree that AI firm's commercialization business model is easily adapted, accepted, and reached to its client globally compared to other industry's product and service offering. Whereas, AI startups must embed themselves into the value-chain globally by expanding external networks outside their ecosystems.

2.3 Successful Ecosystem Framework

With the introduction with the concept of a business ecosystem to literature by Moore (1993), a significant number of research has taken place since. Practitioners and scholars alike have added research, introduced the various type of ecosystems in terms of business, innovation, service, platform, knowledge, technology, and entrepreneurial ecosystem (Grawer & Cusuman 2014; Kapoor & Furr 2015; Tsujimoto et al., 2018). Nonetheless, the idea around the ecosystem is of importance, according to Adner (2017), and the importance of further investigating the underpinning framework of types of ecosystems (Adner, Kapoor, 2010). Conversely, Kaiser and Landau, (2019), suggested that there are six focal components required for the development of a thriving ecosystem that are: the nucleus which aligns value proposition on the specific trainable asset, actors that are all entities inside the ecosystem including both firms and individuals, an activity which is defined as a set of interdependent actions which actors undertake within the

ecosystem, a relationship which is where participants inside the ecosystem interact and link to each other, access which is defined as entry into the ecosystem for new entrepreneurs, and governance where actors and actions are formalized and controlled centrally.

Bongsug (2019) draws light on a framework around the digital innovation ecosystem that builds off the existing ecosystem framework. The author added that the use of digital data, computational algorithms, and evolutionary ontology to where a need for research into this area is of interest to both industry and academia. Studies around the evolution of digital innovation moved beyond the study of service, product, and digital infrastructure, which shows resource heterogeneity, recombinant logic, and dynamic changes are focal factors of digital innovation (Clercq, and Voronov, 2011). Moreover, Nambisan and Baron (2013) suggest that high-tech firms inside an innovation ecosystem that is most prevalent where a single firm establishes and leads the ecosystem. Undoubtedly the most driving factor for an innovation ecosystem is the survival of the firm in the critical years, which can be classified as the entrepreneur's need to identify and pursue an opportunity within the ecosystem. The second survival is to recognize opportunity outside the ecosystem in due to the firm’s need to be independent of the platform. Accordingly, Bongsug, (2019), suggests that a digital innovation ecosystem is framed from concepts, regulations, application, organizations, individuals, professional meetings and association, knowledge, and tools. Chae, 2015a; Chen, Chiang & Storey, 2012; Yaqoo et al., (2016) strengthen this position by claiming the digital ecosystem is formed by technical and social means, dynamically interacting and creating the digital ecosystem over time. Recent studies create consistent results with Bongug (2019).

Despite these discoveries in research beyond organizational and individual technologies, macro, meso, and microanalysis are extremely rare in digital innovation literature to let alone the AI ecosystem (Granstramd. and Holgersson, 2019). Furthermore, there tend to be different theoretical frameworks for studying ecosystems in literature but continue to be more on the stage-based models which are not frame to explain the nonlinear pattern, evolution and framework around AI ecosystem or digital innovation ecosystems (Nambisan et al., 2017; Bongusg, 2019). Ojaghi et al., (2019), claim that the need for a conceptual framework which is based on a new body of knowledge may strengthen the robustness of an emerging theory if it has built on construct demand and propositions by previous research are meaningful and valuable.

Adner and Kapoor, (2009), argued that the success of innovation or innovation firms often depends on the direct efforts of other innovations within the environment. Moreover, Gome et al., (2018), suggested that the key for a successful formation of an innovation ecosystem is at the core of the startup survival. Nambisan and Baron, (2013), argued that members of an ecosystem must be bound together by a common goal (market objective or value proposition) where the leverage of knowledge and capabilities coevolve to achieve such goals. Adner and Kapoor, (2009), approach around on their ecosystem framework by identifying various actions in the firm's environment by way of identifying each role following location to where activities are bundled in the ecosystem by the flow of input and outputs of the firm. The authors address the concern of innovation inside an ecosystem, claiming technology innovation leadership are drivers within and depend on the level of uncertainty and location of the said ecosystem.

Moreover, vertical integration outside the ecosystem must be used as a strategy to manage ecosystem uncertainty, assess the technology life cycle, and determine its benefits for its

customers (Kapoor and Lee, 2013). Liao et al., (2003), argued that self-regulation of own cognition and actions is a driving force of growth innovation ecosystem. One in part is self-control of when to resist powerful impulses to undertake a task that is believed to be harmful to the firm or ecosystem or divert away from innovating. The others are grit (being focused and persistent in the pursuit of long term objectives) and metacognition (individual control over individual awareness of their genitive process (Panetti et al., 2019) are relevant in a complex environment of innovation ecosystem entrepreneurs (Rong and Shi, 2015). Therefore, what you pursue and how you pursue is an effective growth factor of firms in the innovation ecosystem.

Gome et al. (2018) created a framework around the formation of innovation ecosystems by assessing startup firms. With that, the authors suggested that managing uncertainty would sustain all actors by way of the firm process, which includes capturing value creation or the business idea, then creating actual value, where investors and government will support the business model financially (Samuelson and Davidson, 2009). After that, actors outside the firm, including co-producers and complementary assets, will flow through distributors down to the final customers where firms manage uncertainty both collectively and individually around the process. As in line with Adner, 2017, Gome, 2017 also confirms that entrepreneur's actions managing uncertainty impacts their innovation ecosystem partners (actors). Uncertainty in entrepreneurs within an ecosystem remains a significant gap in literature and research. The single most common certainly in emerging innovation is uncertainty, and entrepreneurs must search out and exploit opportunities in the market and also the technological boundaries of the ecosystem (Nambisan and Baron, 2013).

Takahash and Gimenez (2018) argued that the geographical dispersion of the firm's partners play a factor in innovation ecosystem growth, and innovation ecosystem boundaries are not

geographically delimited. Rinkinen et al. (2018) suggested that ecosystems must create policies that govern startup in innovation and economic development, which is in line with Moore (2017), who argued that the ecosystem is a catalyst for new entrepreneurship. By helping ecosystems, it creates new opportunities space for innovation and attraction of entrepreneurship. Instead, a relationship with partners is what is most emphasized over the location.

Conversely, Walrave et al. (2018) emphasized the idea that the innovation ecosystem is formed by public actors with supra-regional policies for strengthening the development of the industry on a regional level. Furthermore, Mason and Brown (2014) argued that an ecosystem could be fully supported and grow through the implantation of a holistic policy. Ylinenpaa (2009) argued that policies focus too much on reciprocal links rather than on the ecosystem approach, and large firms are important collaborators partners for startups and further attract keystone organizations to join into the ecosystem, which is a driving force of ecosystem growth. Granstrand and Holgersson (2019), suggested that an innovative ecosystem must have actors, activities, and artifacts that continuously interact with each other. Innovation is value creation by definition something new to all, and useful to some actors; however, it destroys value, being harmful to some actors (Yo et al., 2012). Xu (2016), claimed growth and formation is defined in the field of innovative ecosystems by focusing more on collaboration actions, and little on components of competition/substitute and artifacts (resources, technology, products, services, etc.)

It then can be argued that innovation ecosystem growth is influenced by an organic and dynamic interrelationship formation in which firms grow with external firms that access essential resources for creating an innovative product or service (Turkina, 2017). Therefore the firms seek out specific resources provided by firms inside the ecosystem, globally dispersed, aiming at cost and risk reduction (Takahash and Gimenez, 2018). In terms of product and service production,

local manufacturing factors allow financial and economic gains to firms. That is, localization of product produce faster and higher velocity in the introduction of new product in the market and ensure competitive advantage to the innovative firm (Su et al., 2017). Rapid research is required to help stakeholders make informed decisions about complex and quick emerging innovative ecosystems. However, the concept to which underlie digital ecosystems or innovation ecosystems are not well defined, coherent, nor commonly accepted (Shaw and Allen, 2016).

2.4 Startup Success Factors.

Su et al. (2017) suggested that the survival of startups within an innovation ecosystem is built on the benefit of the overall ecosystem. Furthermore, it is difficult for a single startup to acquire all the necessary elements for successful innovation (Rong and Shi, 2015). Pan et al. (2017) argued that a niche is seen as a form of disturbance for the progress of the dominant socio-technical regime, whereas the niche provides a possible alternative to industrial and social development in a domain. Nevertheless, this alternative trajectory cannot be sustained and explored by learning from peers only (Hu et al., 2016). The further driving force from sequences of experiments in various local texts, eventually adds up to a niche trajectory, according to Adner and Eucher, (2014). With that, some researchers argued that innovative startups are born out of a central node, such as a technology platform and often, a set of socio-economic conditions that bring key stakeholders together (Su et al., 2017). Caputo et al. (2002) discovered that this resulted in the initial divergent and dispersed routines and processes becoming more specific, articulated, and stable over time. With such changes, any attempt that startups make to commercialize new technology that follows these process and routines are likely to survive and grow (Adner et al., 2013). Protection for a niche in the early stage is a crucial aspect, as niche actors are not likely to

survive the cycle if pressure is exposed too early (Amit and Zott, 2012). Such protection is argued that it can come in the form of financial and non-financial support for startups in high-tech sectors. That support includes tax breaks, grants, subsidies, or market stimulation mechanisms (Autio et al., 2014). Non-financial includes the legal requirement, policy support, education, and public appraisal (Yoo et al., 2012).

The use of niche protection creates an environment for entrepreneurs and other startup actors to exploit the mechanism and grow over time (Walrave et al., 2017). Moreover, available resources other than protection schemes are more likely to enable startups to learn, develop, and grow over time. Startups without available resources, including financial assets and human capital, will have much less opportunity in active engagement compared to startups with substantial resource availability (Ceccagnoli et al., 2012). Hu et al., (2016) suggested that the speed and phasing of socio-technical transition is a factor for startups and the ecosystem. While punctuated equilibrium theory argues that at times socio-technical environment transition path-breaking innovation rapidly, path-breaking innovators tend to adopt a longer time horizon in trying to convey their EVP (Storey, 2005). Shaw and Allen (2018) further suggested that startup successes arise from the achievement of internal alignment, and external viability are both dependent on the configuration of the EVP and EM. Oparoacha (2015) also suggests that networks of government, suppliers, financial institutions and complements, intermediary agents, customers, research institutes, universities, and competitors constitute the entrepreneurial environment that supports entrepreneurial activities.

The proceeding chapter extrapolates a theoretical framework that is based on the review, underlining paradigms, and understating from literature. It will outline a theoretical framework that was derived from the literature discussion and review.

Chapter Three

AI Startup & Ecosystem Framework

3.1 Introduction

Based on the literature review, a theoretical framework for AI ecosystem success factors and AI startup success factors are proposed. Various internal and external factors should be considered when AI firms are set up to be part of an ecosystem or starting up in general. Conversely, similar considerations should be taken when it comes to the AI ecosystem. The proposed framework is intended to be used by AI firm's founders, key decision-makers, and AI stakeholders as well l as in conjunction with providing business and technical perspectives highlighted in this research.

3.2 Outline of the Framework

The proposed framework is organized into two parts with subsections for each:

3.2.1 AI Startup Framework

- Review the AI market assessment model
- Identifying AI use cases, clients, opportunities and optimum location
- Identifying key resources
- Assess technology readiness, optimize the firm structure, time to market and commercialization

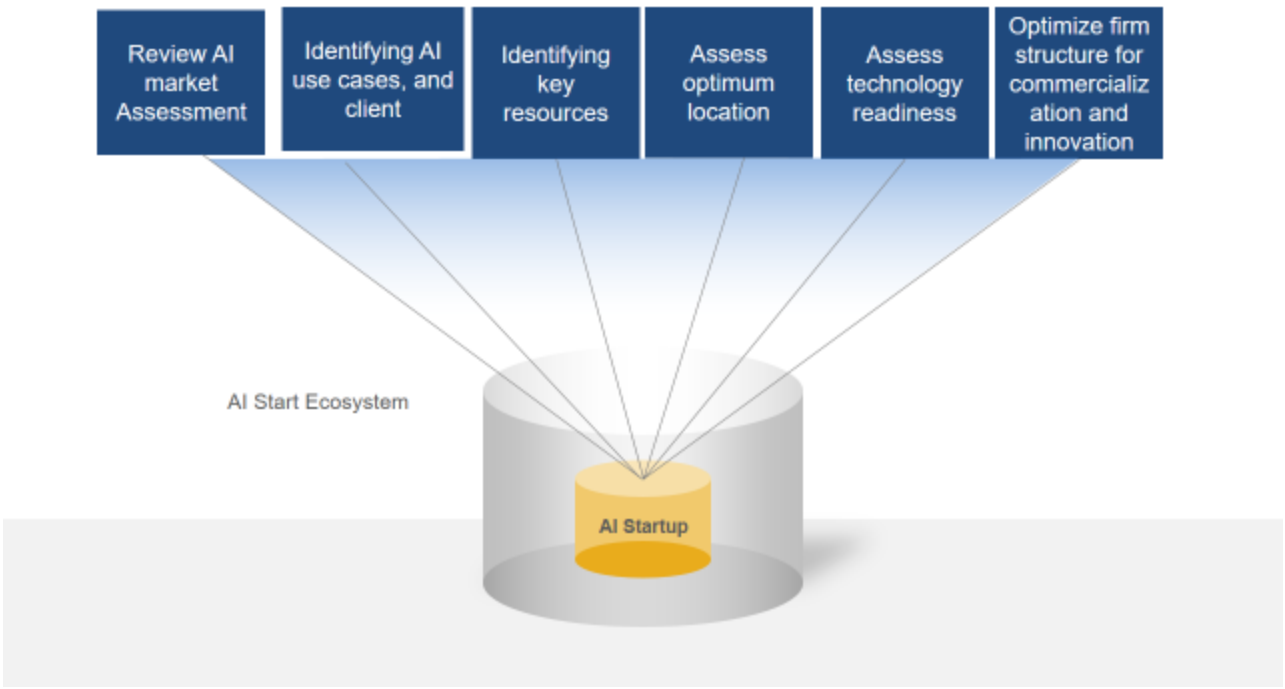


Figure 4: AI startup Framework. (Source: Author)

The review of the **AI market assessment model** guides founders in evaluating the AI market to establish a competitive position advantage by assessing the AI market globally and locally. Industries and organizations will need to transform the disruptive nature of AI. The AI, market assessment model provides a holistic approach to analyzing the 'current state' of the artificial intelligence market and seek out opportunities by aligning market demand & requirement with the founding resource and talent. The founder can assess the following within the AI market to better position its startup for organic growth, sustainability and fist-five survival:

- AI market revenue market by AI sector
- AI market funding by industry, sector and use case
- Growth ratio for startup by industry
- Industry AI adoption, and top use cases

- Total number of AI startups by ecosystem, country and globally
- Patent research locally and globally
- Expert talent and talent resources locally and globally
- Distribution of AI firms by industry within an ecosystem
- Business and customer acceptability of AI by sector and country
- The potential impact of AI by industry and value creation
- Local industry analysis on the AI market and potential clients

Identifying AI use cases, clients, opportunities, and the optimum location is an assessment for startups' decision-makers and founders to evaluate the best case use to attract buyers while maximizing long term relationships and opportunities by selecting the perfect location to start. This assessment will help evaluate the current state of AI adoption, gain specific industry knowledge into sectors of potential customers. Furthermore, this will create a 'realistic' timeframe in which the AI adoption progress will be for various industries by identifying a given industry AI adoption phase, which is categorized as AI pioneers, AI investigators, AI experimenters, and AI laggards. By understanding the specific industry and AI adoption phase, startups will gain a better understating of market expectation and delivery, and build trust for AI partnership. The next phase is to seek out all potential opportunities by creating a competitive advantage by way of market position, type of AI offering, type of customers within the startup catalog, and level of partnership with various industries and other AI ecosystems/firms. Location is key in establishing proximity from the necessary resources, customers, and the value chain. It is important for startups to be positioned in a physical location that is close to funding, talent, and depending on the type of AI offering, necessary networks, and AI labs.

The **identifying key resources** include funding, talent, equipment, patent protection, and infrastructure and establish networks. Funding is one of the single important resources startups require to strive, grow, and innovate during the process of startup. A startup is as good as the talent it acquires, including AI experts and business intelligence. Where AI startups require both savvy business talent to navigate the business side of the firm, tech-savvy talent is needed to build out the AI. Infrastructure is a key resource that includes big data, AI labs, and supercomputers (compute power) to design, build, and deliver the AI. Next, is patent protection, with the growing number of AI startups worldwide and its demand, startups need to seek out protecting its AI application through patent protection to secure growth opportunities and gain competitive advantage. The last resource is effectively establishing networks and partnerships through various actors, including unicorn AI firms, government agencies, AI stakeholders, other AI firms, and customers in target industries. This is an important resource due to the valuable knowledge sharing, openness of collaboration inside and outside the startup.

Assess technology readiness, optimize the firm structure, time to market, and commercialization is the next step. First, the prioritizing efforts when assessing a particular industry or organization's ability to use AI and generate business value. For example, what should be addressed is the Foundational Readiness: data storage, could resources, software packages and server infrastructure. Operational Readiness: strategic leadership, skill and expertise, cybersecurity, agile delivery, and operational management. Transformational Readiness: business acceptance, clarity of business case and business opportunity. Next is 'time to market' which is, how fast AI can be deployed into the organization from the initial design

stage. Having a fast time to market, generate competitive advantage and further creates trust among customers, which influences organic growth for startups. The commercialization process is the stage where AI firms can bring the AI application from the design phase to the deployment phase on a large scale. Without commercialization, there will be no revenue, and without revenue, there will be no growth. Lastly, optimize the firm structure to deliver a balance between optimum time to market, continuous funding, talent acquisition, which in turn will commercialize AI application to realize profit and growth.

3.2.2 AI Ecosystem Framework

- Ease of entry for startup firms and market demand
- The support structure, firm structure, and market connectivity
- Openness and knowledge sharing culture
- Customers and Unicorn ecosystem leaders
- Optimize resources of talent, financing, government policy and infrastructure (big data and supercomputers)
- Sustainable cost structure and optimized location
- Political stability and social acceptance of AI
- Collection of influential networks and actors
- Competitive advantage- speed to market commercialization, affordability, expert talent, AI use case (rapid innovation process) and cross-pollination

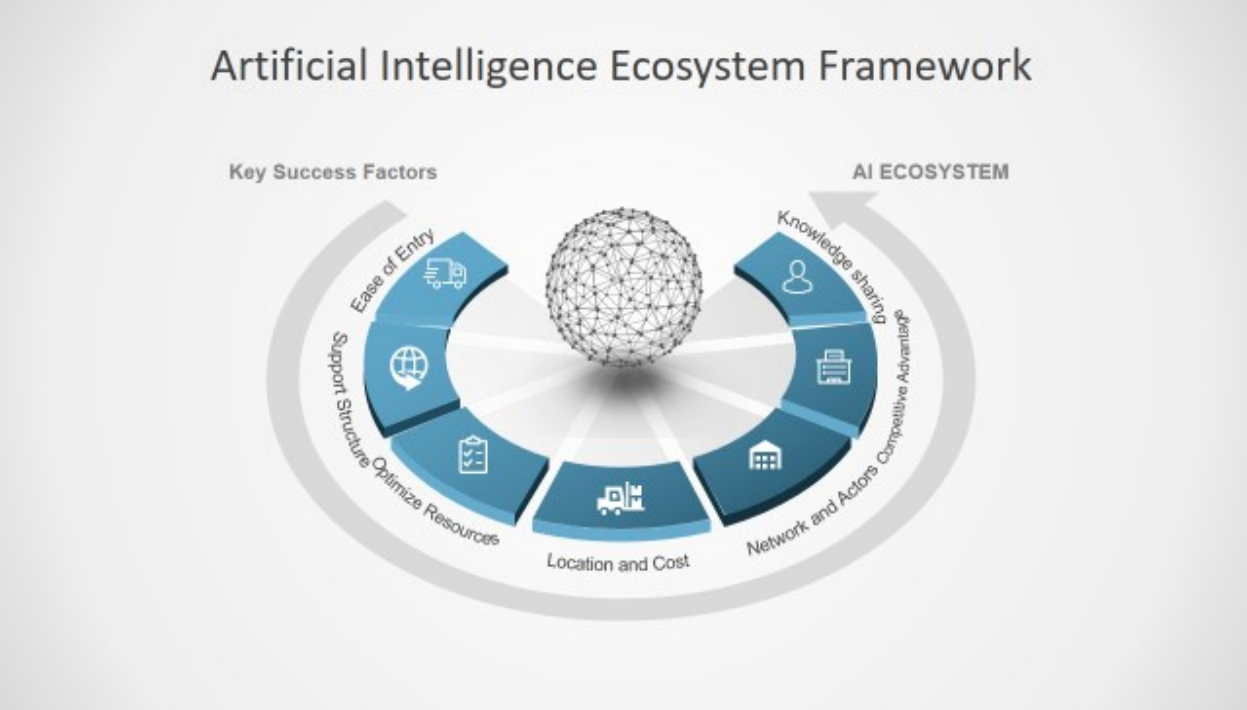


Figure 5: AI Ecosystem Framework. (Source: Author)

The **ease of entry for startup firms and market demand** is one of the success factors for an AI ecosystem. That is, the AI ecosystem needs to be barrier-free for AI startups to enter the ecosystem and grow. Since AI ecosystem growth and sustainability are correlated with the growth and success of AI startups, including firm structure and size, by providing an entrepreneurial environment for AI startups, ecosystems can organically grow through startups, increase innovation and create a collaborative, competitive landscape which all influence growth. Furthermore, the specialized field of AI and industry that AI startups focus on is a factor. For example, an AI ecosystem must promote AI startups that focus on AI applications and industries which the market demands to indirectly and directly add value within the ecosystem.

The **support structure, firm structure, and market connectivity** are the next ingredients of the AI ecosystem growth factor. The support structure is when AI firms actively participate in the ecosystem and are able to seek out resource support openly. These resources can range from access to big data, immigration reform to support the acquisition of talent, research and development centers, patent protection agencies, capital, clients, and open research labs to support AI firm's application and algorithms. AI firm structure is vital for the success and growth of the firm. With firms, growths come ecosystem growth, and AI firms must optimize their resources and commercialization by effectively structuring the firm to meet economic pressure and market shift inside and outside the ecosystem. Market connectivity is when all stakeholders, including firms, universities, labs, and talent within the ecosystem, are aligned with the market demand, technology readiness, and industry adaptation to pivot and adapt to industry technology requirements and business cases.

The **openness and knowledge sharing culture** are critical aspects that contribute to ecosystem growth. The openness to collaborate with other AI firms, customers, industries, and larger firms is necessary for growth and sustainability. For example, if an AI firm discovers a breakthrough technology where the technology was acquired by a large giant. If that large giant or AI firm decide to hoard the technology and not share it within the ecosystem, then it creates a lagging problem of innovation and growth for the ecosystem. If the tech shares as open-source, then other AI firms can adapt to the tech with existing resources and infrastructure. This, in time, will create a competitive advantage outside the ecosystem and create attractiveness not only for customers but for talent. Knowledge share culture is where stakeholders inside and outside the ecosystem are open to collaborate and knowledge share among AI firms, other stakeholders, and decision-makers to enrich aspects of AI application prosperity.

C**ustomers and unicorn ecosystem leaders** influence the growth factor of the ecosystem in ways of revenue generation, attractiveness, and strength. The main objective of the entire existence of a firm is to generate profit. Customers are the most critical aspect of profit creation, and without profit, the firm cannot grow, sustain, or survive. Having the right customers is also crucial in terms of customers who are industry leaders since other organizations within an industry traditionally adapt to the actions of the industry leader. This will create future demand for AI applications within industries. Ecosystems having one or more unicorn AI firms will ease the tension around investment and talent within the ecosystem, due to the skepticism of growth and survival which is lifted when unicorns are around. Moreover, unicorns can rapidly disrupt industries, innovate faster and attract expert talent and influence stakeholders within the ecosystem.

Optimizing resources of talent, financing, government policy, and infrastructure (big data and supercomputers) are the foundations of success factors. Resources like talent and funding are a must-haves for any growth and sustainability of an AI ecosystem. The funding is required to fund AI projects, use-cases, purchase equipment, and pay salaries. Without funding through investment, grants or customers, the survival of firms is not likely. Talent is also the single most crucial factor for both inside and outside the firm. Having the expert talent to build the technology and further conduct research and development in support of the overall ecosystem plays a vital role in growth.

Moreover, the right government policy, which creates an environment to support AI inside and outside the ecosystem in ways of privacy, access to data, security, tax breaks, economic stability, free market, and immigration reform, are some aspect government policy help to keep the ecosystem growing. Lastly, infrastructure is as critical as anything else. An AI ecosystem needs

adequate supercomputers to design, test, build, and deploy AI application efficiency. Big data is said to be the currency for AI application, and having unrestricted access to big data is a must-have for continuous growth.

Sustainable cost structure and optimized location are the next ingredients that influence growth and sustainability within the AI ecosystem. As technology becomes more advanced, the cost for development is unpredictable and volatile, which creates an unforeseen financial barrier for completing projects, research, and AI applications. Sustaining costs through green power, living expenses, operating costs, and commercial space are some factors to consider in sustaining cost. Location optimization is a factor when considering the AI ecosystem. Location selection is based on access to necessary resources, including funding, talent and cost of living/operating, proximity to the value chain, customers, and an area where the ecosystem can benefit the greatest from knowledge spillover.

Political stability and social acceptance of AI are the factors outside the ecosystem that directly influence the growth of the ecosystem. A free market is correlated with political stability for which the ecosystem can strive and grow organically. Moreover, political stability provides confidence for investors, customers, large firms, and talent in a country that is hosting the AI ecosystem. The social acceptance of AI, along with the trustworthiness, is an essential factor what drives ecosystem growth. That is, the more customers and businesses accept AI in a given industry; the region and country will continue to move the production line for AI applications rather than holding up inventory. This will create further demand and the need for more business cases, which results in AI growth.

The **collection of influential networks and actors** is known to be a factor for ecosystem growth and sustainability. A network of actors inside and outside the AI ecosystem each play an essential role collectively. These actors include government agencies (federal and provincial), private investors, universities, AI pioneers, significant industry leaders, supplies, and customers. The networks are that of the value chain, technology industries, other AI ecosystems, business experts, financial institutions, and other networks of influencers outside the ecosystem.

Competitive advantage- speed to market commercialization, affordability, expert talent, AI use case (rapid innovation process) and cross-pollination are on the list of growth factors for AI ecosystems. AI ecosystems need a competitive advantage where all firms operating within the ecosystem have something that they are great at coercively including but not limited to speed to market, commercialization, concentration on specific industries, and innovation in areas that create business values and market disruption. Affordability of AI applications that are available to everyone, anywhere like Microsoft word. Furthermore, having the ability to cross-pollinate effectively with industries and existing business models influence growth.

The next chapter provides a contextual framework that aims at analyzing the AI ecosystem from a macro, meso, and micro (firm-level) in order to help bridge the gap between the literature review and the research. Moreover, the next chapter is structured and framed to address and help answer the research questions ahead of the research.

Chapter Four

Contextual Framework

4.1 Introduction

The importance of a contextual framework is that it plays a significant role in constructing validity and sets the scene for the research. Moreover, this chapter provides a brief analysis of AI globally, highlighting the top growth of AI ecosystems and the reason for their growth. The chapter further analyzes AI ecosystems from the macro, meso, and micro level, which aligns with the research and help bridge the gap in the literature review and discussion. The first part (Macro level) outlines Artificial Intelligence Ecosystems globally by assessing each country/region growth factors individually and global policies which influence AI. The second part of the chapter (Meso level), analyze the current state of Canada's AI Ecosystem as a whole to assess the factors influencing growth. The last section of the chapter (Micro level) explore Montreal and Toronto AI ecosystem by doing a deep dive into the characteristics, structure and other specific influencing factors of AI growth.

4.2 Macro Overview of AI Ecosystems

Artificial Intelligence (AI) has taken the global stage as a leader for economic growth and dominates through innovation and efficiency, just to name a few. Conversely, AI is embraced by a more significant number of businesses, governments, and individuals due to its track record of productivity and efficiency between those sectors (ARIES, 2011). Furthermore, a shift in

exponential growth has been seen in startups thanks to the benefits of AI. According to Clark (2015), the risk of countries, government, and businesses not using AI to innovate create a significant gap leaving those at the bottom further and further behind, making it less possible to become competitive with industry leaders. Whoever owns the most robust AI controls the economy and world (Baura, 2019). Perhaps this is the reason why nations are racing to become the subject experts in AI, aka alien tech. Moreover, nations, including Canada, are at the forefront of embedding AI at the federal level by offering an abundance of resources, including flex policy and financings (Deloitte Omnia AI, 2019).

Since the introduction of AI in the 1950s, researchers and innovators have showcased more than 340,000 AI-related application and published over 1.6 million publications between 1960 up to early 2018 (Singh, 2019). This large number can be attributed to a social and technological shift in change in a traditional business model where more and more companies are switching their focus towards Artificial Intelligence as they incorporate cognitive technologies and machine learning into current offerings (Russell and Norvig, 2016). With AI disrupting the industry, it is shifting the familiar economic model of a single dominant pole, a leading system of governance, and primary technology is being replaced by multipolarity (Flower, 2000). This means that startups and large firms that implement AI must make a priority the plethora of paradigms, governance and technologies as big data becomes the new shipping route internationally. For example, cloud storage is taking the place of shipping containers, and digitization and decentralization are vastly replacing conventional transaction and means of communication.

The surge in AI started to take shape in 2001, but the shift from AI theory to the commercialization of AI surges between 2010 and 2016 (Hau, 2018). Despite these staggering figures of AI-related patents, the entire AI market globally is expected to reach $390 billion by

2025, with an anticipated CAGR of 46.6% from 2019 to 2025, according to Grand View Research (2020). Accordingly, the number of AI patent applications filed globally grew between 2010 and 2017 by a factor of 6.5 (OECD, 2019). This spike suggests that the number of patent applications relating to the commercial application of AI solutions lags that in AI publication by roughly ten years (Aghion et al., 2018). The world is connected more than ever online, resulting in an increase of data which means, a breathing ground for more AI integration across the board. AI is changing the economy where oil is no longer the most precious commodity, but rather big data as AI takes center stage for most sought after.

On the contrary, it is suggested that the number of AI patent application to publication is increasing, showing a greater interest in the actual use of AI globally (Stone et al., 2016). The AI undertaking application is more common in machine learning, followed by logic programming and then fuzzy logic (Dirican, 2015). The most popular type of AI is that of computer programming, which includes speech processing and natural language processing. In that, the top industries to which AI are patents are in order of telecommunications, transportation, life, and medical sciences (Alsheibani et al., 2018). However, nearly all industries show steady growth in patenting activity in the past five years (Barua, 2019). The field of Artificial Intelligence has a noticeable publication of literature for modeling of technical systems which implement machine and deep learning methods. However, very few literatures aim at connecting literature for both the success factors of AI startups and AI ecosystems, businesses, and identifying the development of a framework for AI startups and AI ecosystems.

The first stage of digitalization has showcased without much government influence despite the fact that Google and Facebook are now under the radar with plans to break up their monopolies, government influence is lagging behind the market argued some critics, which perhaps would

either lag the AI market or create more innovation capabilities (Agrawal et al.; 2018). However, AI has been viewed as a multitude of initiatives, governance, and strategies of various government grounds world-wide. The reason for this is, AI can shift and impact climate protection, economic policy, governance of the domestic industry, and the privacy and security of all citizens (Chen, 2019). In recent times, a national strategy and action plan were introduced for AI globally. However, the European Union is at the crossroad of whether or not to invest in investment-intensive strategies and long-term plans of AI due to the high cost of AI long term plans (Faggell, 2019).

Conversely, countries, including China, have a more precise plan on how the country wishes to propel AI and become a powerhouse of AI (Becket and Ge, 2017). China's vision on AI is influenced by the country's outtake on economic success, military dominance, controlling one's citizens, and muscular foreign policy (Bandera, 2019). Combined with China, the USA, and Japan capture 78% of the total AI patent worldwide; still, China and the USA hold the most AI publication globally (OECD, 2018).

Despite the US landmark companies who are the leaders in AI research, which includes Amazon, Google, Microsoft and Facebook, and with the popularity of Silicon Valley, the US has yet to find a finite line of long term plan for AI as China (Xinhua, 2016). To that effect, the US has been promoting research and development in AI and partnering with private firms through various ministries and secret services (Russell and Novig, 2016). With Geoffrey Hinton, Yoshua Bengio and Yann LeCun, who are considered to be the strongest researches in AI globally, make Canada a great beneficiary of AI in the last 7 years. Conversely, Canada like China has a clear vision of AI long term initiative over the years (Easton, 2018)

Israel has become as noticeable as Canada in the AI global stage in terms of long term initiative, however, Israel is still a smaller player. Despite this norm, Israel has more AI companies compare to France and Germany together due to Israel AI ecosystem. Israel successfully bridges a network of universities, access to American and Asian capital markets and close relationship with the government and the military (Chen, 2019). To prove the progress of Israel AI breakthrough, Mobileye (Israel AI firm) was purchased by Intel for $15 billion (CAICT and Gartner, 2018).

Despite government influence into AI which provides the framework conditions for research, data, financing and regulations, in the interim, AI must be developed by firms and brought to the market (Hidemichi and Shunsuke, 2017). That is, private enterprise is the pinnacle of the distribution and commercialization of AI. For example, global players including Google, Amazon and Microsoft who are considered global leaders in AI and; Tencent, Baidu and Alibaba are significant players of AI on the world stage and act as a catalyst during the transition of AI being fully accepted by consumers, globally. Conversely, Berger, (2019) argues that there are two types of companies when it comes to AI, those that develop and distribute AI and those that implement AI to complement their value chain. Nonetheless, firms that compete today, either domestic or international, big or small, have to interact with AI in one form or the other. The primary driver of AI is to reduce costs and maximize profitability in any business atmosphere, and that can translate to innovation (Singh, 2019). On one side, AI can be integrated into a firm's business processes: prediction, sales, administration, management, accounting, controls, compliances, and recruiting. On the other hand, it can replace existing and traditional business models (Faggell, 2019).

According to the OECD, (2019), who reported that the AI ecosystem has attracted more than USD 39 Billion in private investment in 2016 alone about 70% of this amount are from large firm's internal investment, where 20% are directly for AI startups, and the remaining 10% is for acquisition. On a global scale, large tech firms are acquiring AI startups at a rapid pace (Osborne, 2019). This suggests that larger tech firms with capital are creating growth through AI startups. Or perhaps the large influx of investment from the private sector helps drive growth for AI startups, which grow the ecosystem. For example, AI represents 12% of total investments for startups globally, an increase from 3% in 2011 (Alsheibani et al., 2018). Furthermore, China and the USA account for the total investment in the private sector. This indicates that the top 2 leading AI ecosystems are strongly correlated with access to capital (Panetti et al., 2019).

4.2.1 The US

The US leads the race in the global market for AI with 40% of the world's market share while China leads 2nd, and Israel gasp on 3rd place for leaders in the world's highest growth AI ecosystems (Hidemichi and Shunsuke, 2017). While other countries lag behind the AI race due in part of the integration of funding, research, entrepreneurship, and mergers & acquisition, to grow and sustain their respective AI ecosystems (Osborne, 2019). Globally, there are not enough real problem-solving AI solutions available, but far too many Chabot that have crowed the AI space (Alsheibani et al., 2018). It is without surprise that the US has the largest AI ecosystem worldwide, and that number would increase if taken into account headquarters in the US while their plant is located globally in countries including France, Poland or Israel. This is due to the US leadership in its capital market and access to funding and governance, which promotes AI (OECD, 2019). That is, over 16 plus government agencies support the research and development

of AI politically and financially (Hall and Pesenti. 2017). Furthermore, the US has an excellent integration of universities (MIT, Harvard, and Stanford, along with private firm support of research facilities, including Google DeepMind and Microsoft AI (Berger, 2019). As mentions earlier, these are the factors to consider for the growth of an AI ecosystem. Despite being the global leader in AI, the USA falls second behind China being the 2nd most AI patent filing (Hidemichi and Shunsuke, 2017)

4.2.2 China

China leads the global AI ecosystem by a staggering 38%, where China is ambitious to be the world leader in AI by 2030 (Faggell, 2019). As such, China's initiative to intergrade AI into its government policy and finance is shown as a priority where China's startups are well funded financially and politically (Chen 2019). Furthermore, China has the most substantial growth over the past decade for published AI academies' papers and has a steady growth of AI startups. Conversely, China has led the world in patent filling as number one (Becket and Ge, 2017)

4.2.3 Israel

Despite being the 3rd leader in AI worldwide at 11% of all AI firms, Israel per capita of 8.5 million, citizen, Israel has 40 times more AI firms compared to the US which marks Israel the hidden global champion of AI leader (Hidemichi and Shunsuke, 2017). One explanation with this push to be a global powerhouse of AI is the network of Israel technology sector, the military, tech universities, a robust entrepreneurial ecosystem, and access to capital (OECD, 2019).

4.2.4 The UK

The UK is at 4th as the leader in the AI ecosystem at 7% and is the top leader in the entire European Union by far (Berger, 2019). This has to do with the financial hub in London, which creates access to capital for AI startups (CAICT and Gartner, 2018). Moreover, with the investor and entrepreneurship environment the government created over the years, it has been made possible along with excellent universities that integrate well with AI (Singh, 2019).

4.2.5 Canada and the Rest of the World

Canada has made its debut to the AI world stage some time ago and has become visible over the years despite being the world's 5th leader in AI (.JFGAGE, 2018). While Canada has a considerable influence on government funding, university integration, and entrepreneurship policies, the main driver can be derived from Canada's Deep Learning Mafia from Toronto (Easton, 2018). That is, Yann LeCun, Yoshua Bengio, and Geoffrey E. Hinton, who headed the Deep Learning renaissance over the past seven years. Lagging behind Canada is Japan trailing at 3.1%, France at 3.1%, and Germany at 3% of total market share for global AI (OECD, 2019). All these economies are strong with a large domestic and financial market. With an innovative country such as Germany and Japan, the effort to develop AI to be a global leader is quite small in contrast to that of Israel, China, and the USA. Moreover, the same can be said for countries including India (9th place), Russia (20th place), Brazil (17th place), and Spain (13th place), which all have a shortfall of developing AI companies (Panetti et al., 2019). This trend can be contributed by the lack of funding, integration, and free flow of the market for entrepreneurship; these countries will be depending on AI resources from the top 5 world leaders of AI.

4.2.6 Top Cities for AI

According to OECD (2019), the world's more immense AI hub in Silicon Valley followed by London, Tel Aviv, New York, and Beijing. Then follow by Boston, Tokyo, Shanghai, Los Angeles, and Paris. Berlin, Toronto, Shenzhen, and Seoul are next in line for the top spots for global AI cities. This shows that the USA has 4 top cities of AI in the world out of the top 10, while China takes the 2nd spot of largest city AI hub. However, Toronto is ranked 12th, while Canada is in the top 5 categories as AI leader.

According to Alsheibani et al. (2018), the economic impact of AI adoption over the next ten years will be between $1.49 trillion and $2.95 trillion. During that time, AI is predicted to innovate industries in the following ways but is limited to (Chen, 2019):

- Virtual assistances that assist humans from perusal finances to various services
- Automation to which no human interactions is required
- Improve language processing which allows the computer to understand better
- AI that identifies objects that are used for facial reconstruction, and car-safety stems
- Create efficiency in manufacturing, supply chain, and design engineering

4.3 Meso Overview (Canada)

As Canada becomes a global leader in AI, it is without a doubt that the Canada AI ecosystem is growing at a faster than reasonable rate. However, although Canada continues to add a massive influx of AI startups to its ecosystem up to 2018, fewer startups in the sector in the past few

years were seen (Easton, 2018). Conversely, funding for AI remains on the rise, with approximately $660 Million (US) being invested in 2018 alone (OECD, 2019).

Large organizations in Canada and around the world are investing in AI in the hope of boosting their bottom line through innovation and efficiency (Bahrammirzaee, 2010). Business investment continues to be on the rise, where a reported 70 AI labs are in the form of corporate facilities (Easton, 2018). To that, about 50% of the total enterprise solution market is in AI in 2018 (OECD, 2019). The Canadian AI market has the potential of growing, considering AI only represents 5% of the total revenue of the total enterprise solution market in Canada.

As of 2018, the Canada AI ecosystem is made up of more than 650 startups, over 60 investor groups, at least 60 public research labs, and over 40 accelerators & incubators (JFGAGE, 2018). The major provinces which have a dedicated AI hub are listed from larger size hubs to the smaller: Toronto, Montreal, Vancouver, Waterloo, Ottawa, Quebec, and Edmonton (Easton, 2018). Chart 2.1 below illustrates the geographical distribution of AI firms in Canada as of 2018.

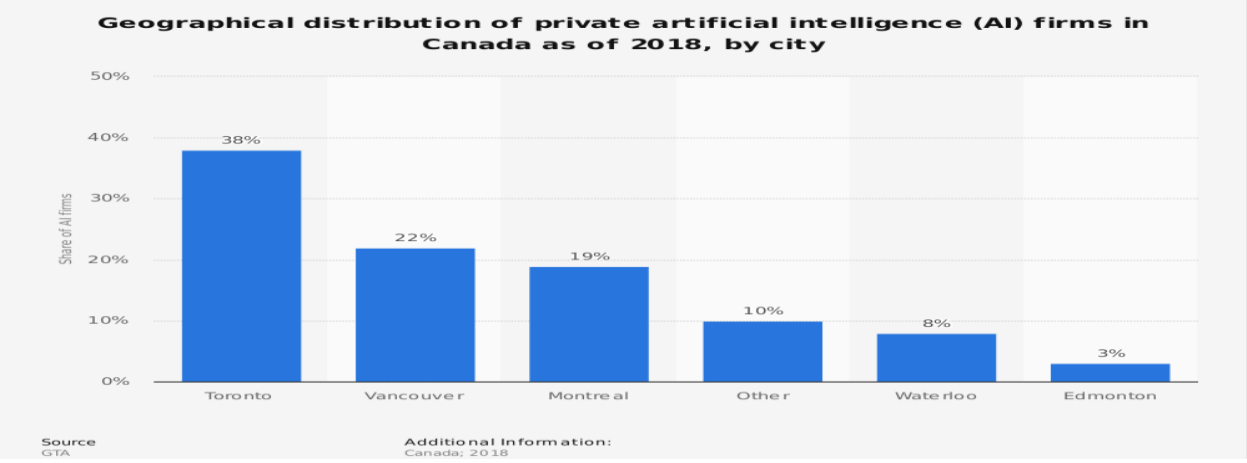


Chart 4.1

4.3.1 Canada AI Startups

Despite the Canadian tech industry showing a slowdown in the growth of new companies over the past few years, the AI startups have shown growth over the past few years. That growth starts to follow the industry overall in 2018, meaning overall growth in AI startup fell to 5% in 2018 compared to 29% in 2017 (Berger, 2019). The slowdown in AI startup growth is correlated with AI startups that developed early in the current market cycle, while the run rate of AI startup has remained consistent. Furthermore, according to the startup genome project, it is estimated that 90% of all startups will not survive past the fifth year of operation, and Canada is at the peak of that five years since the last AI boom between 2011 and 2012. This means that this is an expectation in the ecosystem lifecycle model.

4.3.2 Government

Under the government of Canada's support of AI, Canada is credited to be the first country in the world to adopt AI as a national strategy (Becket and Ge, 2017). With the government on the federal and provincial level vesting over $125 million, which was announced in the first quarter of 2017, it shows the government continuing to support AI research and commercialization (Easton, 2018). Thereafter, other countries follow suit, including China and the USA, which announce strong government support in developing AI ecosystems in their respective countries (Faggell, 2019). To which, the government of Canada takes the further initiative beyond investment by implementing the new initiative on AI regulation, which includes data protection and algorithmic accountability. That is, the directive on automated decision making and algorithmic impact assessment (AIA) aims to frame corrective principles of fundamental justice and the rule of law, including fairness, due process, transparency, and the right to an explanation (KPMG, 2019). The main purpose of such decree is to better inform better governance of AI for

private players, which in turn will gain Canada's momentum on differentiation as leader of multi-stakeholder AI research and development (Easton, 2018).

4.3.3 Talent

As the AI industry sees a steady growth year over year globally, talent becomes the forefront of growth and a critical element of any ecosystem (Ylinenpaa, 2009). According to the 2019 global AI talent report, Canada is ranked the top five in both numbers of high valued researchers and supply of talent, along with demand in terms of job openings on indeed.com. Accordingly, the AI talent pool is both versatile and mobile in terms of location flexibility. For example, studies shows that one-third of AI researchers work form AI firms in countries that they did not receive their Ph.D. (Spigel, 2019). Canada is at the forefront of attracting AI talent globally, where that number is steadily growing; however, Canada's retention rate of AI talent is moving in the opposite direction (Easton, 2018). This is due in large part to the vast number of outflow of graduates from universities compared to the 18 other leaders in AI research (Oparoacha, 2015).

4.3.4 Investment

To date, 2018 was the strongest year the Canadian AI ecosystem has seen in terms of funding across the board (OECD, 2019). According to Tracxn.com, Canada AI firms had 98 rounds of funding, with a total of US$660 million in funding from the private sector. However, Canada AI

firms have seen a slight decline in early-round funding, including series A and seed capital, despite the overall number of increased funding in 2018 (CAICT and Gartner, 2018). In terms of capital location, about 70% of investments are Canadian and are similar the year before, which indicates that Canadian investment is fueling the Canada AI ecosystem compared to international sources (Easton, 2018).

4.4 Micro Overview

As mentioned earlier in this thesis, Canada has various AI hubs located in its significant provinces, which makes up its AI ecosystem. For this thesis, we will focus on the top two provinces – Toronto and Montreal, which are said to be the leaders of AI startups and the drives in ecosystem growth compared to other AI focus provinces.

4.4.1 Montreal

Montreal creates an environment and mantra where it believes scientific progress should be for everyone and not for private firms alone, which is one significant difference between Montreal and other AI hubs. That is, Montreal has forged its AI ecosystem around knowledge- sharing by the world's top researchers that attract top AI talent and support, including top research labs from both private and public sectors (Easton, 2018). Top researchers who have academic roots in Montreal, such as Hugo Larochelle of Google Brain, returned to Montreal to grow AI labs that are privately funded, have attracted some of the top minds of AI to Montreal over recent years.

Other great minds of AI are the renowned professor Yoshua Bengio who is an AI pioneer, a computer scientist. As part of the "Deep Learning Conspiracy," while the AI world waited for data and computing power, Yann LeCun, Geoffrey Jinton, and Yoshua Bengio continued AI research, and when data became the new currency for AI scalability, Hinton and LeCun were recruited by Google and Facebook (Deloitte, 2019). However, Bengio remained committed to academics to train the next generation of AI experts. With the co-founding of Element AI and the non-predatory model his team designed at Montreal's Institute of Learning Algorithms (MILA), it was aimed to keep talent localized to Montreal universities rather than monopolizing it in a large corporation (KPMG, 2019). Bengio's enormous investment in MILA, Element AI, and other research interests have played an essential role in Montreal's AI cluster, where several promising tech giants and smaller firms established their AI footprint in Montreal (Easton, 2018).

Despite the Bengio pioneer of AI in the Montreal AI cluster, it is not a standalone variable that distinguishes the Montreal AI cluster. It is a combination of Montreal's research institutes, government support, and a critical mass of AI intelligence talent, which have drawn the interest of large corporations and startups seeking out ways to harness this "Alien-Tech" (Osborne, 2019).

MILA was found in 1993 in collaboration with McGill University and University de Montreal to facilitate and democratizes access to research and talent in the business sector. With that, MILA attracts the top Ph.D. and postdoctoral AI research around the world and is building tomorrow's researchers (Easton, 2018). In short, MILA is the AI factory that produces top AI talent for the business sector while maintaining top research to train the next wave of AI talent. For example, corporations large and small can gain access relating to R&D and technical and business

advisory through the Canadian National Research Council's Industrial Research Assistant Program (IRAP) (ReflectionAI, 2019). Furthermore, the Computer Research Institute of Montreal (CRIM) is another bridge between universities and businesses since 1998 (OECD, 2019). Startups and large corporations can access CRIM resources through a membership model, which in turn creates an extensive network of AI firms as well as innovative partnerships and subject matter experts in the field of AI (KPMG, 2019). Another actor in the Montreal AI cluster is the Montreal Institute for Data Valorization (IVADO), which acts as the filler for the supply and demand gap that both MILA and CRIM face by democratizing and create awareness operations and AI through its membership programs (Easton, 2018).

Over the past few years, Montreal has seen a massive influx of AI research firms becoming part of its cluster, which is driven by top talent in Montréal along with proximity to resources and knowledge sharing and collaboration (Easton, 2018). Such a concentration of expertise creates the development of AI applications and helps grow new AI startups (Deloitte, 2019).

Figure 6: Montreal AI Ecosystem Network (Source: IVADO)

The Canada First Research Excellence Fund was allocated in 2016 where $84 million went to McGill, and $93.5 million went to University de Montreal, and in March 2017, another $40 million was allocated to Montréal from the government of Canada from the $112 million Pan-Canadian AI strategy (Easton, 2019). Then in the spring of 2017, $100 million was allocated by the Government of Quebec for the development of AI clusters province wide (OECD, 2019). Then in 2018, the Government of Quebec issued a total of $1 million in grants for both private sectors and universities ($10 million over five years to HEC NEXT.AI and CDL). Aside from financial support, the government, with the help of the Montreal Chambre de Commerce (CCM) and Montreal International, is working to develop AI infrastructure to help local AI firms and research labs while attracting foreign talent to the Montreal AI ecosystem (ReflectionAI, 2019).

The Montreal AI ecosystem is made up of continuous financial and strategic support from the government on both the public and private side, various agencies that produce top talent and academics for research and training for the next wave of talent. This means that large firms and startups will have access to necessary and prudent resources where the cost of living in Montreal and quality of life creates a sense of attractiveness for both entrepreneurs and global talent (Easton, 2018). Conversely, the knowledge sharing centric culture, underpins the cluster aims to attract both large firms and outside investment while creating cutting edge AI through collaboration & cooperation (OECD, 2018). Such a combination drives growth and worldwide attention in Montreal. Below is a snapshot of the Montreal AI ecosystem.

Figure 7: Montreal AI Ecosystem Key Players

(Source: https://medium.com/believing/canadas-artificial-intelligence-ecosystem-4798b0517016)

4.4.2 Toronto

To date, over 8,000 published journals and articles for Toronto AI since 2019 (OECD, 2019). This creates a worldwide buzz for investment into the ecosystem. Conversely, the Toronto AI ecosystem has shown consistent growth in terms of size and finance (Easton, 2018). Toronto and Waterloo, as of 2019, have more than 275 AI startups, which raised significant funding from venture capitals outside of Canada (JFGAGE, 2018). Toronto AI ecosystem is faster growing than San Francisco, D.C, and Seattle combined (KPMG, 2019). Moreover, Toronto is rated as one of the best places to launch an AI career. This cause-effect is rooted in the loyalty of Toronto AI pioneers and experts driven by 1. Polices and infrastructure in support of AI innovation and 2. Government investments, and 3. Institutes that create access to world-class AI talent (ReflectionAI, 2019).

Ontario has three physical supports for its AI ecosystem to help it grow for years to come. These actors merge public research interests and corporate commercialization objectives and capital through talent, which is the common interest (Deloitte, 2019). That is, by attracting, retaining both local and international talent by offering attractive compensations, flexible opportunities to apply skill-sets across top corporations, universities, and research labs (Easton, 2018). Moreover, these actors provide the opportunity for all actors to participate, share knowledge, and collaborate across the board (Ylinenpaa, 2009). These actors are the Canadian Institute for Advanced Research (CIFAR), Vector Institute, and Waterloo AI (JFGAGE, 2018). These actors, backed by corporations, government, and individuals, drive significant foreign and local investment in the Ontario AI ecosystem (KPMG, 2019). For Waterloo AI, Vector Institute and

CIFAR focus on talent, which creates overwhelming demand for graduates into research and financing opportunities (Easton, 2018). Conversely, while the University of Toronto and the University of Waterloo has a reputation to generate AI talent of grads over the years, it was not until loyalty of homegrown AI experts planted roots in these institutions that created a competitive advantage for talent which develop reasoning for talent to stay in the Ontario AI ecosystem (OECD, 2019). For example, this cultural characteristic of the Ontario AI ecosystem of loyalty influenced Canadian AI firm ROSS Intelligence to return from the US.

As with Montreal, the Pan-Canadian AI research institutes create access for multinationals to setup up R&D labs in Canada to gain access to world talent and private funding for the ecosystem (Easton, 2018). For example, RC, Uber, Goggle, Samsung, and Nvidia are among the few big firms that have a physical and financial presence in the Toronto AI ecosystem. The table

below illustrates the investment and impact of these firms.

R&D Centre	Research Lead	Key Community Impact
Borealis AI Toronto, one of **Royal Bank of Canada**'s 4 AI labs	Nymi co-founder Dr. Foteini Agrafioti is Chief Science Officer at RBC and head of Borealis AI	Borealis Ai has committed $100,000 annually across 10 students wishing to pursue graduate-level work at Canadian universities in machine learning or AI, through its Borealis AI Graduate Fellowship Program (launched February 2018)
Google Brain Toronto, Alphabet's second Canadian Deep Learning Research centre	Geoffrey Hinton, emeritus distinguished professor at University of Toronto, lends his expertise part-time	Google Brain Toronto has invested $5M into the Vector institute's development of AI talent
Uber's Advanced Technology Group (ATG)	Raquel Urtasun, University of Toronto professor and founding member of the Vector Institute	ATG is connected to the Government of Ontario's Autonomous Vehicle Innovation Network (AVIN)
Nvidia Research lab	Sanja Fidler, University of Toronto professor	Fidler hopes that the lab of 50, which aims to double in size over the next few years, ,will strengthen Nvidia's connection with the University of Toronto, and provide great recruiting opportunities for students interested in machine learning, computer vision, robotics and beyond
Samsung Toronto AI Centre	Sven Dickinson, University of Toronto professor	Samsung's Toronto centre focuses on core AI technologies and works closely with Waterloo.ai and the Vector Institute, as part of its global strategy to acquire 1,000+ top AI researchers by 2020

Figure 8: Toronto AI R&D Key Actors

(Source: https://medium.com/believing/canadas-ai-ecosystem-3c5d04bb5016)

*Government influence holds a part of finance and policies helping to lead the path for firms like Google to invest in Toronto (Wang and Wang, 2012). For example, Ontario allocated $350 million for AI technology, 5G, autonomous vehicles, quantum tech, and advanced computing, intending to develop sustainable commercialization and innovation of AI in Ontario (KPMG, 2019). These key initiatives and investments from Ontario and the Federal government have increased opportunities for talent development and retention (Susan and Acs, 2017).

Universities play a significant role in the Ontario AI ecosystem. The University of Waterloo and The University of Toronto (Geoffrey Hinton) are top computer science programs worldwide and continue to produce a high volume of AI graduates (Easton, 2019). While many top talents left Toronto in 2010 to Silicon Valley and other AI hubs, Geoffrey Hinton and Yann LeCun stayed. Hinton and LeCun not only pioneer the significant research opportunities within universities but are the center of the institute that reverses the cycle of brain drain (Deloitte, 2019). Without the influence of the surrounding ecosystem of finance, partners, and institutes like Waterloo.AI, Vector Institute, and CIFAR, there would not be much buzz and focus north of the border (Paradkar et al., 2015). Ontario is set to be a flexible innovation infrastructure and dense startup community with easy access for finance and government support (OECD, 2019). Just like its neighbor, Montreal, Ontario's nature of fellowship within research institutes and universities aim at disrupting breakthrough technology. Ontario priority is the foundation of the commercialization of AI by obtaining a common objective between private firms, the government, research labs, and universities (Easton, 2018). By creating proximity of scholars, researchers, businesses, new grads, and entrepreneurs, the network of knowledge- sharing has become one key success factor of Ontario's AI ecosystem growth (Zahra and Nambisan, 2011). The next objective is to advance AI application and research like Montreal (KPMG, 2019). However, what sets the Ontario AI ecosystem from Montreal is the finite financial hub and regulatory support of innovation that is rooted from the start. Not only has this financed the physical infrastructure and programs for talent management within Ontario's AI ecosystem, it is a quintessential display of the province's high commitment to AI, which creates a snowball effect for global support within the ecosystem (Easton, 2018). By linking networks of communication within all major actors not only in the ecosystem but outside, Ontario creates a

platform of generating more opportunities for talent while harnessing foreign and local investment, which fuel the necessary collaboration and communication to expand the global application of AI (Richter et al., 2015).

4.5 Micro Overview

The business community would argue that it takes a high growth and sustainable ecosystem to build a successful startup (Wang and Fang, 2012). The province has partnered with Ontario's industries, colleges, universities, investors, research hospitals, and government, with a network of innovation centers that facilitate over 30 partnerships and programs to harness AI application and use cases to gain global competitiveness (Easton, 2018). Below is a diagram that illustrates the 17 centers know as Ontario Center of Excellence (OCE), where Toronto's MaRS Centre and Waterloo's Communitech are the heartbeats of Ontario's AI ecosystem?

Image Source: https://www.launchlab.ca/regionalinnovationcentres/

Figure 9: Toronto AI Ecosystem Networks

Ontario's support for AI is beyond financing and infrastructure. The province implemented the Startup Visa Program, which fast-track the immigration of highly skilled workers within just ten working days, which enables AI firms to hire quickly within weeks, not months or years (OECD, 2019). Provincial support of AI is backed by infrastructure, funding, and policies, which reduces the barrier for AI talent and provides a competitive advantage as Ontario AI startups gain access to collaborative break- through AI applications and financing, which influences survival and ambitious growth (Russell and Norvig, 2016).

The next and proceeding chapters outline and underpin the research of this thesis. The next chapter addresses the research design structure, including the approach taken to answer the research questions.

Chapter Five

5.1 Introduction

This chapter highlights the design criteria of this thesis. Moreover, this chapter further includes the validity of the research, reliability of the research, confidentiality, ethics, and mixed-method of both qualitative and quantitative research.

5.2 Research Design

A mixed method was executed using a collection of secondary data derived from the Artificial Intelligence industry/market. A qualitative method was executed using a semi-structure interview in person and over the phone for 17 AI firms across Toronto and Montreal. The structure of the interview considered to determine the success factors influencing AI startups and AI ecosystems as part of the interview questionnaire for the participants of the 17 AI firms. The factors considered when forming the interview questions for the 17 AI firms determine the influential factor and criteria for a firm to grow within a given AI ecosystem and the success factors for the growth of AI ecosystems (internal and external factors) and other factors aim in answering the research questions. The method used in the research, which is secondary data and interviews, is the operationalization of the literature and research questions that were reviewed in chapter two of this thesis.

5.3 Philosophical Foundation of the Research Design

Many scholars argue that despite how many research methods and procedures have been successfully linked to certain paradigms, such linkage between research methods and research paradigms is not necessary nor sacrosanct (Johnson and Onwuegbuzie, 2014) to overcome such issues associated with the use of paradigms in mixed-method research, some scholars have chosen various types of positions on the approach, including, dual-paradigm (or dialectical), a paradigmatic, and a single- paradigm approach (Metens, 2012, Hall, 2013). Researchers who support the dual/dialectical stances, the incommensurability argument fuels the popularity of the pragmatic paradigm (Onwuegbuzie and Leech 2005; Biesta 2010, Hathcoat and Meixner 2017). Supporters of the pragmatic approach argue that despite some differences between paradigms, the various paradigms are said to be logically independent which means it can be mixed and matched in line with choices about methods, to obtain a combination that is most appropriate for a given inquiry (Grenne and Caracelli, 1997,87). In conjunction, this paradigm allows researchers an epistemological justification for mixing methods and approaches and suggest that the main driver of research methods should focus primarily on the research question(s) and not the research method (Onwuegbuzie and Leech 2005; Biesta 2010).

Owe, (1988) suggests that the advancement of the various approach of pragmatism with the continuation of the rational towards the development of designing mix- method research that is the productive dialogue between quantitative and qualitative research traditions (Beista, 2010, Onwuegbuzie, De Waal, Stefurak & Hildebrand, 2016). The push for the compatibility thesis; i.e., the assertion that qualitative and quantitative research should be mixed when the research question warrants such action (Howe, 1988). In such where the push for mixed-method research as a distinct methodology is outlined by Green (2006) who described four distinctive interrelated

but conceptual domains that are: (a) inquiry logics, (b) sociopolitical commitments, (c) philosophical assumptions and stances and (d) guidelines for research practices.

According to Flick (2005), mixed-methods draw the conclusion where such an approach creates an understanding of knowledge that could not have been achieved using one single method. That is, the reciprocal supplementation of two methods is assumed on fundamentals. In the quantitative section, the importance is identified when a phenomena is derived, while in the qualitative section, a basis for a broad understanding of the research study subject is created. This research is designed under a mixed-method approach by using both quantitative methods and qualitative methods.

5.4 Mixed Method

The approach of mixed method which is a mix of both quantitative and qualitative method approaches which are said to be a good thing aiming at providing the best possible explanation and result for research with a structure such as this (White, 2000). Furthermore, this approach develops quantifiable and reliable data, which can allow a numerical generalization of identifying typologies and patterns around factors within a given ecosystem (Hurmerinta-Peltomaki and Nummela 2004). White (200) also argued that the quantitative method aims at creating an examination of a cause and effect relationship that generates in the form of numerical data, which is later analyzed by the researcher. The data can be analyzed using a series of tables, charts, or diagrams, which White (2000) referred to as a descriptive statistic. This research uses secondary data collected from various sources to effectively establish a relationship or correlation (if any) between the success factors of both artificial intelligence ecosystems and

startups. The stone linkage between the two approaches happen in their sequential structure through a derivation of the research questions from the qualitative approach and the assessment in the quantitative approach and through the linkage between the results from the quantitative and qualitative sections. This mixed method aims to gain a more comprehensive understanding, which would not be able to be achieved with just a single method (Hurmerinta-Peltomaki and Nummela, 2004). However, care must be taken when usingmixed method to ensure that a two-way perspective of mode- switching does not falsify or verify the results solely through complementary triangulation but should create solely a broader understanding of the subject (Flick, 2005). In short, a mixed method approach develops consideration of multifarious aspects of one phenomenon.

5.4.1 Data Selection

The researcher selects the data using an existing dataset from reputable sources and databases accessed from the Internet. The data that was selected covers the following sections:

- The Macro, Meso and Micro level of the AI industry globally
- AI industry financing year over year; growth rate year over year
- Startup numbers within the AI industry and failure ratio of startups globally
- Government policy and funding, R&D, network and growth factors
- Talent measurement within specific geography AI ecosystem
- Commercialization of AI, patents, types of AI

- Startup funding, growth, use cases, application, patents and unicorns
- AI Industries, Sectors, Distributions, Value Chain, Regions and Benchmarks

The data selection was sections drawn from a review of the literature where some academics found these areas to have been influenced by the success factor/ingredient of ecosystems, and startup growth and sustainability. Further, these sections are linked to answering the research question(s) asked.

5.4.2 Data Collection Method

The data collection processes were from a collection of web-based databases. The database service provider which enables the researcher to design a series dataset on the AI industry to answer the research question(s). The data is in a raw format where the researcher can commence analysis from scratch.

5.5 Thematic Coding

Qualitative methods compared to the quantitative method can be evaluated in terms of their canon and procedure only if they are made explicit. The strength drawn from the qualitative approach is its ability to provide a sophisticated textual understanding of the reaction of people's experiences in a given research issue (Denzin, 2000). It further provides the human side of an issue, which is often contradictory opinions, beliefs, behaviors, and relationships of individuals. Furthermore, the qualitative method becomes most useful when assessing intangible factors,

including social norms, roles, worldview, socioeconomic status, and talent expectation to which this research undertakes as part of its research aim (Pope and Mays, 2000).

Thematic analysis has been widely used in qualitative research which is appreciated as it provides core skills for conducting other forms of qualitative analysis (Kavanagh and Knaft, 2003). It is argued that thematic analysis creates a high flexible approach where it creates the opportunity for the needs of many case within case studies, and creating detailed and rich complex amount of data (Paterson 2010). Furthermore, thematic coding within a case analysis is a useful method to examining the perspectives of different participants in a research by outlining differences, generating unanticipated insights and similarities (Eisenhardt, 1989). Moreover, this approach help summarized key features of large data by forcing the research to take a well-structured approach of the data which in turn produce a more organized and clear final report (Yin, 2009). Lastly, a rigorous thematic coding within a case analysis help to produce trustworthiness and insightful findings if done correctly (Krippendorff, 2012). This research will adopt the thematic coding approach within a case analysis as part of its qualitative method.

5.5.1 Pilot Study

The pilot study was executed to determine effectiveness and efficacy in the research objectives and analyze an appropriate timeline to forecast the time required to set aside to interview for each firm representative. Three Artificial Intelligence startups participated in the pilot study, to which did not affect the outcome of the research itself but rather added value (White, 2000). In

such, each participant has extensive knowledge in AI, the ecosystem, networks, industry knowledge, data science, and AI startup business model.

5.5.2 Interview Structural Design

The interview questions aim towards the AI firms (including some AI startups) within Canada's ecosystem (Toronto and Montreal) were covered under the following section:

- The success factors of AI ecosystems
- The success factors of AI startups
- The growth factors/ingredients for AI ecosystems
- The drivers and factors inside the value chain affect the growth and sustainability of startups and ecosystems
- The type of Artificial Intelligence application that drives growth
- The type of industries are a catalyst for AI applications

These sections link to the literature that was reviewed in the literature chapter of the thesis in which some academics identify these areas to have had some relationship that influence AI ecosystems success factors, growth of AI startups, and other influential factors. The interview questions can be found in the appendices section of the research. Conversely, AI firms participants were asked to name the most significant challenges the AI industry faces & why and whether the main success factors/ingredients are required to not only survive as an AI startup but to grow. The participants were further asked to rank on a scale from 1 to 5 the importance of funding, government policy, talent, collaboration locally and internationally; and commercialization vs. research for growth and sustainability of AI ecosystems. Furthermore, the

participant was also asked if there were any circumstances on how does the local value chain affects success within the ecosystem, and given the pandemic of 2020 (COVID-19), how can AI help drive local markets and not dependent on the overseas supply chain. The awareness of issues from the interviews was a participant that were interviewed were either unavailable for the interview at the initially scheduled time or in meetings at their lunch. The researcher had to re-schedule the interviews for 6 participants at downtime, which were between 4-5 pm. The average time of each interview was about 45 minutes to one hour with an average of 3-5 pages of transcript for each participant.

5.5.3 Data Collection Method

The AI firm's participants were conducted through a series of one-on-one interviews with one participant from each AI firm. The Interviews are more personal compared to questionnaires, and it allows the researcher to interact with the respondent and ask follow-up questions and rectify any inconsistency among respondents to fully understand each participant's concept to compare the answers against other respondents and identify any linkage, pattern or relationships of the data collected from the databases. Furthermore, the interviews were conducted in an actual and everyday setting, as White (2000) stated it to be an essential factor of an interview. With that, each AI firm's participant accepted the interview invitation with a positive attitude after they were notified about the nature of the interview.

5.6 Ethics and Confidentiality

The respondent of the interview was notified ahead via email and telephone about the nature of the interview and its use. The respondent was given ample information about the nature of the research over the phone and via email, which outlines that their confidentiality is guaranteed and maintained at all costs as well as the number of AI firms participating in the research. Moreover, the respondent of the research was allowed to ask any questions or address concerns before starting the interview at anytime after the completion of the interview. The information was provided in an email and over the phone to each respondent, which further acknowledged that the respondent has the right to withdraw from the interview before or after the completion of the interview, and all information regarding the interview and its purpose is disclosed to the respondent. All respondents that took part in the research were treated equally, respectfully, and with sincere consideration within the guidelines of proper ethics and utmost confidentiality. All respondents that partook in the research were allowed to request a copy of the research upon completion.

5.7 Validity of the Research

According to Yin, (2009), validity is said to be one of the two most important concepts used to build into the research design. Validity is considered to be the main focus of the research questions and objectives the researcher aims to achieve and answer (Yin, 2009). To achieve validity in the research, the literature and contextual chapter discussed the various framework of the formation of ecosystems; macro analysis on the global AI industry, analysis on the Canadian ecosystem, analysis on the provincial level ecosystem in Canada; resources and other factors for

AI firms, networks inside and outside the firm, to stem factors influencing the growth of startups, and within a given ecosystem. The data selection and interviews were all structured around the literature chapter and discuss the above proceedings and aim to answer the research question(s) set out in the thesis. Further, all the datasets are related to specific areas in the literature that were reviewed in chapter two of the thesis. The validity of the first part of the thesis has been improved by a pilot study. The pilot study was to gain feedback from respondents to increase the quality of the interviews by rearranging questions, changing questionnaires in the semi-structured interview, recording the average time it took to complete the interview, and analyzing the finished data to get a better understanding of what to expect. Based on these results, both the datasets and interviews were significantly improved to concentrate efficiently on the research question(s) and objectives.

5.8 Reliability of the Research

The next most important concept to build into the research design is the reliability as Yin, (2009) clearly outlined. It is said that reliability focuses on the research and consistency and whether another researcher can adapt the same research design and observe similar findings (Yin, 2009). The respondents for the interview were from 17 AI firms throughout the AI ecosystem in Canada (Montreal and Toronto), which commonly represent the majority of the AI industry in Canada. Hence, the perspective is not only shared from one AI firm in a specific location or class but by the majorly of AI firms represented by a startup, established firms, and unicorns within Canada. Furthermore, AI firm participants are from different sectors, backgrounds, and areas of business, different education levels, different locations, and different firm structures and business cycles that demonstrate an active community of AI firms within the ecosystem. This, therefore, shows

the research can be reproduced using a similar methodology and be adequately interpreted without difficulties making the research extremely reliable.

5.9 Researchers Role

The role of the researcher was to collect the data from databases and facilitate an interview by assuming the role of the interviewer. Respondents were first notified about the interview, along with the primary purpose of their content and intention three weeks before the distribution of the interview. Respondents were notified that the purpose of the research was for the completion of the researcher's thesis at HEC as the final step in achieving the Masters of Science –International Business. Participants were also informed that each interview could be completed privately, and their names, title, and firm name were not needed to be recorded as part of the interview. Upon completion of the interview, the data was collected without the recording of any names to maintain confidentiality and anonymity of all respondents.

5.10 Chapter Summary

This chapter identified the methods used to which data has been collected, the choice of techniques, the pilot study, the validity and reliability of the research along with the choice of questionnaires for the semi-structured interview. The next chapter will outline and interpret the results of the research.

Chapter Six

Result and Discussion of Research Findings

6.1 Introduction

This chapter outlines the result of the research findings of the interview and dataset. Moreover, it discusses the results based on the findings. Furthermore, this chapter compares and contrasts the perception of the AI firm's participant with the analysis of the data to illustrate any linkage, patter, and relationship with the factor influencing the growth AI ecosystems and AI startups.

6.2 Interview Result Summary

6.2.1 Success factor of an AI Ecosystem

F1 stated that the success factor needed for an AI ecosystem are specific firm structures, precision location, openness within the ecosystem of information sharing, and access to prodigious talent. However, F2 claim that the success factors are based on the commercialization of AI, strong network inside and outside the ecosystem. While at the same time, F4 claim that talent, knowledge spill-over, and infrastructure is at the core of the success factor of an AI ecosystem. Consequently, F3, F5, F16, F9, F6, and F11 all agreed that big data, financing, research, public and private enterprises, a collection of AI firms in a specific specialization that require partnership with firms outside the ecosystem to solve a problem are success factors. However, F6, F7, F10, and F12 claim that location proximity close to financial markets is key along with government policy, talent, and compute power is at the core of building a thriving

ecosystem. Alongside those, F8, and F13 suggest that influential entrepreneurship/business savvy CEOs with leading vision is necessary, partnership with large firms to collaborate to determine demand and availability of big data is needed. F14 stated that location, the publication of AI research attached to the cluster, strong R&D, talent, government influences, and useful application are the ingredients for a thriving ecosystem. However, F15 took a different stance by insisting that patent protection, clients, government and private enterprises, talent, deployment of AI application to end users, types of AI being manufactured, cost, and speed to market, and stable flow of funding and talent during stages of the ecosystem are at the core of AI growth. F15 further argued that while location plays a vital role, it is not at its core, considering an AI ecosystem can thrive if it is at proximity to its value chain, clients, or financial market. For example, Silicon Valley has a high destiny of AI firms that are successful not because they are close to Wall Street, but Wall Street comes to Silicon Valley and begs AI firms to take their money. F15 suggested that there is a considerable amount of talent in that area with a lot of knowledge spill-over since the tech boom and the birthplace of some of the largest firms in the world, helping to create the buzz around the next big AI firm. Therefore, talent, funding, and knowledge spill-over from the IT culture are helping fuel the AI ecosystem in Silicon Valley to which Canada does not have a past technology infrastructure and knowledge spillover from Bay Street. For example, F3 quoted that "*AI ecosystem requires constant innovation through R&D centers, immense partnership with outside the ecosystem, collaboration with industry leaders in given industries including healthcare, finance, ecommerce, technology, and neighboring ecosystem including other parts of Canada and the US to gain access to trend, projects, research and most importantly talent and finance. This must be done through stakeholders and the formation of a body/committee/ambassador that serves as the face of the ecosystem. The*

ecosystem also needs more unicorn firms to lead and attract talent, finance, governance, innovation, and market disruption and acceptance for other firms to strive and distribute knowledge and collaboration". This suggests that the AI ecosystem's success factor can be related to the ecosystem's characteristics and culture/environmental norm. It further indicates that strong government policy towards AI, flex immigration for AI talent in Canada, private funding, firm characteristics inside and outside networks, robust AI application for commercialization, knowledge spill-over through networks, and infrastructure with big data are part of the success factors of AI ecosystem. More importantly, networks, actors and in most cases, location plays a significant role in influencing the growth of the ecosystem

6.2.2 Success Factor for AI Startup

Almost all interviewees suggest that an AI startup needs adequate talent and funding at least throughout the first few years. Moreover, participants suggested that defining the AI goal, big data, talent, and financing is the epicentre of an AI startup success. While other factors are detrimental to any startup success, AI startups are slightly different where data is the new currency. While a majority of respondents maintained the view that government involvement accompanied by competitive pressure, managerial expertise, vendor partnership, seed capital and AI compatibility are the factors to sustained an AI firm within the Canada ecosystem, or any AI ecosystem to that matter. Moreover F6, claim that *"The inside factors are the talent, excellent leaders, and brilliant minds to get projects from stage 1 to commercialization in an acceptable time frame. On the other side, a startup needs a great support system for success. These include promising financing over an extended period, excellent talent management and recruitment, an adaptive idea that is patent protected, clients that are already bought into the concept, and*

realistic delivery time." This suggested that startups must choose the right project to go after, then choose the right people inside the firm and build a competent team. Moreover, it further suggests that AI firms that have similar yet different factors are believed to grow the firm inside the ecosystem. The majority suggests the need for talent, funding, access to resources in terms of big data, computer power, collaboration, cooperation and openness, all indicate AI firms need an entrepreneurial environment where the resources are different from a traditional business model of startups. More emphasis is geared towards having a competitive advantage, proof of concept, market demand, and networks to help drive the AI projects. These factors includes funding, infrastructure and industry access using policies and government support.

6.2.3. Growth Factors/Ingredient for AI Ecosystems

The majority of respondents suggest that the need for openness to collaborate, fund, government influences, find talent, control climate, and develop more vigorous AI applications within the AI Ecosystems are some success factors for growth. Moreover, AI ecosystems require constant innovation through R&D centers, immense partnership outside the ecosystem, collaboration with industry leaders in given industries including healthcare, finance, ecommerce, technology, and neighboring ecosystems including other parts of Canada and the US to gain access to trends, projects, research, and most importantly talent and finance. It was also found that AI ecosystems also need consistency in growth and influence power through the development of commercializing applications on a larger scale, publication on the ecosystem to attract clients, and collaboration (resources gathering to feed the ecosystem). Furthermore, stakeholders with the same interest inside and outside the ecosystem and firm structure with characteristics to continuously innovate quick and fast turnaround are the main factors suggested among

participants. For example, F8 stated that '*The ecosystem needs to increase the stability of startups through increase support at an early stage by partnering up with unicorns or large enterprises outside the ecosystem*.' This is the common norm that was argued among participants. The responses indicate that there is a strong correlation between startup firm success factors and ecosystem system factors. It further suggests that influential factors for growth can be linked to resources for firm growth, networks, and partnership outside the ecosystem.

Conversely, competitive advantage, unicorns, openness, sustainability structure, funding, actors, and customers are other factors that were influencing ecosystem growth outside the firm. Moreover, it shows that ecosystem structure is linked to networks, actors, partnerships, government, culture, and firms' active participation within the ecosystem. Growth is derived outside the ecosystem of AI firms where firms are co-dependent on forces outside the ecosystem for growth, including socio and cultural norms.

6.2.4. Value Chain Innovation

Respondents generally suggest that the growing concerns around the levels of risk associated with adopting AI, including counterfeiting, regulations, privacy, and lack of transparency. For example, '*Firms that are deploying AI in heavily regulated industries, including banking and healthcare, may face roadblocks accessing data under privacy policies,'* was argued by F4. Moreover, the constant claim by respondents were concerns that firms adopt AI into their digital design model, including marketing and advertising platform, for the wrong reasons. These are some aspects that need to be addressed within the value chain of AI and overcome before AI can see the true potential of the value chain. Furthermore, some respondents suggested that some

industries with physical products or infrastructure assets that are physical have a greater challenge in adopting AI, which limits the types of client and industry AI aim at servicing. This is in comparison to clients/industries with light to no physical assets and infrastructure. This scenario makes the demand for AI less dependent on firm structure unless the AI firms fully understand the industry and understands the areas of the business model to which AI can be implemented seamlessly. For example, F14 quote that '*The value chain needs to consider effective AI Application Strategy, Data Analysis, Longer-term Implications, Human Talent, acceptance of AI and policy within a specific industry to support technology advancement and its underpinnings.'*

This implies that AI needs to be fully integrated with technology readiness and with the right use cases. It further suggests that specific industries are more receptive to AI adoption than others, including challenges with policy, risk, and infrastructure that affects the value chain. Moreover, it implies that the value chain influences growth and sustainability in both the firm and the ecosystem.

6.2.5 Types of AI and Industry

Participants were asked to provide the AI application and specific industry they believe are driving growth and sustainability inside the ecosystem and for startups. The participants provide answers not based on the AI application and AI targeted industry their firm is currently focused on, but what they believe are drivers for growth and sustainability. All participants agreed that a shortlist of AI applications and specific industries plays a significant factor in growth. The participants explained that because of where AI is today, the computing power, policies, and

talent available creates a narrower platform as to what and how to target. For example, F17 stated '*With the pandemic, a higher focus on healthcare with an improved system in diseases, equipment testing and mass-producing of supplies, drugs, and other peripherals. NLP, Machine Learning, and Computer Vision*'. The responses indicate that growth in firms and the ecosystem are based on the type of AI application and industries targeted. It further implies that machine learning, computer vision, and NLP are leading AI applications while manufacturing, telecommunication, healthcare, marketing, and transportation are leading industries that influence growth for ecosystems and AI startups.

6.2.6 Other Factors Influencing Ecosystems

Participants were asked if there were any other factors they believe influence the ecosystem in a systematic positive way, and they all claim that indeed there were. For example, F5 stated that '*big data and policy allowing big data to be used in AI safely but freely is of priority.'* Participants suggested that a collection of AI firms within the ecosystem with special project areas that aim at delivering a solution to end-users- value creation. Contributing impactful milestones globally, adding future employees (job creation, not job elimination), security (enhance, not purposely breach), flex but responsible regulation on data, the use of AI, and mandatory protocol are at the top of the list of growth influences, which were among participant responses. Moreover, participants argued the technology itself -it is ubiquitous; many cannot afford it, comparing to the use of expensive human services, and these are significant factors. The acceptance into the culture and more education around the adoption of AI are echoed among participants. Lastly, *the innovation cycles need to be shortened tremendously among AI firms*

with the help of government, financing, and other necessary resources that help boost AI in a free market. Stated by F16.

This indicates that other influences factor from growth in firms, and ecosystems stem from climate, political stability, social and economic factors, market demand, prudent infrastructure and the ability to innovate quickly. It further implies that ecosystems need to commercialize and manage uncertainty inside and outside the ecosystem which are factors influencing growth.

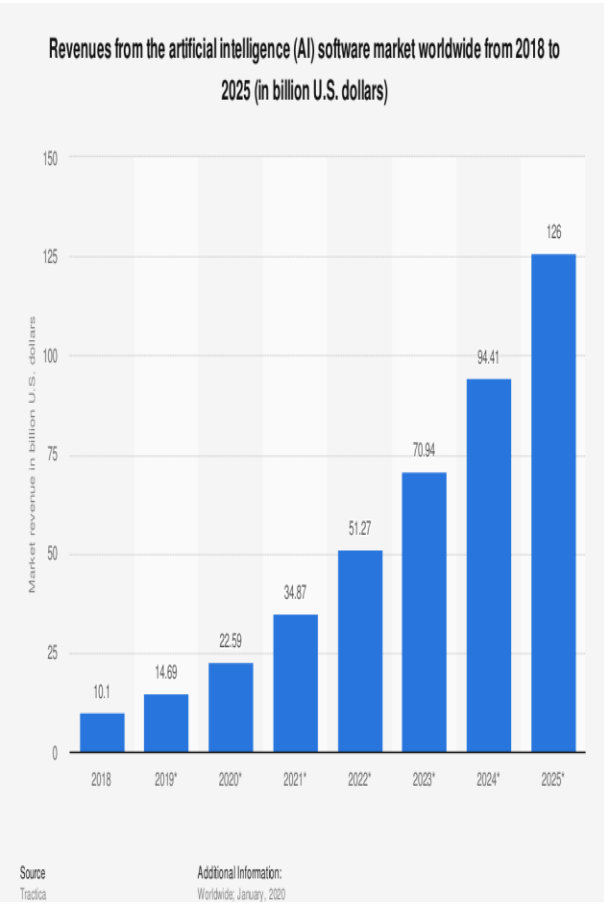
6.3. Quantitative Analysis

Based on the data collected from over 50 sources [see section 9.5 List of Data Sources of the appendices**],** the data analysis was done by the author where a total of 37 charts was created and analyzed. These charts capture necessary information to analyze any relationships, linkages, and patterns that influence growth in both the AI ecosystem and AI firms. Moreover, it outlines the AI industry from a macro, meso, and micro level in the analysis.

6.4. Data Analysis Summary

The revenue from the AI software market worldwide from 2018 to the first quarter of 2020 and forecast to 2025 is shown in chart 6.1; the revenue from the robotic intelligent processing automation and artificial intelligence automation from 2018-2025 are shown in chart 6.2; the revenue from the natural language processing globally from 2018-2025 is shown in chart 6.3, and the revenue from the artificial intelligence software worldwide by region is shown in chart 6.4. Chart 6.1 shows that the software market for AI is estimated to be $22.59 billion in 2020,

and growth is expected to be at $126 billion within five years, a 458% increase. However, chart 6.4 shows the AI software market is dominated by North America then Asia, specifically following by Europe for market share. This indicates that the AI software market is on a rapid growth rate globally, and the potential of AI firms and the US has a majority of market share in that sector. In comparison, the robotics/intelligent process automation (RPA/IPA) and artificial intelligence automation market have seen steady growth over the past four years and expect to more than triple in size within the next three years. In such, robotic process automation has a higher CGAR, but AI business operation is growing faster year over year, while IPA dominates market share in that space and overall cumulative growth year over year. Conversely, the natural language processing (NLP) software market is seeing a steady growth year of over a year and expect to go from $1.50B in 2020 to $4.489B in 2025 (327% increase). This indicates that AI software follows by NLP software in leading the AI sector, where robotics is trailing in third place.



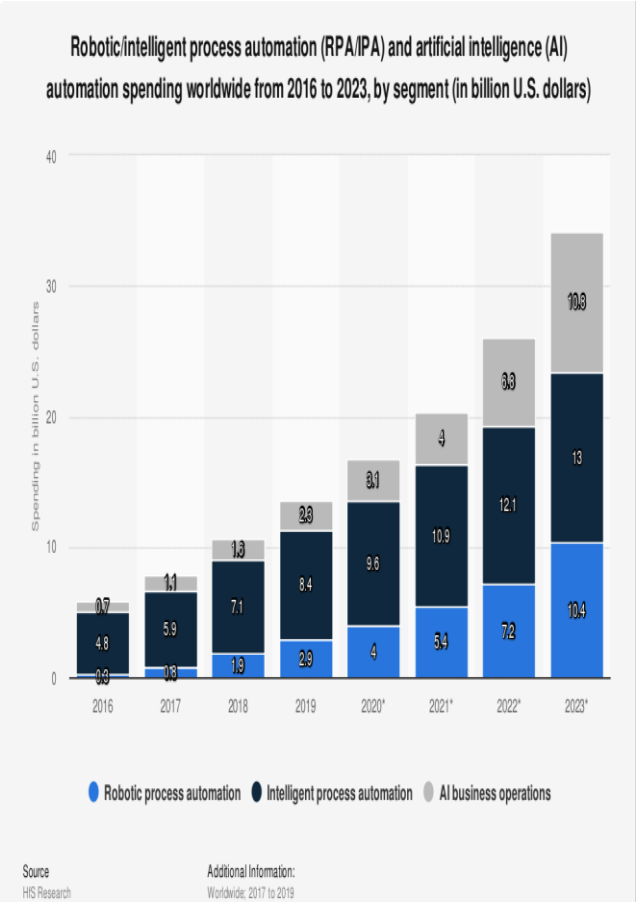
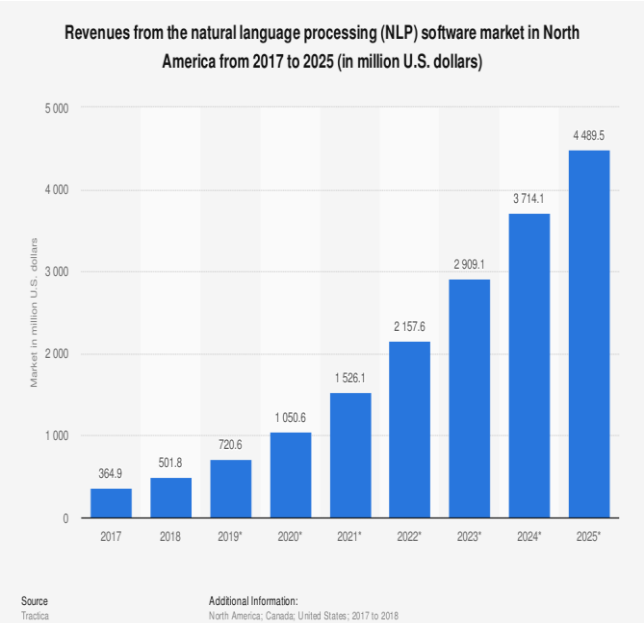


Chart 6.1 **Chart 6.2**



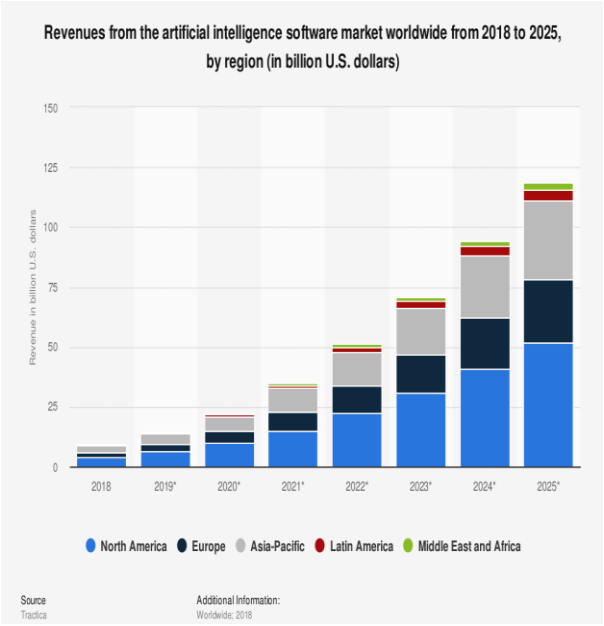


Chart 6.3 **Chart 6.4**

Chart 6.5 to 6.8 illustrated the global market AI startup funding investment and growth. Funding of AI startup companies worldwide from 2015 to 2019 is shown in chart 4.5; the funding and investment of AI startup in Canada from 2012 to first half of 2019 is shown in chart 6.6; the growth in startup funding between 2012 and 2017 by industry is captured in chart 6.7, and share of global AI investment and financing by country from 3013 to first quarter of 2018 is shown in chart 6.8. Funding since 2014 has grown from 4.24B to 26.58B (6.5 times) with continuous increase year after year. However, funding and investment of AI firms in Canada are volatile year after year, where 2014 was the lowest investment year of $14m and 2018 being the biggest investment year of $421M and just $100M in the first half of 2019. This does not show any correlation with investment growth globally. Chart 4.7 further shows that the leading investment in AI startups that focus on the specific industry are: advance manufacturing and robotics as number one, followed by blockchain, Agtech, and then AI between 2012 and 2017. However,

chart 4.8 shows that China is the leading AI investment recipient of 60%, followed by the United States with 29.1%. Canada is sitting in fifth place at only 0.7% of the total investment between 2013 and the first quarter of 2018. This is an indication that Canada receives less than 1% of AI investment into firms while its investment and funding is volatile year over year. It also shows that advance manufacturing and robotics outpace AI more than three times in growth.

Chart 6.5

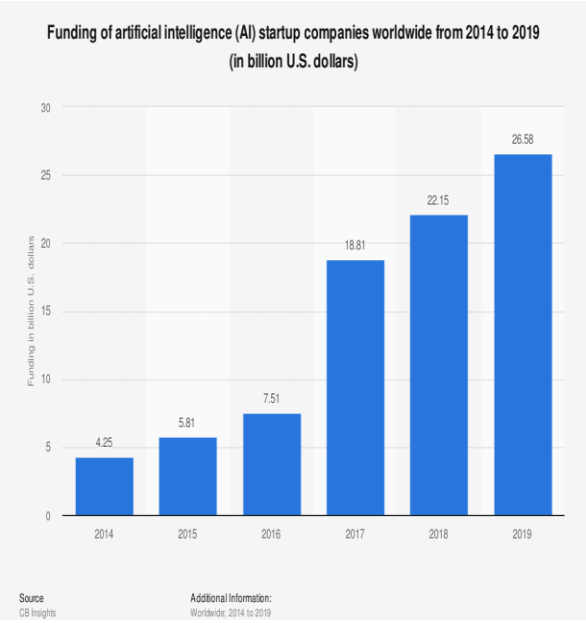
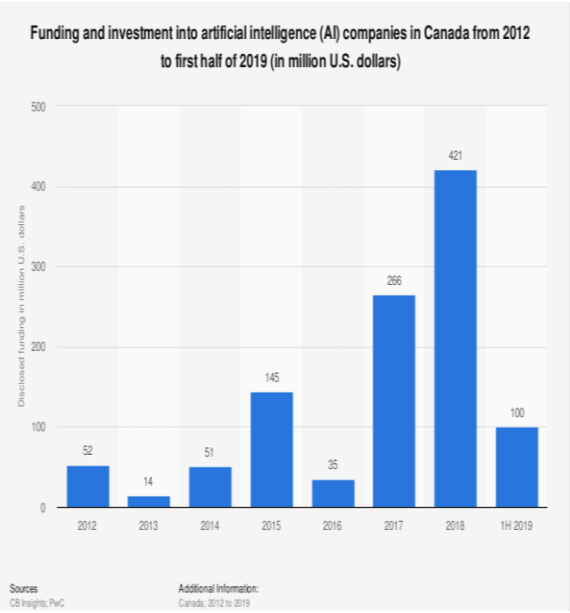
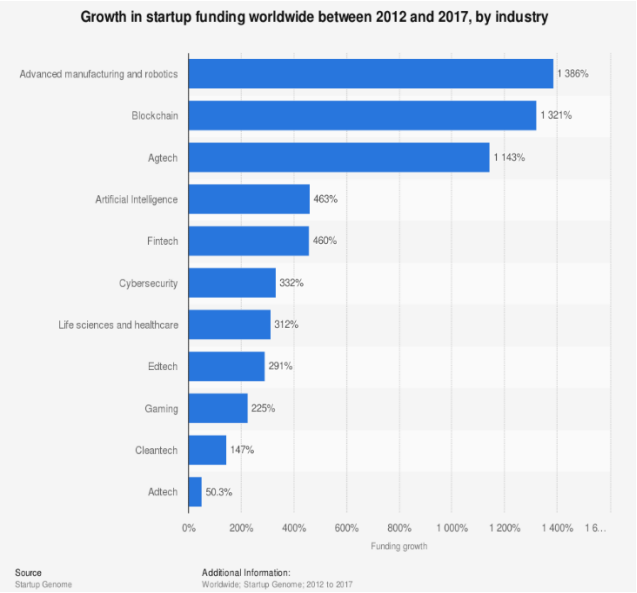


Chart 6.6





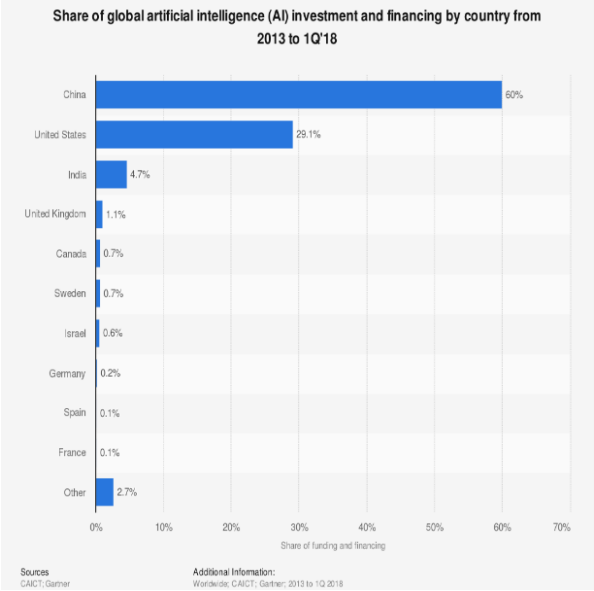
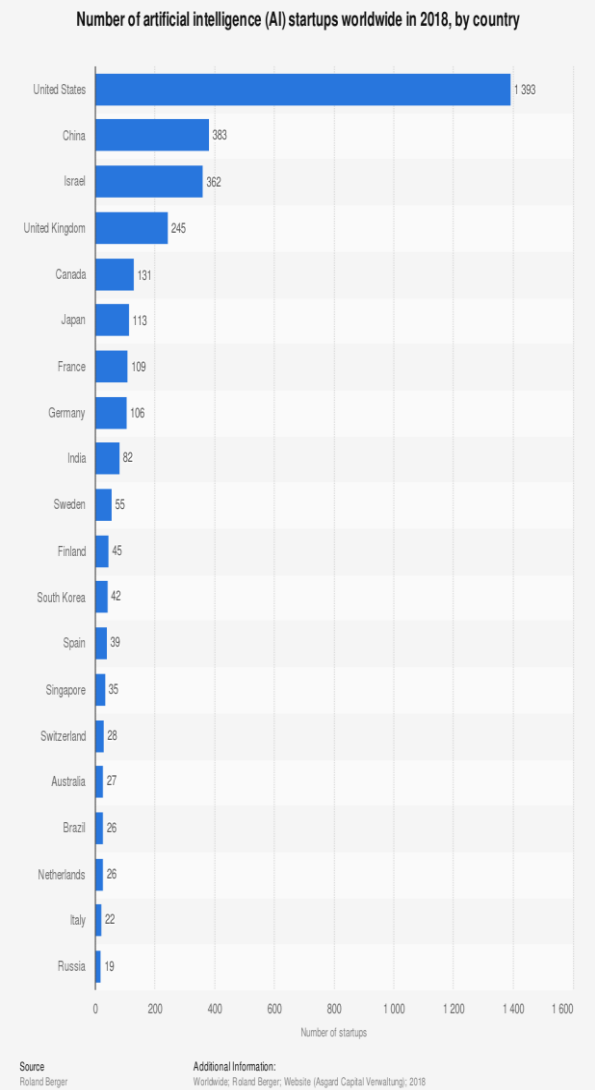


Chart 6.7 **Chart 6.8**

The number of AI startup firms in 2018 by country is a highlight in chart 6.9, and AI funding by AI category worldwide is shown in chart 6.10 cumulative through 2019. It shows that The US has over 1,300 startups, followed by China with 383 and Canada sitting in 5th place with 131 AI startups behind the UK with 245 startups. Canada has 10% of startups compared to the top leader. ML application leads the pack in terms of the AI funding category, trailing with ML platforms and comparison vision applications. NLP is sitting 4th place in the AI funding category. This shows that ML is the top leader by capturing 47% of the total funding worldwide. This implies that funding is linked with growth startups, and a pattern between ML application, funding, and the number of firms can be linked with ecosystem growth.



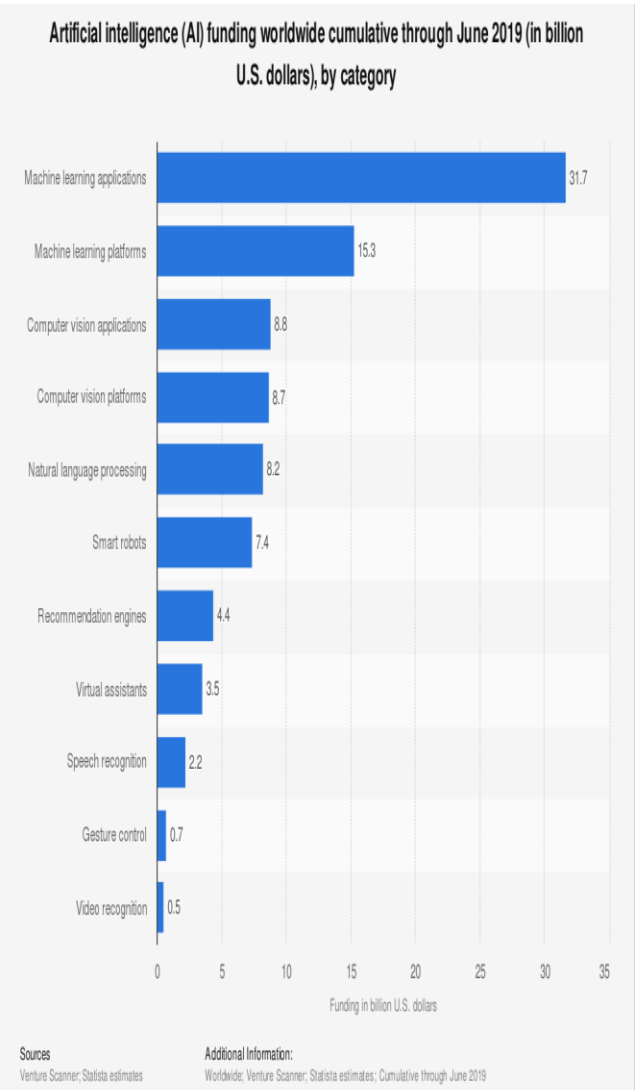
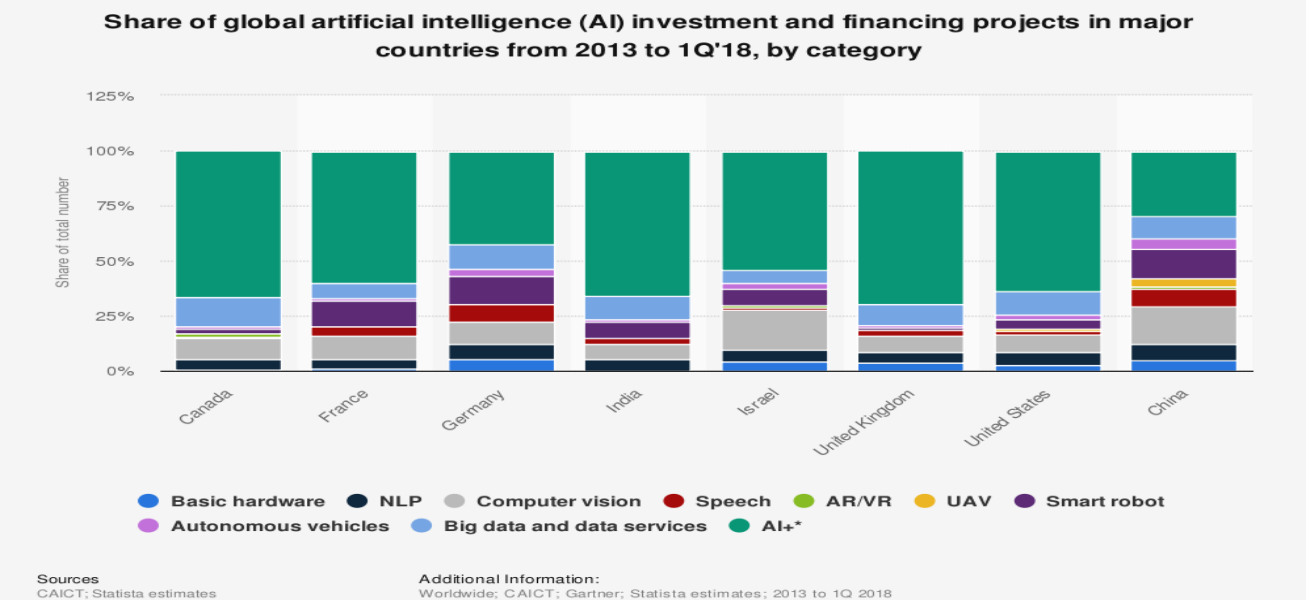


Chart 6.9 **Chart 6.10**

The share of global AI investment and financing projects in leading countries from 2013 to the first quarter of 2018 by category is found in chart 6.11. It shows that for Canada, AI accounts for 70% of total investment, while 25% is in big data rather than computer vision and NLP. This is a consistent, diverse mix with leading US investment projects except for smart robots and autonomous vehicles. However, China and Germany adopt a more diverse investment class by having more speech, smart robots, and autonomous vehicles within their AI projects. This indicates that growth in AI in the top 3 regions can be seen mainly from AI broken down by a

mix of hardware, big data, smart robots, and software. This further implies that the infrastructure of AI is linked with growth.



Chat 6.11

The distribution of private AI firms in Canada as of 2018 by industry is shown in chart 6.13. It shows that marketing represents 38 firms, followed by fintech at 20. It further shows there are 13 top industries in the AI ecosystem in Canada, with 112 firms spread across other industries. This suggests that the Canada AI ecosystem is missing a significant opportunity by not creating a leading industry like other ecosystems, including robotics and manufacturing.

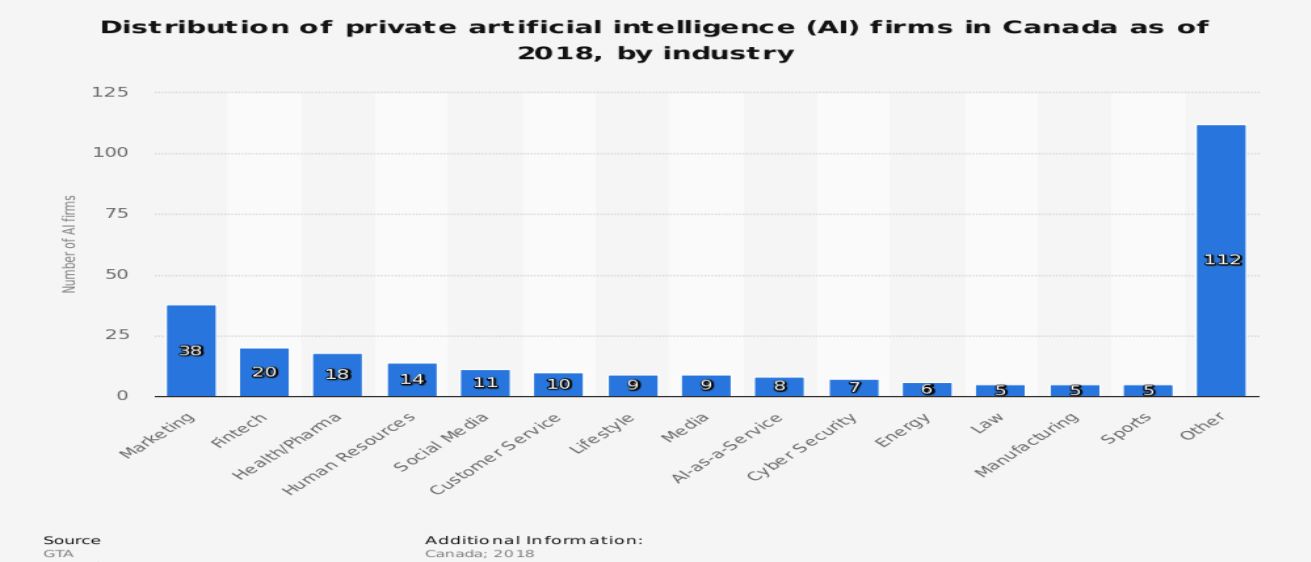


Chart 6.13

The distribution of the 500 most potent supercomputer worldwide is shown in chart 6.14; the share of global AI patents application for 20 years (1997-2017) is found in chart 6.15; the number of papers in the field of AI from 1997 to 2017 is shown in chart 4.16 and; the number of AI companies by country as of 2018 is shown in chart 4.17. It shows that China received the most supercomputers, followed by the US, Japan, and the UK. Canada has lasted with just eight supercomputers, which indicates that Canada's infrastructure for AI is lacking. Moreover, China also holds the most AI patents in the past 20 years (1997-2017), followed by the US and Japan. Canada once again is ranked last with just 1% of total AI patent during those 20 years. However, the US leads the total amount of AI firms as of 2018, followed by China, UK, and Canada ranking 4th on the list with 285 AI firms.

Moreover, Canada ranked 8th on the list for the most AI publications with the US leading ahead of China who ranked 2nd on the chart. It implies that the top AI growth regions ecosystems are

linked with a high number of hardware, AI patent, and several firms. While there is a correlation between the numbers of publication to high growth AI regions, it is not significant.

Chart 6.14

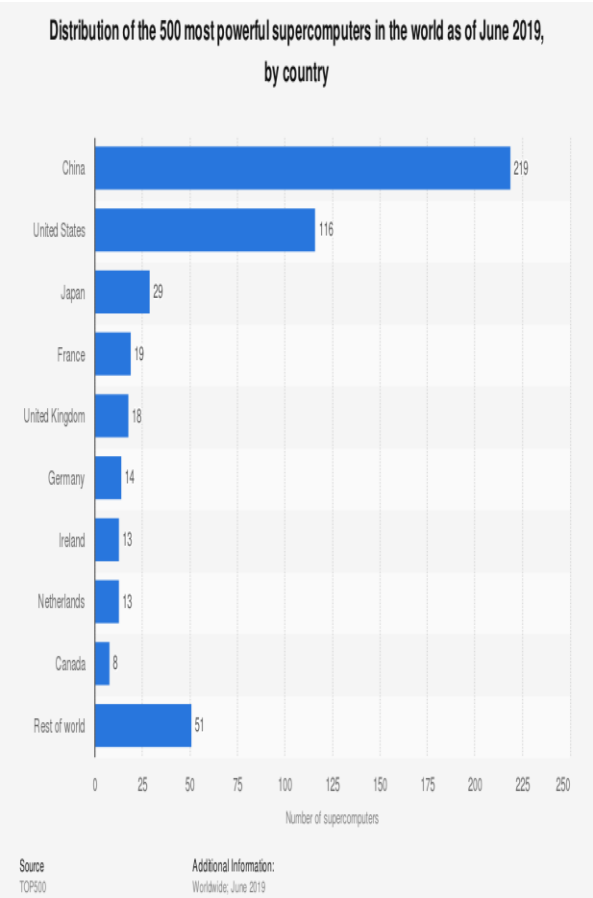
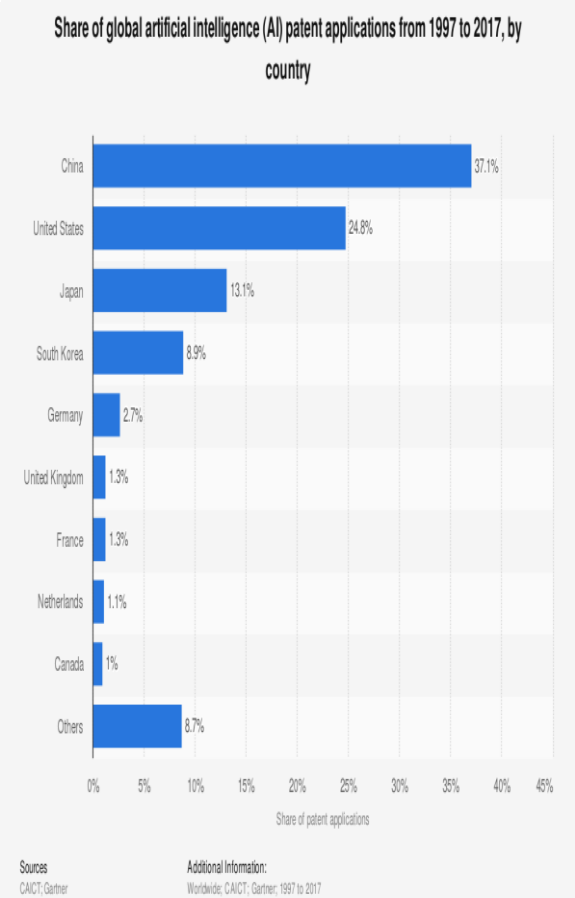
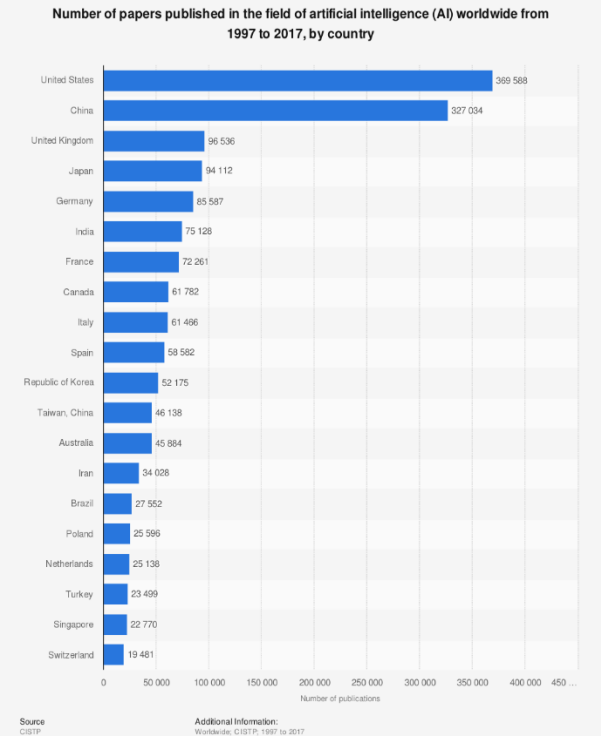


Chart 6.15





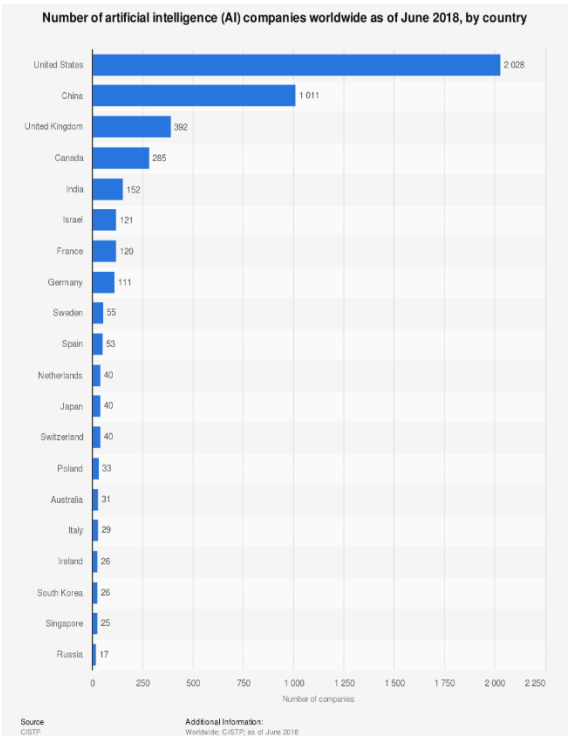


Chart 6.16 **Chart 6.17**

The percentage of scholars with publications in the field of AI in leading countries are shown in chart 6.18, and the percentage of AI talent experts in leading countries are shown in chart 6.19. The United States leads with 47% of scholars with the publication, followed by China in second place with 11%. while Canada ranked 3rd with 7% globally. However, Canada is ranked 8th in the world for AI talent experts, with only 2.2% compared to the United States, with 16.5% who is ranked first on the list of talent experts. This suggests that while Canada is in the top 3 ranks for scholars and publication, Canada is lagging in the talent pool for AI experts. This further implies that expert talent is highly correlated towards high growth AI ecosystems while publications are linked to a high growth ecosystem.

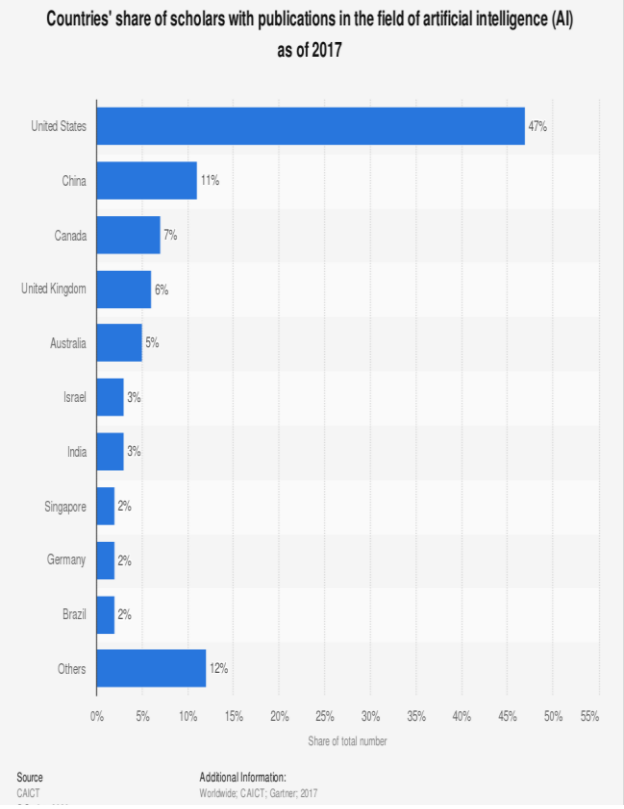


Chart 6.18

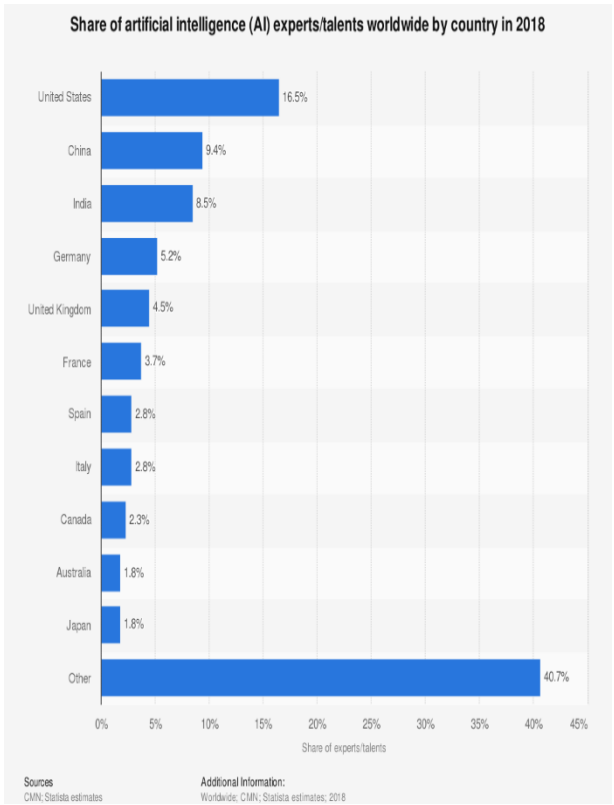


Chart 6.19

The AI performance benchmark by country as of 2018 in the sub-category, including personnel, monetary impart, competitiveness, research & education, and technology are shown in chart 6.20. This indicates that the United States is leading the AI performance benchmark while Canada is ranked 8th on the list of top countries behind the republic of Korea. It further suggests that while Canada is on the verge of AI advancement, it is lagging far behind leaders and other countries without a developed AI ecosystem, particularly in areas of research & education, technology, monetary impact, and personnel. Canada, however, does carry a strong benchmark in competitiveness in comparison to the other top countries' benchmarks. Moreover, the

benchmark in technology, research & education, competitiveness, and monetary impact is correlated towards regions with high growth AI ecosystems.

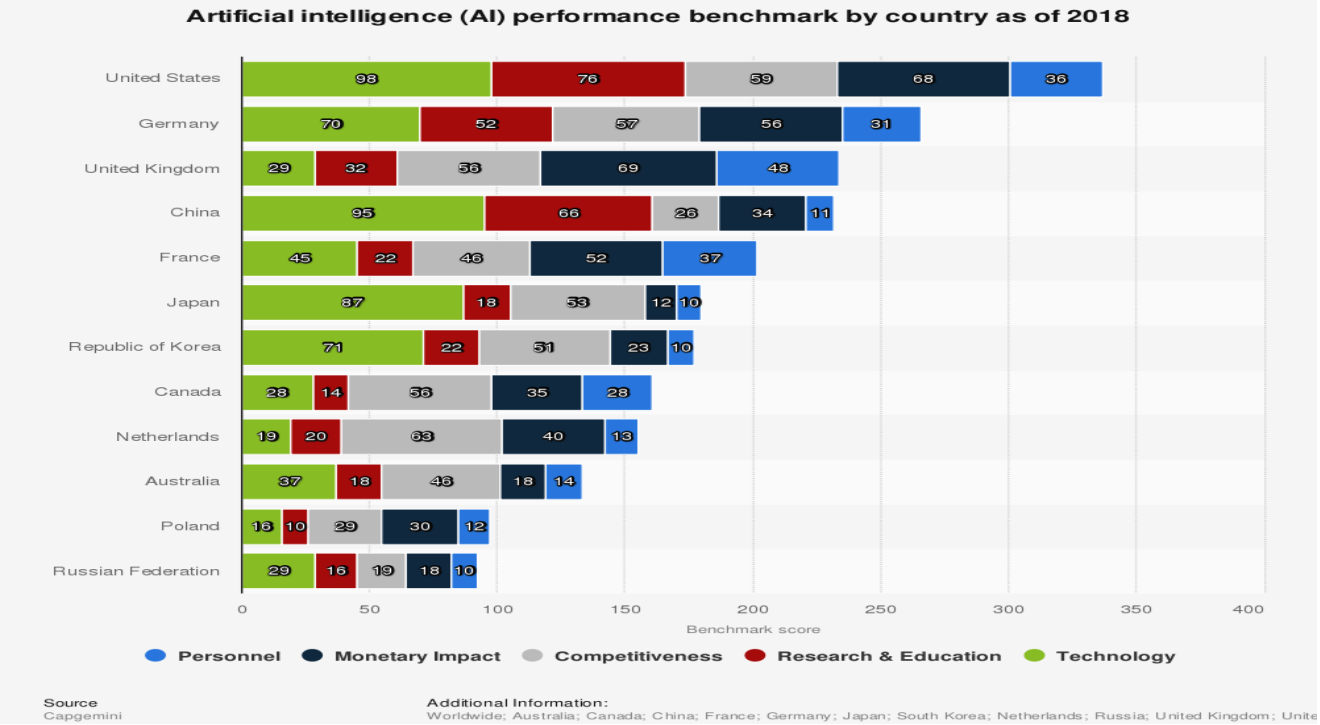


Chart 6.20

The percentage of AI startups worldwide in 2018 by industry is shown in chart 6.21. This suggests that general/cross-sectional in business to business services is at number one with 25% of worldwide AI startup firms focus, followed by AI startup with a concentration in communication, sales/marketing, and healthcare/biotech, all within the business to business service sector. While there are 21 AI startup industries worldwide, it shows that over 50% are dedicated towards business to business services, while 1% is focused on business to customer structure. Fintech and government defense security are also winning the top 7th rank with a market share of 7% each of all AI startup in 2018. This can further indicate that firm structure and specific industry focus is linked to high growth firms and ecosystems.

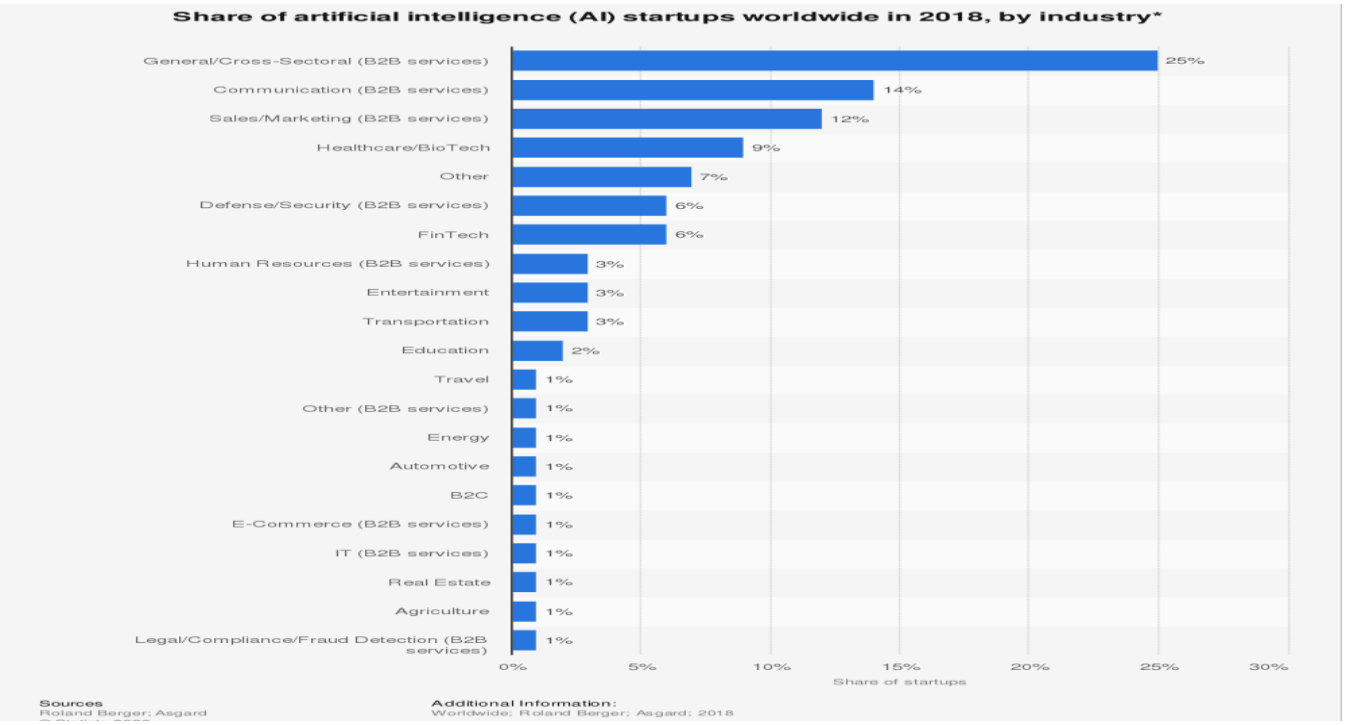


Chart 6.21

The total jobs within the AI sector by country in 2018 is shown in chart 6.22; the total number of AI experts/talent by county is shown in chart 6.23; the AI skill benchmark is worldwide by country is detailed in chart 6.24, and the total number of AI jobs by sector, by county, per million inhabitants is shown in chart 6.25. It shows that China and the United States ranked first and second respectively for AI jobs while Canada is 8th with 649 jobs compared to China with 12,113 and the United Stated with 7,465 available jobs in the AI sector. This suggests that job creation within a country can help fuel the country's ecosystem growth. Conversely, the United States had the most AI experts and talent pool worldwide, trailing ahead of China in the 2nd place. Canada ranked 11th place in terms of AI experts and top talent. While Canada had an appropriate mix of AI experts to AI talent, it is still lagging AI talent, and AI experts compare to its ecosystem size. Moreover, India trails third in most AI talent, and Iran, followed by Brazil with little to no top AI talent, suggests that other countries with top AI talent and ecosystems have an opportunity to

seek out talent in these regions. Moreover, the United States AI skill benchmark comparison is set at 1 to follow by China, India, and Israel. Canada, however, is sitting at 7th place with a skill benchmark at 0.34. This suggests that while Canada is ranked 7th in terms of AI skill performance worldwide behind Switzerland, they are ranked 5th worldwide for a total number of AI jobs per million of inhabitants behind the United States that sits in 4th place. This suggests that the distribution of jobs per inhabitants in Canada shows fair, yet, when taking into account AI top talent and job availability, Canada is still ranking low on the charts worldwide. It further implies that top expert talent is linked to AI ecosystem growth.

Chart 6.22

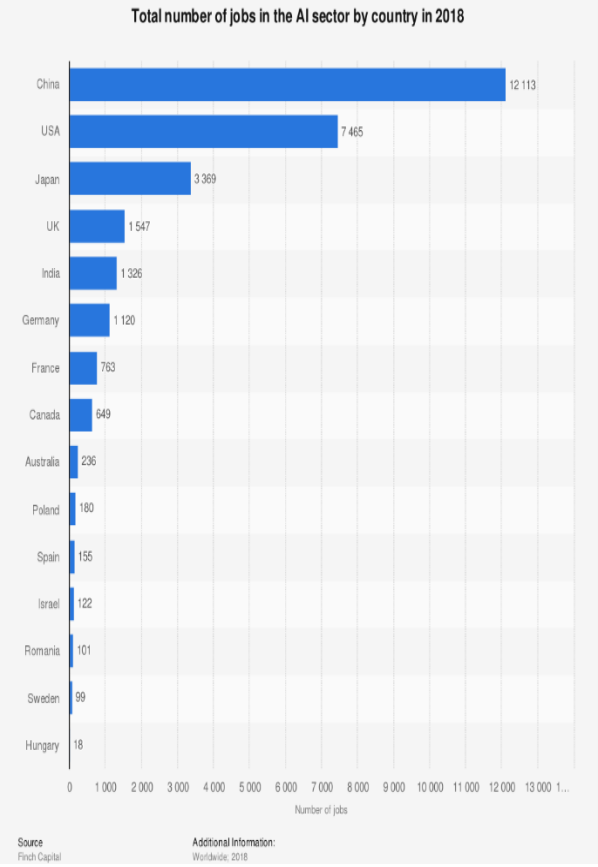
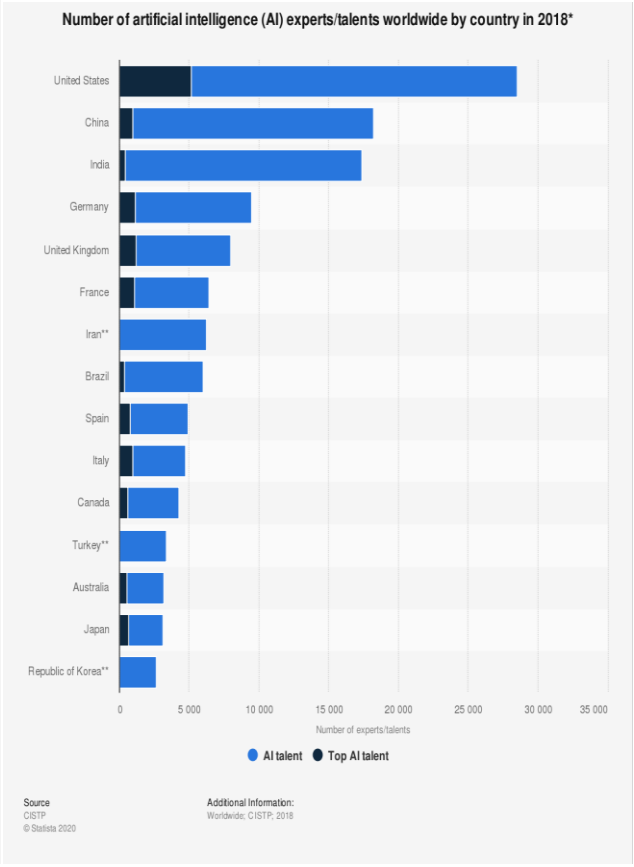
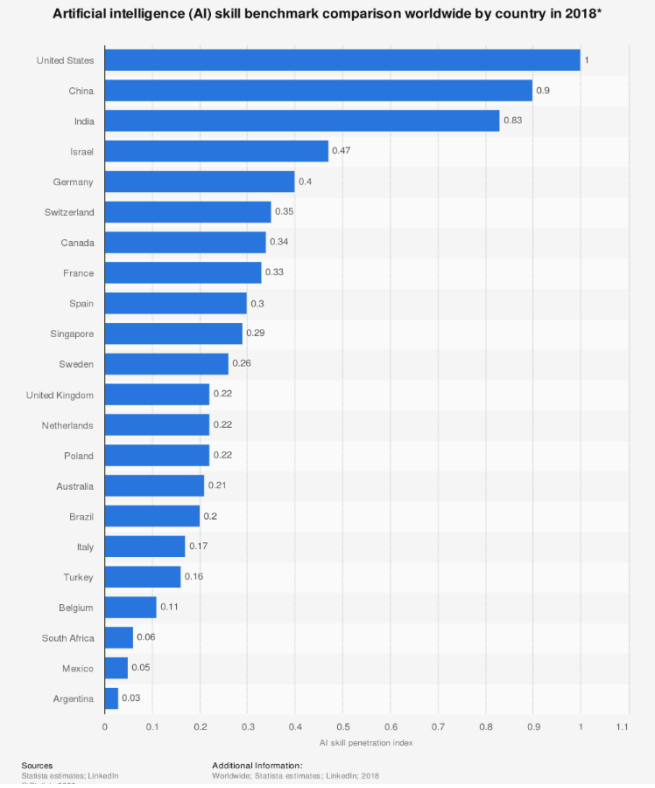


Chart 6.23





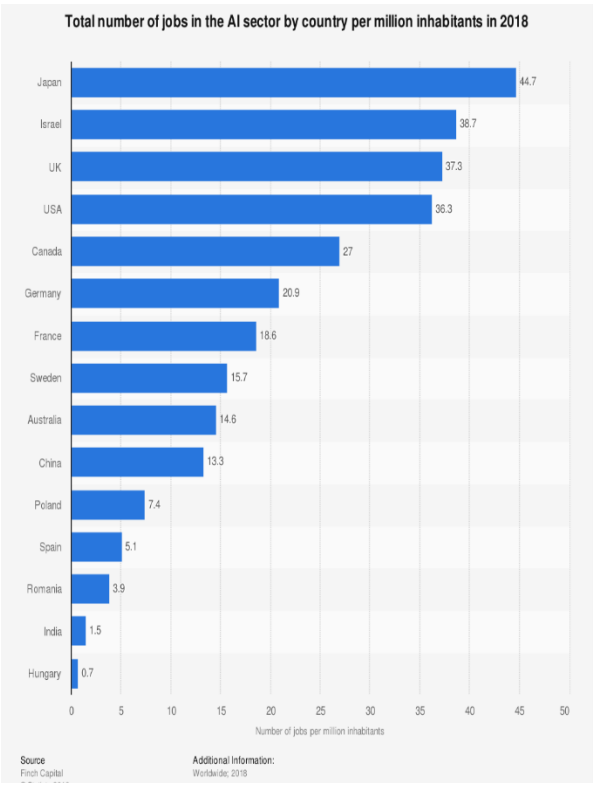
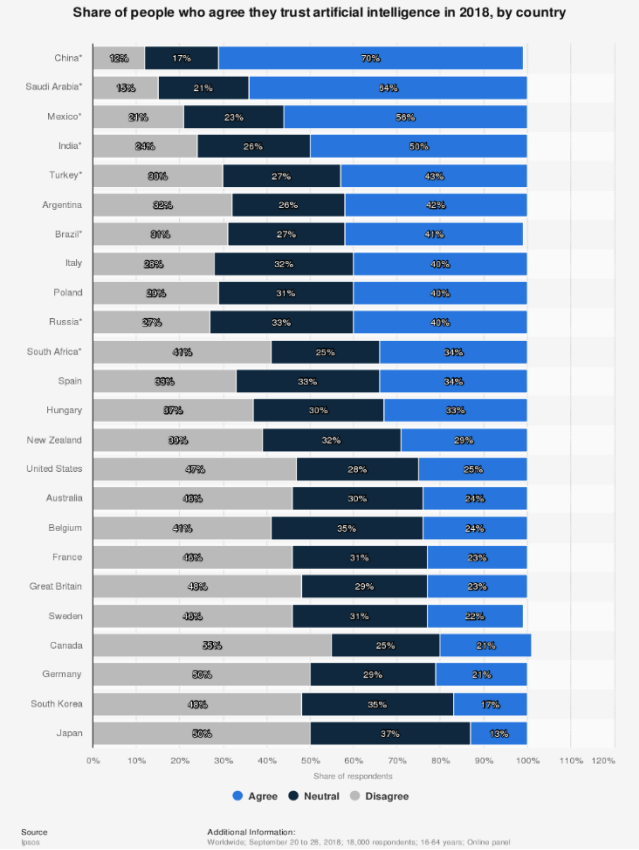


Chart 6.24 **Chart 6.25**

The share *sheer? amount of people who agree they fully trust AI by country is shown in chart 6.26, and customer and business buyer attitude towards AI globally as of 2019 is shown in chart 6.27. It suggests that China has the highest for all customers for AI trust. Canada, yet, has just 22% of all customers who trust AI, including 25% of businesses and 55% of AI customers. Whereas the United States has similar figures of 25% of all customers' trust and 28% of businesses' trust. This suggests that globally, less than half of customers and businesses, aside from China, Saudi Arabia, Mexico, and India, trust AI.

Furthermore, globally, 77% of business buyers are open to using AI to improve user experience, and 52% of customers are open to using AI to improve the experience. Overall, this suggests that both business buyers and customers are likely to accept AI, which is linked to be the highest

growing ecosystem. It further suggests that social and economic acceptance of AI within a region is correlated with AI growth in that region.



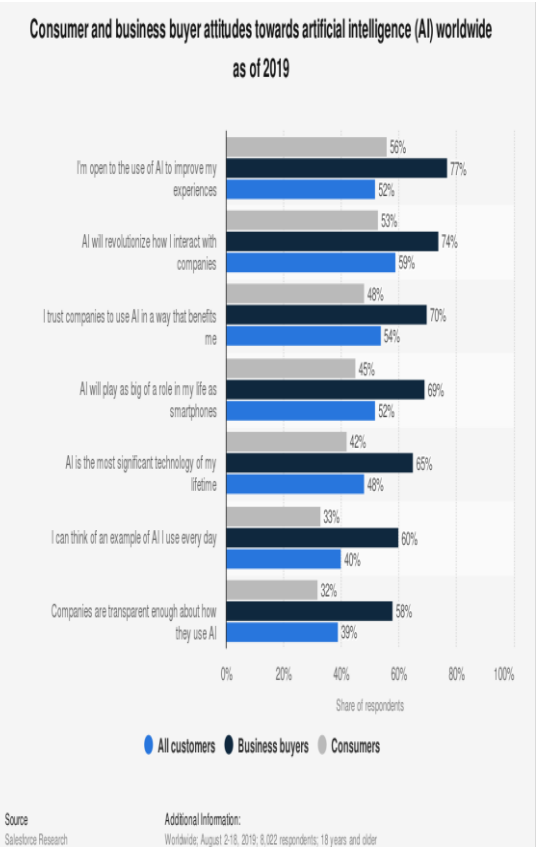
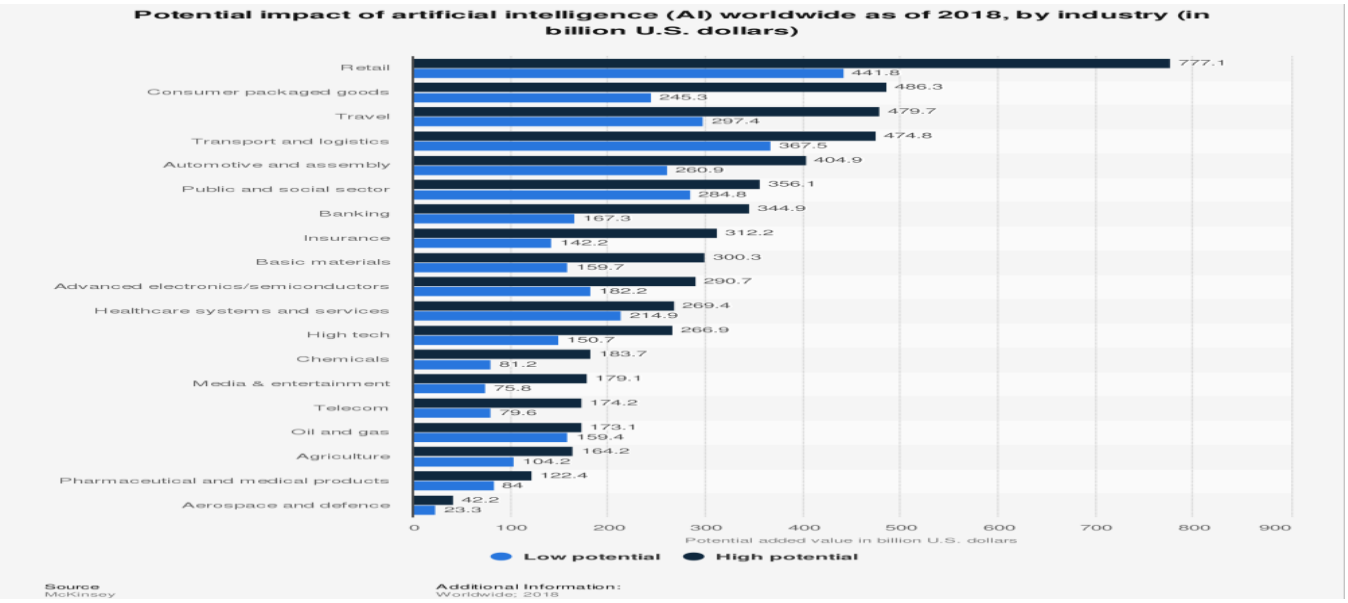


Chart 6.26 **Chart 6.27**

The potential of AI's global impact by industry in billion US dollars is detailed in chart 6.28, and the business value created by AI worldwide in US trillion dollars is shown in chart 6.29. Overall, the retail had seen the highest potential impact and low potential impact by AI in terms of dollar value. To that, the CPG, travel, transportation, and automotive industry top the chart for high potential impact, respectively. This suggests these listed industries are more likely to keep benefiting greatly from AI in the order, given current AI availability and research. The areas of

business value created by AI are decision support/augmentation, followed by agents, decision automation, and smart product, respectively. This is expected to increase in growth over the next five years, with the decision support/augmentation being the most significant area of value created by AI year over year. This further suggests that businesses can expect AI and AI firms to continue to add value to these given areas steadily. Moreover, it suggests that innovation and AI business case growth are linked to AI growth by specific sector.

Chart 6.28



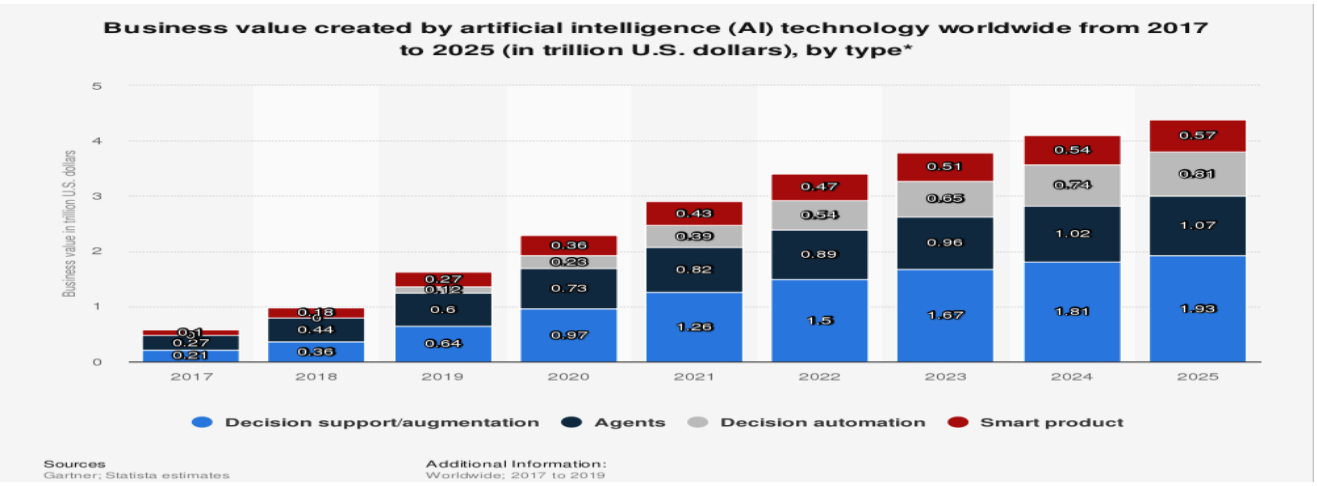
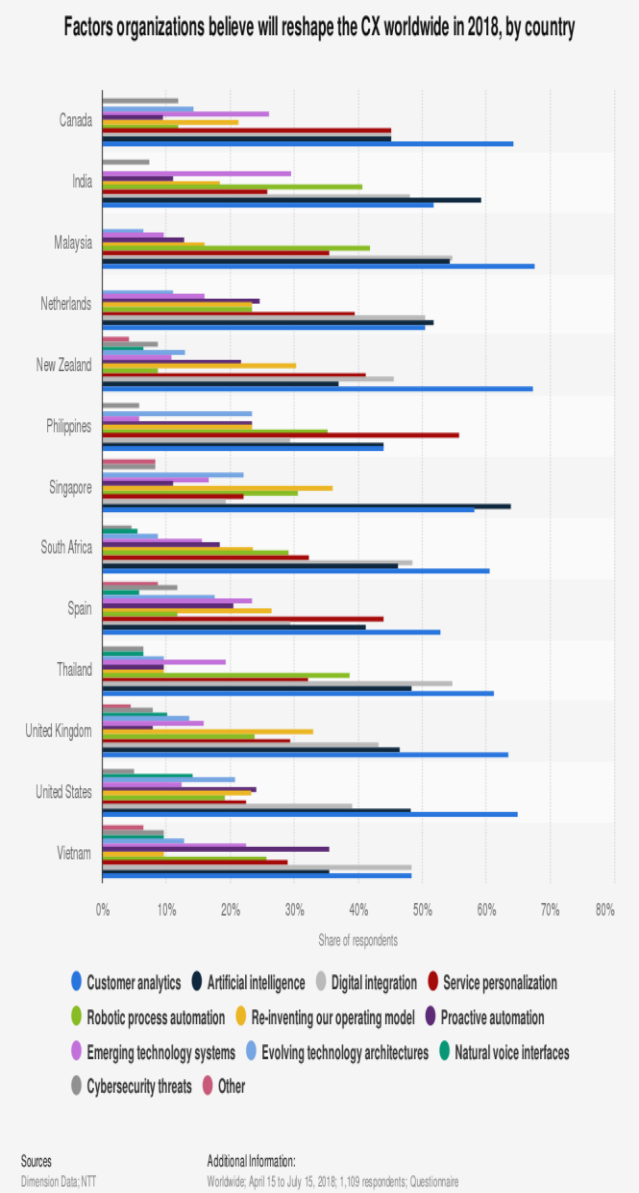


Chart 6.29

Chart 6.30 illustrates the factors organizations believe it will reshape the customer experience (CX) globally by country, and the cost decrease from the adoption of AI in an organization globally by function is shown in chart 6.31. It suggests that Canada ranks 1st on the chart of organization CX factors, which includes customer analytics following AI, digital integration, servicer personalization, robotics process automation, re-inventing operating models, proactive automation, emerging technology systems, evolving technology architecture, natural voice interfaces, cybersecurity threats, and others, respectively. This suggests that AI plays a large part in organization CX. India, Malaysia, the Netherlands, and New Zealand fall behind in the top 5 countries. Moreover, it shows that cost decrease due to AI adoption is recognized slowly in manufacturing, with 37% of that function being seen to decrease more significantly than 10% overall. Supply chain management, Risk, HR, strategy and corporate, finance, and service operation are over 20% of the total function, which saw a decrease of 10% or higher. This implies that leading industries that adopt AI relatively grow AI, which means leading industries are factors that drive AI growth and are industries that are most impacted by AI.



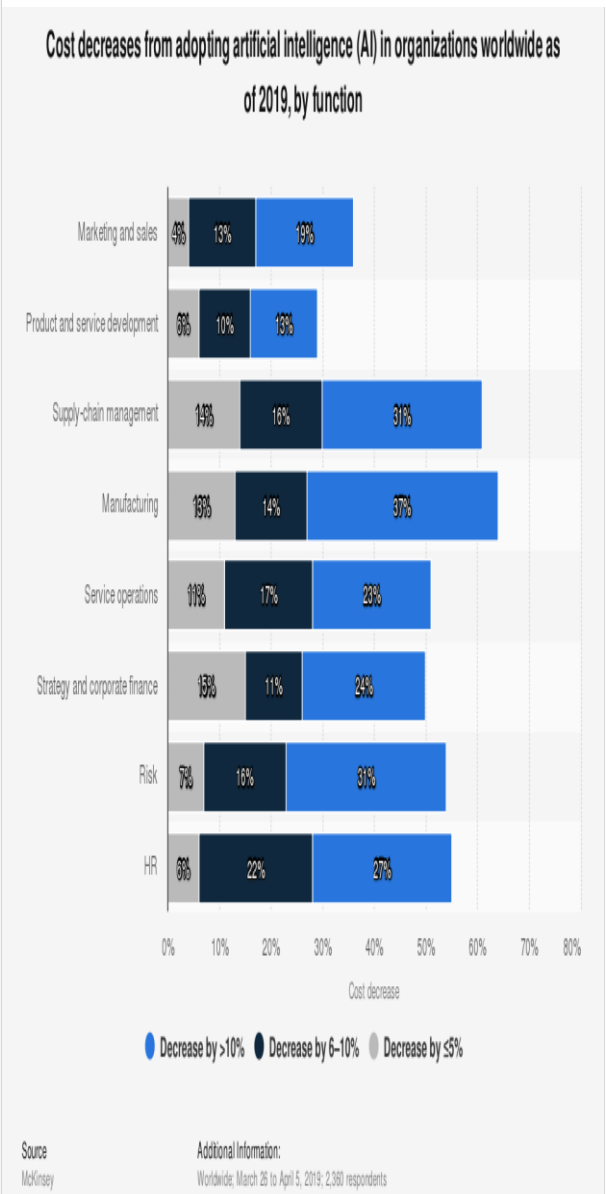
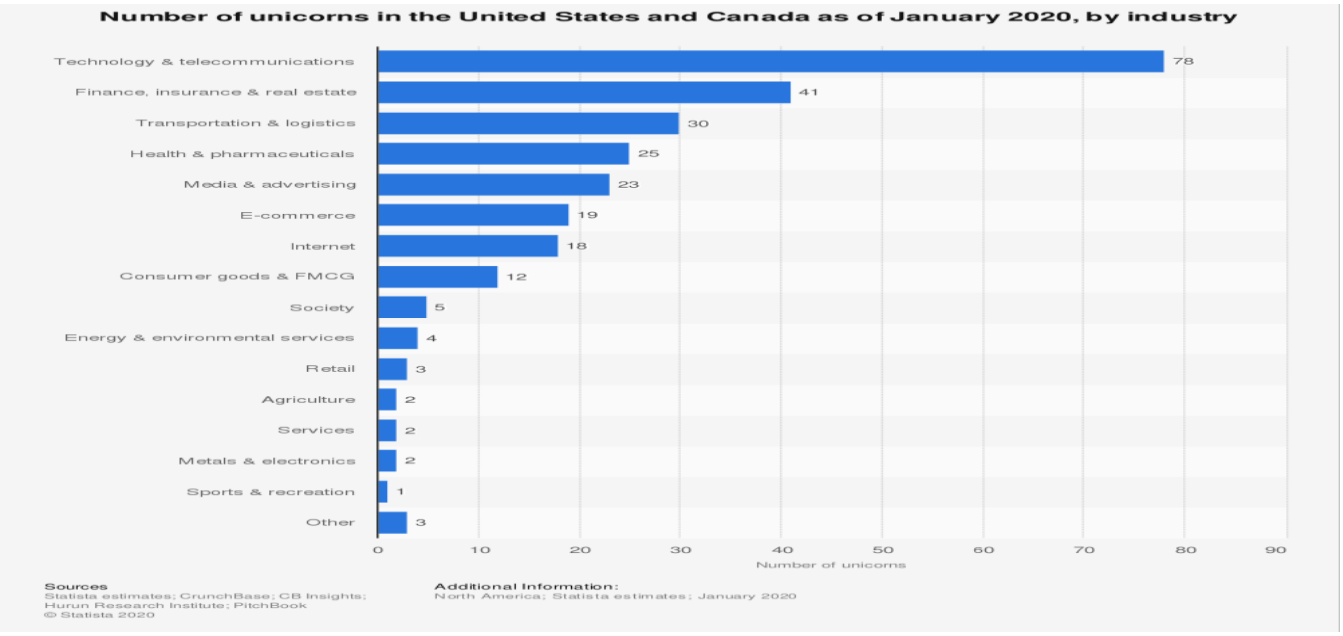


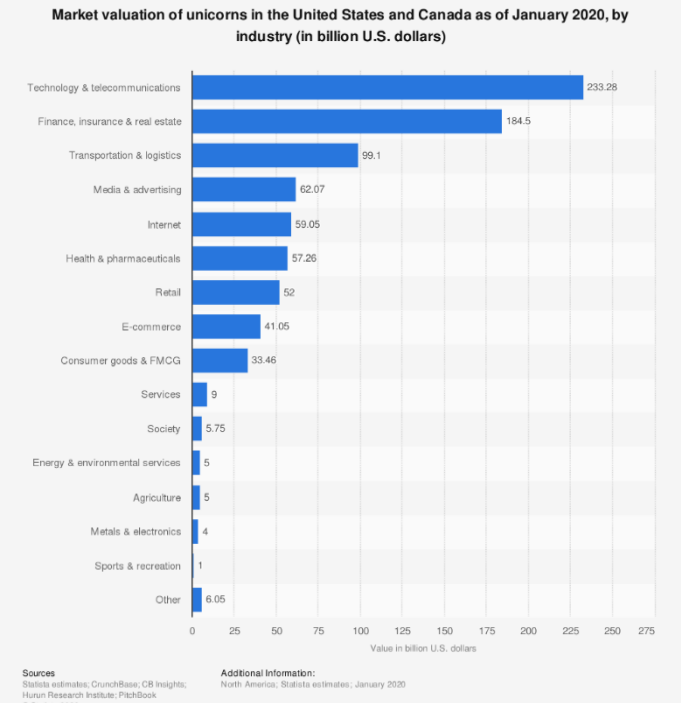
Chart 6.30 **Chart 6.31**

The number of unicorns in the United States and Canada as of January 2019 by industry is shown in chart 6.32; the market value of unicorns in the United States and Canada by industry is shown in chart 6.33; the distribution of unicorn in the United States and Canada by industry is shown in chart 6.34, and the total number of unicorn globally by country is illustrated in chart 6.35. It shows that Technology & telecommunications are the leaders in a unicorn for Canada

and the United States with 78 total firms. Next, Finance, insurance & real estate the transportation & logistics, health & pharmaceuticals and Media & advertising are of the top 5 industry with unicorns which account for 203 unicorns out of 274 firms. In such, technology & telecommunication has the most significant market valuation by industry followed by Finance, insurance & real estate, then Transportation & logistics, media &advertising, and the Internet respectively ranked in the top 5 in terms of market valuation. This suggests that the top 4 industry unicorns are the same in market valuations. The top 3 unicorns have a majority of distribution by industry compared to the rest of the industry, with more than 50% distributed. However, on a global scale, the United States dominates with the most unicorns follow by China, the United Kingdom, India, and Germany, respectively. Canada is ranked 15, with just three unicorns in its ecosystem. This suggests that while North America dominates the AI unicorn but Canada just makes up less than 2% of it. This further implies that compared to the highest growth AI ecosystem, unicorns, sectors, and industry are linked with ecosystem growth.

Chart 6.32





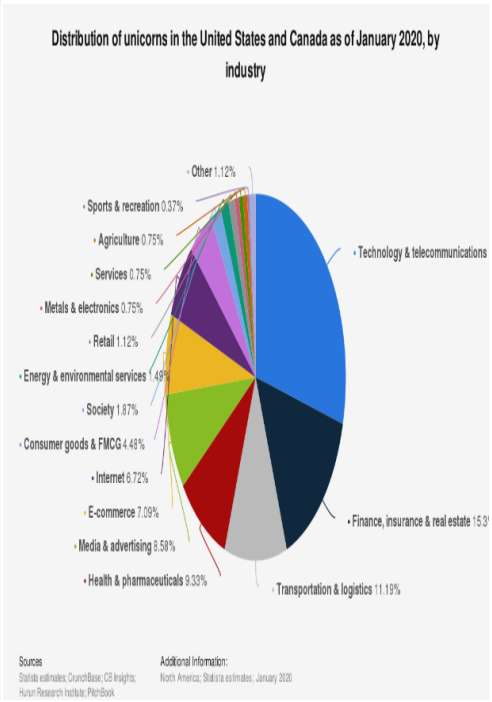


Chart 6.33 **Chart 6.34**

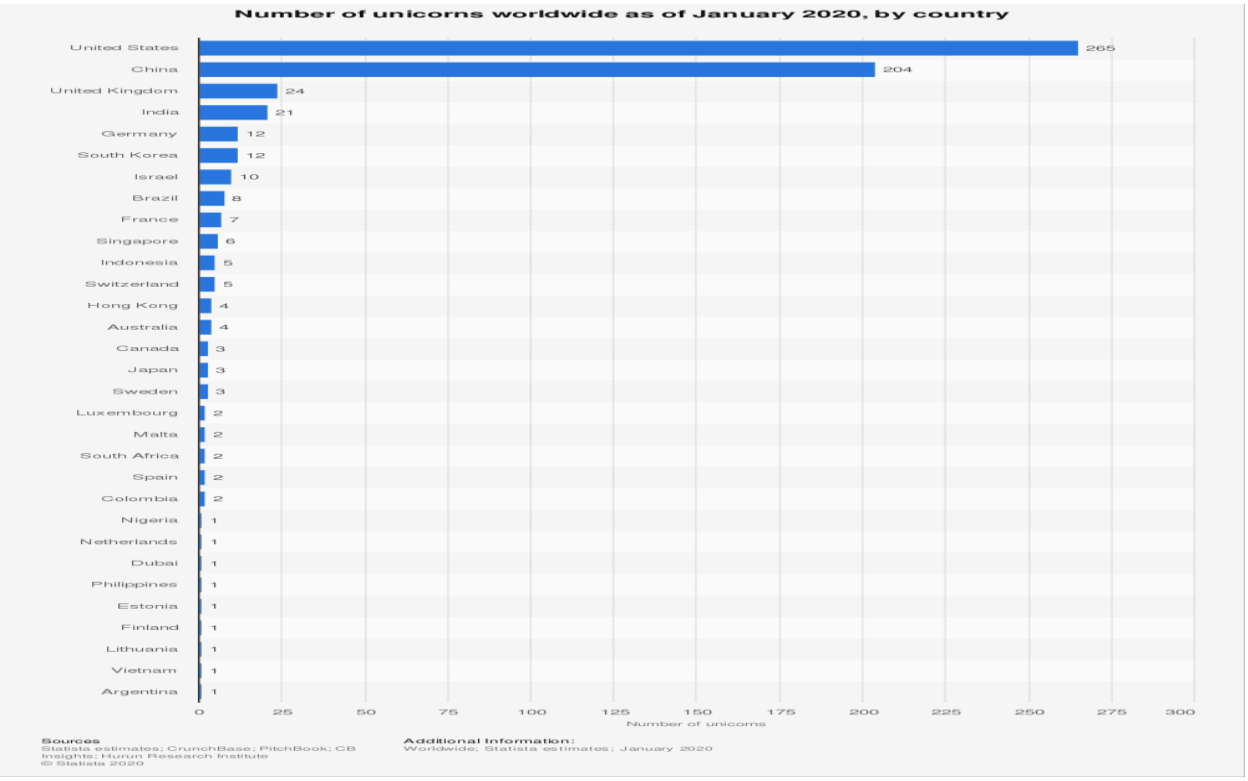


Chart 6.35

The top use cases of cognitive and AI systems in 2019 by market share are shown in chart 6.36, and the leading industrial AI uses cases worldwide by market share are shown in chart 6.37. It suggests that predictive maintenance, quality inspecting & assurance, and manufacturing process optimization capture more than 50% of total market share. Moreover, it shows that automated customer, automated preventive maintenance, automotive threat intelligence, and prevention systems where among the top use cases of cognitive and AI systems in 2019. This further suggests that AI still ranks high worldwide for use cases in a specific market that are correlated to high growth AI ecosystems and AI firms.

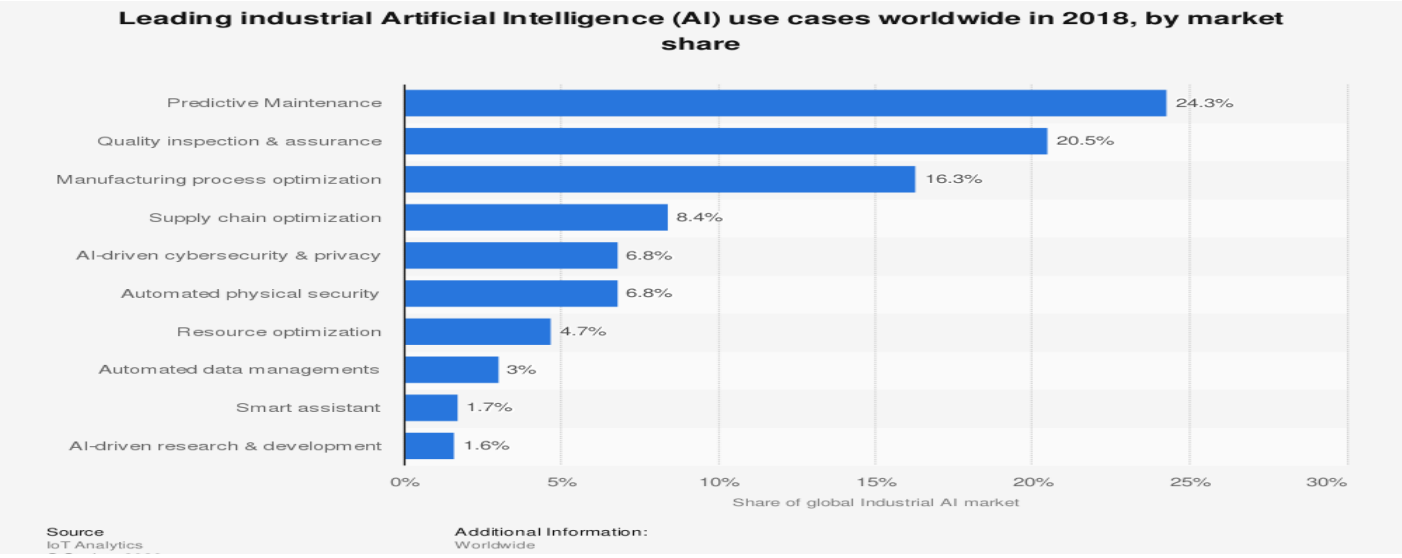


Chart 6.36

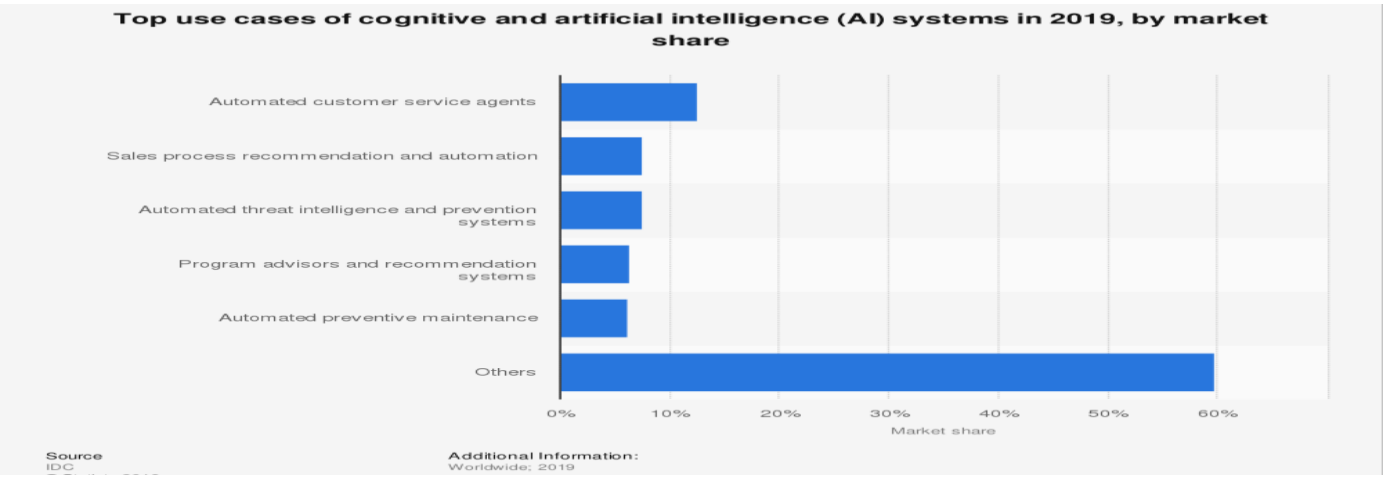


Chart 6.37

4.5 Discussion of Research Analysis

The findings in the research have shown to answer the research questions presented. This chapter has presented the success factors influencing the growth and sustainability of an AI ecosystem and the factors influencing AI startups' growth, which can be tied to the literature and research questions. Conversely, interviews with AI firms in Canada's ecosystem, analysis of various AI market data present in the form of charts have identified the success factors/ingredients influencing the sustainability & growth of an AI ecosystem and startups. A refined framework derives from the research and literature is produced in the next chapter, along with key findings and discussions.

Chapter Seven

Recommendations for Further Research, Limitation, and Conclusion

7.1 Introduction

The main objective of the thesis was to investigate the factors/ingredients influencing the growth of AI ecosystems and; the factors influencing the growth of AI startups. This chapter presents the key findings of the research based on the interviews and data analysis discussed and interpreted. Furthermore, this chapter presents a refined framework derived from the empirical analysis along with limitations where further research is recommended. The thesis closeout with a recommendation for the main objectives of the thesis.

7.2 Key Findings

The findings in the thesis provides a comprehensive overview, techniques, landscape, and current picture of the current stage of AI startups and AI ecosystems growth factors. In terms of success factors for AI ecosystems, there is wide variability in the sample across different AI firm profile groups, where their success factors became equally variable. Although each AI firm's requirement is different when it comes to success factors due to the type of AI firm, stage of the firm, and firm structure; some guidelines can be set from the results. For example, the requirement for success factors is consistent in terms of resources which include talent, funding, customers, infrastructure, and big data. Other factors are government influence, market demand,

networks, partnerships, collaboration, rapid innovation, and the ability for efficient commercialization of AI application. The data analysis also shows that successfully growing AI ecosystems are made up of large numbers of successful AI firms, including unicorns. Moreover, it shows that access to substantial financing, ecosystem located in regions that are supported by governments, and university partnership are correlated to growing AI ecosystem. Unfortunately, the literature review was unable to provide these precise vital elements and ingredients which are necessary for AI ecosystems and startups growth. For example, the finding shows that AI ecosystems should operate in sectors that have market demand (most AI impact), including leading industries, and; firms should offer AI applications that create immediate business value.

The finding further suggest that AI firms have the ability to innovate quickly, have the highest concentration of AI experts, talents, and the ability to commercialize efficiently in order optimize growth. The findings also show that success factors influencing AI startup growth and sustainability are linked to some factors of the ecosystem. They are similar in terms of talent/expert, financing, big data, customers, infrastructure, knowledge sharing, firm structure, and collaboration. However, the exceptions are that of inside the firm, including the structure of the firm, visionary leadership, and the firm's strategy. The evidence shows that AI ecosystem's growth is influence by AI startup growth and various actors. The findings further show that growth is linked with continuous financing through investments, grants, and customers. Furthermore, technology readiness, rapid innovation, and commercialization of AI applications are also influential factors for AI ecosystem.

Moreover, AI ecosystems are embedded as part of the value chain of top leading industries through AI firm's structure (born global). Conversely, the data shows that acceptance towards AI applications by industries and customers is correlated with growth. Yet, growth is shown through

a high concentration of AI startups, AI patents filed, industries AI firms target and firm size. Furthermore, the number of industries targeted by the ecosystem, and the ecosystem's infrastructure, including available supercomputers are all correlated to growth. For instance, the finding further shows that the type of AI application and the industry the AI firm sells to, has an influence on growth where the top three AI applications and specific industries show to be the highest growth factor for AI startups. The applications are ML, NLP and computer vision. The evidence further shows that business to a business transaction in the general, /cross-sectional, sales/marketing, and healthcare industries have the highest concentration of growth year of year within the AI ecosystem and in AI startups. The data also finds that unicorn firms are concentrated in high growth industries which transportation & logistic, media & advertising, and the internet. These same industries are linked to growing AI ecosystems and AI firms.

Nevertheless, the findings shows Canada's AI ecosystem top industries are Fintech, other human resources, energy, and sports. This can help explain why Canada is ranked fifth worldwide for AI ecosystem in size and growth. That is, Canada's AI ecosystem is not operating in high growth industries or focus on the top three AI applications. The analysis also shows that Canada is in 8th place for infrastructure (supercomputers) in the world, and supercomputers distribution. Moreover, it is found that universities, expert talent/talent, AI patents are correlated with Canada's AI ecosystem growth. This indicated that the Canada's AI ecosystem is lagging some of the known success factors for growth compared to the top three global AI ecosystems; which represent over 70% of the world's AI market share. Furthermore, it shows that diversity of AI applications within AI ecosystems does not correlate with growth. Instead, the Use-Cases that are linked to growth are the ones creating business value and are 'technology readinesses. Moreover, the findings imply that AI growth performance in a specific location has no

correlation to industry AI growth. This is due to AI firms are able to advocate customers and mobilize the value chain across borders of more receptive industries and regions for AI adoption.

The contextual framework was able to provide the underpinning of the empirical analysis, where the literature review could not capture. This is of importance in providing the missing linkage between the literature review and the empirical analysis. The findings in the research advance existing research that was reviewed in chapter two by expanding on Kaiser and Landau's (2019) framework on successful ecosystem. Conversely, Bongug, (2019) digital ecosystem framework draws similarities to the AI ecosystem with limitations. The finding in the research was able to lift those limitations by exploring the AI ecosystem by drawing in today's landscape and challenges around technology readiness, big data polices, global perspective and underlines limitation for targeted industries for AI adoption. Moreover, Aldrish and Yang (2014) Entrepreneurial Ecosystem and Entrepreneurial Regional Innovation system and Cook (2007) Regional Innovation system framework was further explored and update with the findings in this research by doing a deep dive into AI startup's success factors and further exploring AI ecosystem's success factors. Furthermore, the proposed framework from the research findings contribute to Audretsch and Belitski (2016) framework around startups; pan et al., (2010) innovation ecosystem framework and Landau (2019) framework around successful ecosystems by further adding a more recent ecosystem and startup framework. Moreover, the framework in this research further addresses limitations in Nambisan and Baron (2013) work on high-tech firm's success factors within innovation ecosystems by addressing the qualitative norms of an ecosystem and combining it with a macro, meso, and micro-ecosystem overview in more recent time. Lastly, the findings directly contributed to Gone et al., (2018) innovation framework by expanding on ecosystem success factors, particularly detailing specific requirements including

the type of infrastructure, algorithms, big data, cost structure, and how to optimize resources within an ecosystem.

7.3 Discussion

The appropriate measures should be considered when considering AI startups. Based on the empirical analysis conducted in this thesis, the Theoretical Framework for AI ecosystem success factors and AI startup success factors are revised and refined. The empirical analysis provided further insight into success factors that influence the AI ecosystem and AI startups that the literature review did not unveil. For instance, AI ecosystems are similar to ecosystems covered in the literature review; however, there are missing vital elements that influence growth in both ecosystems and startups. Below is the refined framework that illustrates and explained the critical missing element that is required.

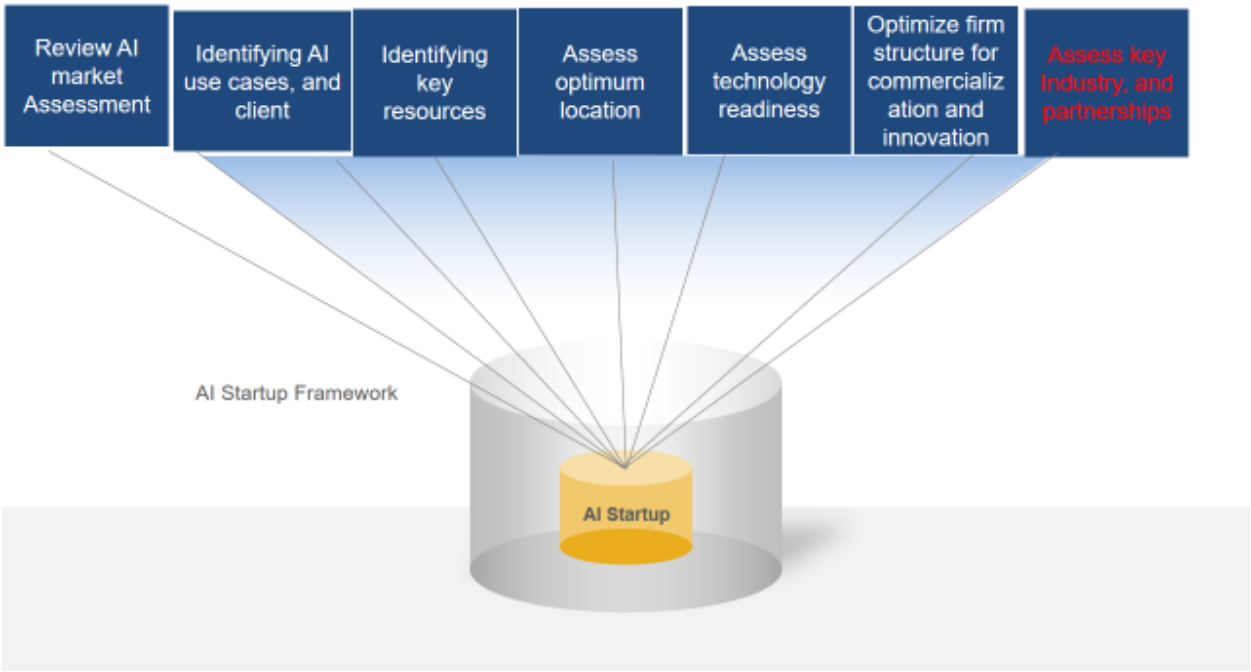


Figure 10: Refined AI Startup Framework. (Source: Author)

Assess vital industry and partnerships are major key elements that were identified in the empirical analysis. The need for startups to fully assess critical industries that are driving and adopting AI through a series of policies, industries and firm structure. Moreover, budget size, and value creation on a specific side of the supply chain is essential for the survival and growth of AI startups. This is because AI startups have no initial clients and the structure of the AI startup creates the option to seek out its' competitive advantages, target market in the particular industry, ahead of the innovation and formation process. Lastly, AI startups must create a class of crucial partnerships to help drive growth and sustainability within the first 5 years. These partnerships range from AI labs, large enterprises with open networks like Google and SAP. Moreover, partnership for AI startups is the grassroots of growth because it allow collaboration, co-operation, knowledge sharing, and access to necessary resources including talent and compute power.

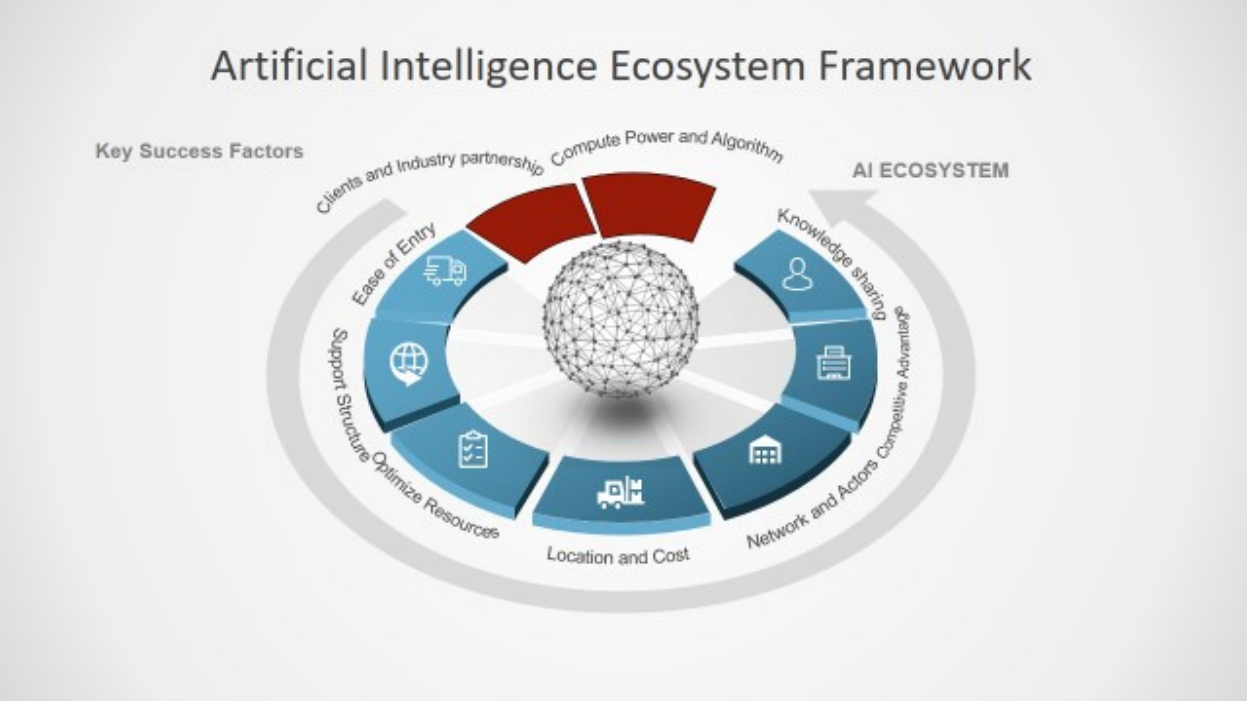


Figure 11: Refined AI Ecosystem. (Source: Author)

Clients and Industry Partnership are the next steps in the success factors influencing growth. Clients and industry partnerships are crucial elements that are a must-have for AI ecosystem's growth. For example, without clients ready to adopt AI immediately, then the ecosystem will not survive or grow despite available AI applications and constant innovation. These clients within specific industries need to be a partner with the ecosystem to collaborate, test, integrate, and transform AI into these targeted industries more efficiently. The partnership will allow AI ecosystems access industries knowledge to better understand, test, and deploy AI at a faster rate with minimal setback or high cost. It further allows AI ecosystem the ability to improve metrics and understand industry-specific requirements by integrating both the AI ecosystem and specific industry's characters to optimize AI value.

Compute Power and Algorithm are the last missing elements that are required for high growth AI ecosystems. For instance, an AI ecosystem innovation is as good as its compute power. All high growth AI ecosystems showed to have the most supercomputers inside the ecosystem. Compute power creates better, faster, and more advance AI applications. This is because the most complex, innovative, and sophisticated AI applications requires a high level of computing power to design and test ahead commercializing the technology to clients. The lack of computing power hinders AI ecosystem growth by lessening the opportunity for advancement, innovation, reduce client traffic to the ecosystem. It furthers reduces attracting talent, and funding inside the ecosystem. Next is the appreciation of algorithms use to build AI applications. Often, open-source platforms and knowledge sharing will help generate a practical algorithm for AI application process. However, to promote growth within the ecosystem, advance and adequate algorithms are required to build necessary AI applications, which creates competitive advantages through patents, provide real options, and optimize innovation opportunities, which translate into growth and sustainability for AI ecosystems.

Artificial Intelligence will change the business and social world we live in a much greater extent to what we imagine today. While this research unveils the success factors for AI startups and AI ecosystems, AI still faces many challenges down the road, and to stabilize AI growth, these challenges should be addressed at an early stage. Some of these challenges are: obtaining data, optimizing market fit, resolving the lack of talent/experts, and addressing the ambiguity around regulation of privacy. Moreover, big data privacy, security, and functional silos in industries and organizations are some challenges that need to be address. Moreover, transforming the culture of people, organizations, and processes to derive value from AI is something that need to take into

consideration. However, there are many factors of AI growth, particularly AI ecosystems and AI startups that are operating in a strong AI focus economy. For instance, financing, expert talents, advanced infrastructure and a strategic focus on high growth markets that are receptive for AI adoption are seen in AI ecosystem globally. In order to increase AI presence and promote growth, regions like India and Iran with a high ratio of AI talent/expert but with low concentration regional AI ecosystems can provide talent/expert to AI ecosystems and in turn exchange for AI ecosystem resources. This can be achieved by easing the immigration of qualified students, skill trade talent, and creating a government branch specifically for AI startups in the form of easing access to all necessary resources for growth and sustainability. The development and promotion of AI should be merged into society for social and business acceptance, and existing and new business models should have AI adoption integration.

7.4 Recommendation for Further Research

It would suggest undertaking interviews with other AI ecosystems in Canada, including British Colombia and Alberta, to widen the scope for the group. Furthermore, taking a deeper dive into current AI applications, client's business models, and transaction method within the AI ecosystem are recommended. Also, the level of talent and contribution level of growth of each success factor of AI startups and AI ecosystem is need for further exploration. This could provide a precise point in time snapshot of Canada's AI ecosystem growth rate and have a more accurate comparison with the AI global market. Furthermore, a sample would be helpful from AI startups in the United States, including unicorns to compare against Canada AI startups best practices and available resources used/needed for growth. This will also provide further detail of the specific contribution matrix for each success factor that influences growth in both AI startups

and AI ecosystems. The Artificial Intelligence ecosystem and startup framework need to be tested in a real-world setting and be optimize base off the firm's structure and ecosystem's characteristics. Lastly, a quantitative analysis should be conducted and observed within each AI ecosystems and AI firms from the top 10 high growth AI ecosystem worldwide in order to assess each influential factors surrounding growth.

7.4.1 Limitation

The research present some limitations including the sample size of the study. By expanding the scope of the research sample to other ecosystems globally in order to compare against Canada AI ecosystem would create a more precise comparison of success factors within an AI ecosystem and AI startup. Furthermore, time is of the essence given the current global pandemic. Doing analysis on growth factors ratio in specific AI industry before and after the pandemic would be value added to the research. Such analysis would conclude how specific economic conditions affects growth factors within specific AI market given current ecosystem structure and characteristics.

7.5 Conclusion

The Artificial Intelligence ecosystems and startups offer the opportunity not only to solve real-world and business problems but to reshape business models and society fundamentally. AI applications, including machine learning, natural language processing, and in-depth learning, help to pave economic growth and efficiencies while helping to drive growth within AI ecosystems. AI startup's founders and decision-makers are confused with the benefits, challenges, complexities around growth, sustainability, and survival of their startups. There is also a lack of framework around the success factor of AI ecosystems and AI startups. As such, this research has provided an overview of AI ecosystems and AI startups' success factors from both a technical and commercial perspectives. This research takes a deep-dive into the AI industry on a global level, firm-level, and also a country level. The goal of this research is to present a realistic baseline that allows AI startups founders and stakeholders to compare their ambition and efforts. This research then proposes an AI startup framework and AI ecosystem framework which guides the stakeholders and decision-makers to model the environment and the external and internal forces that influence the growth and sustainability of AI ecosystems and AI startups.

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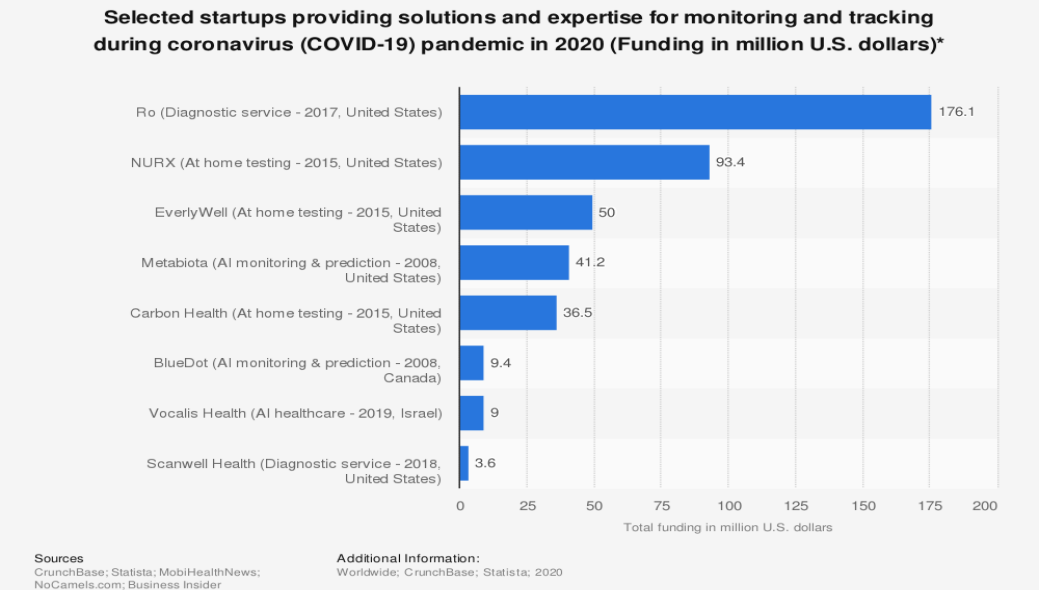
Appendices

9.1 List of Charts



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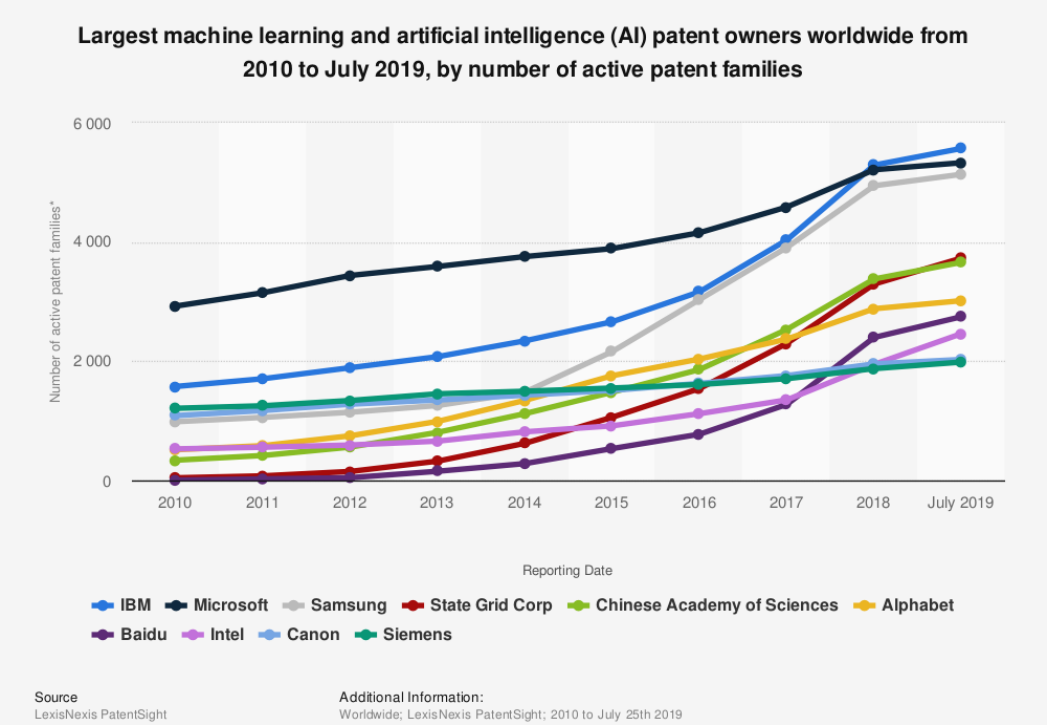

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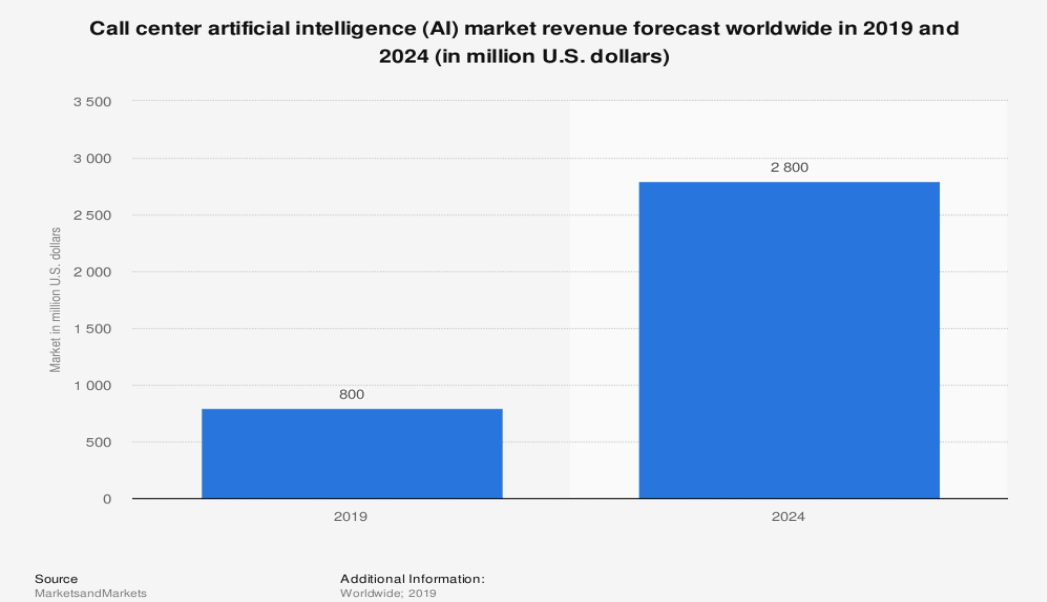

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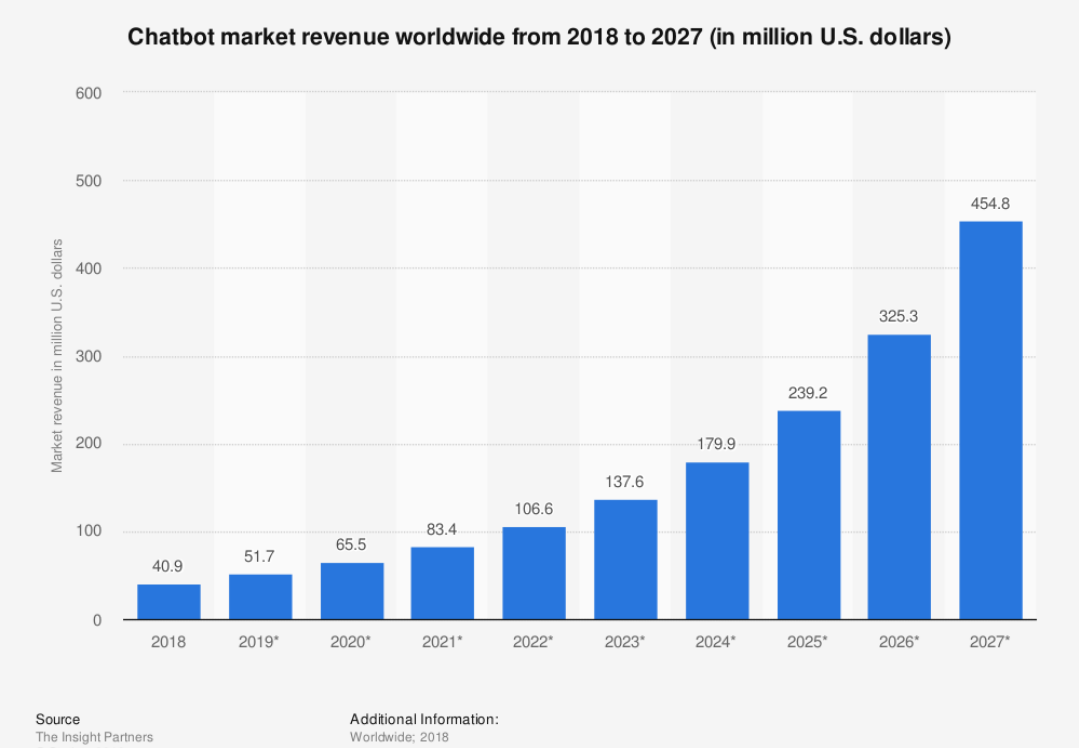

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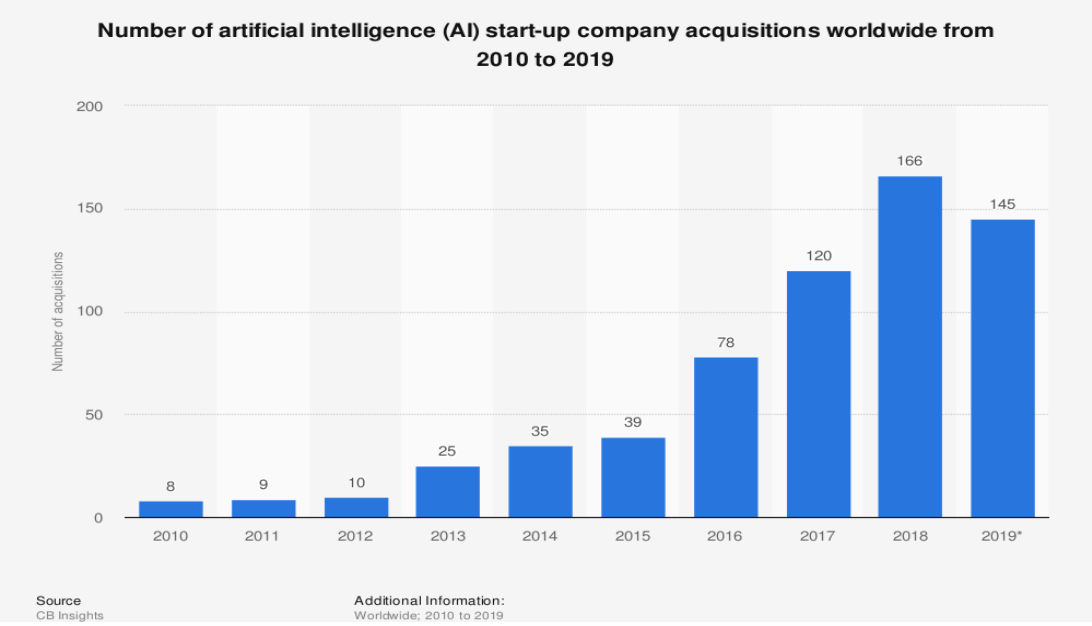

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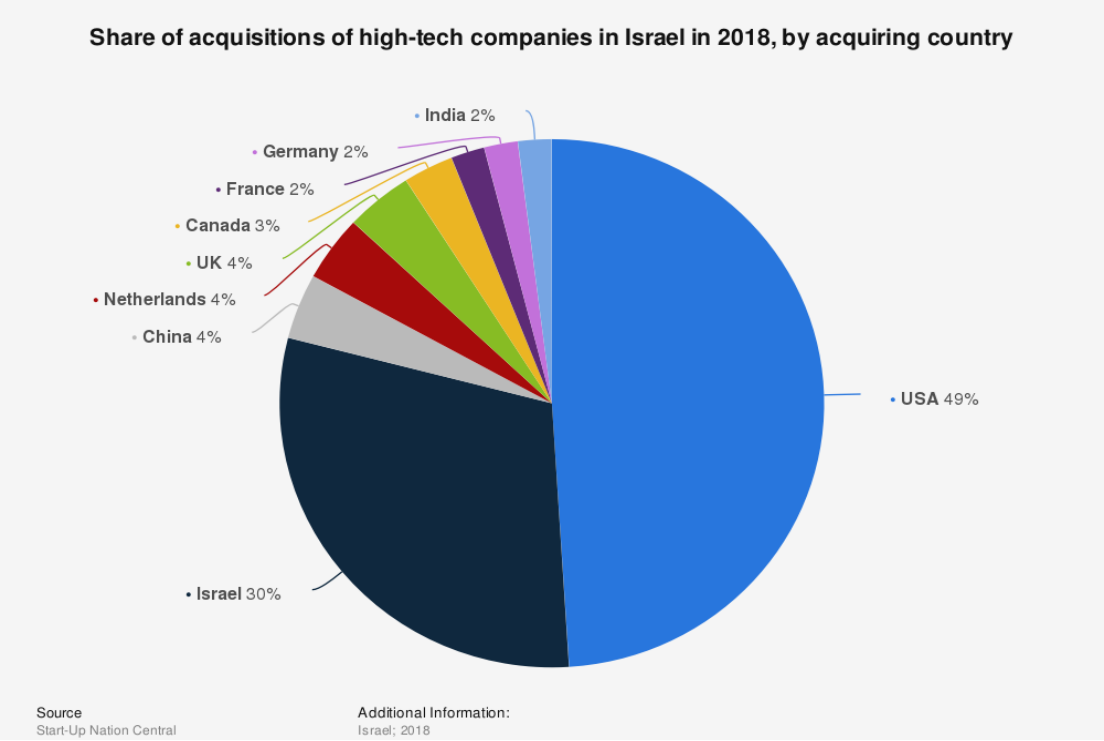

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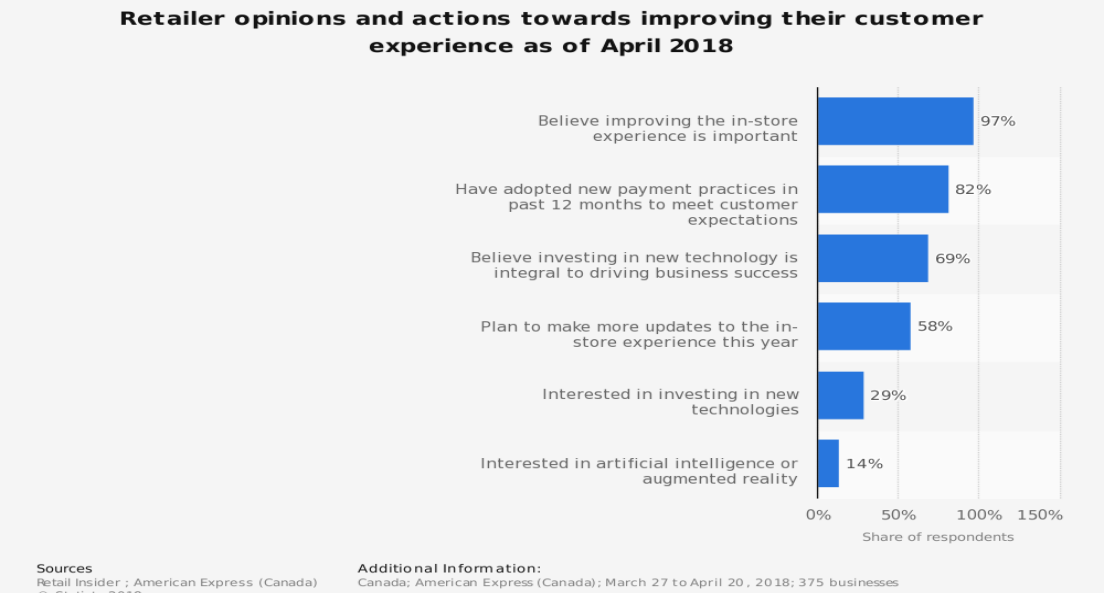

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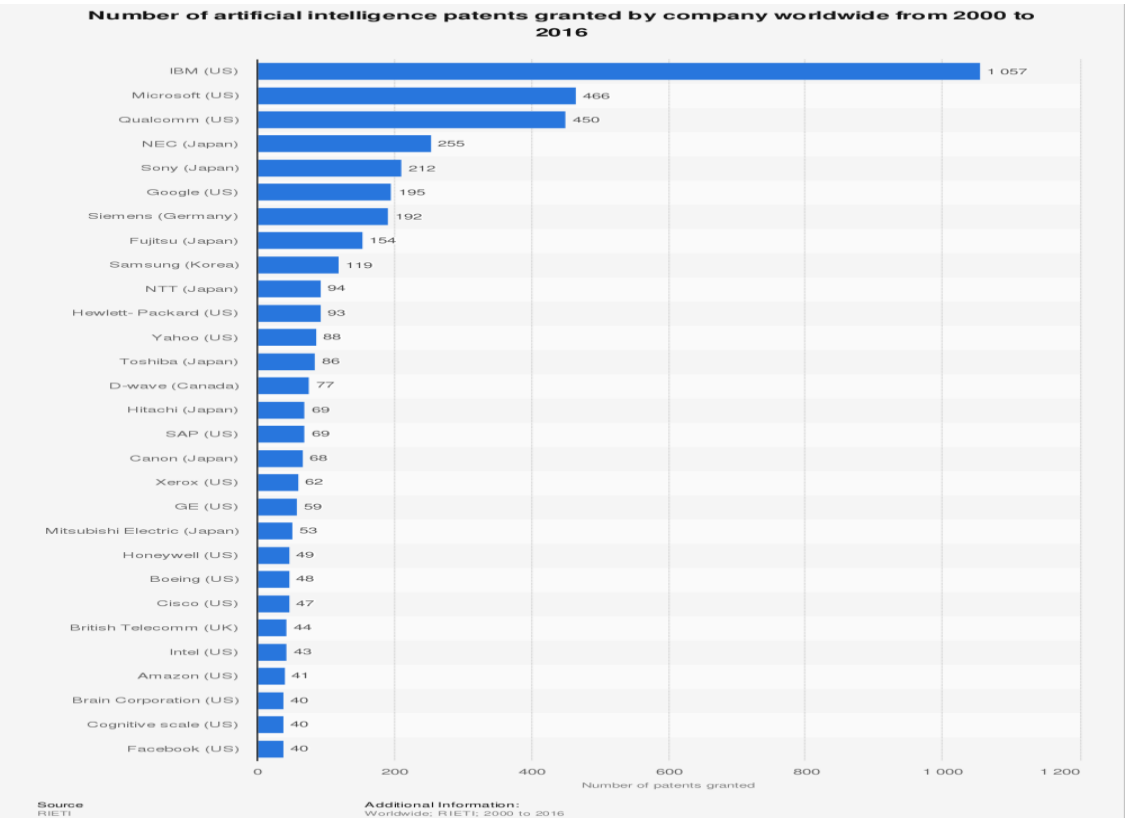
Number of artificial intelligence patents granted by company worldwide from 2000 to 2016
IBM (US) 1 057
Microsoft (US) 466
Qualcomm (US) 450
NEC (Japan) 255
Sony (Japan) 212
Google (US) 195
Siemens (Germany) 192
Fujitsu (Japan) 154
Samsung (Korea) 119
NTT (Japan) 94
Hewlett- Packard (US) 93
Yahoo (US) 88
Toshiba (Japan) 86
D-wave (Canada) 77
Hitachi (Japan) 69
SAP (US) 69
Canon (Japan) 68
Xerox (US) 62
GE (US) 59
Mitsubishi Electric (Japan) 53
Honeywell (US) 49
Boeing (US) 48
Cisco (US) 47
British Telecomm (UK) 44
Intel (US) 43
Amazon (US) 41
Brain Corporation (US) 40
Cognitive scale (US) 40
Facebook (US) 40
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Number of patents granted
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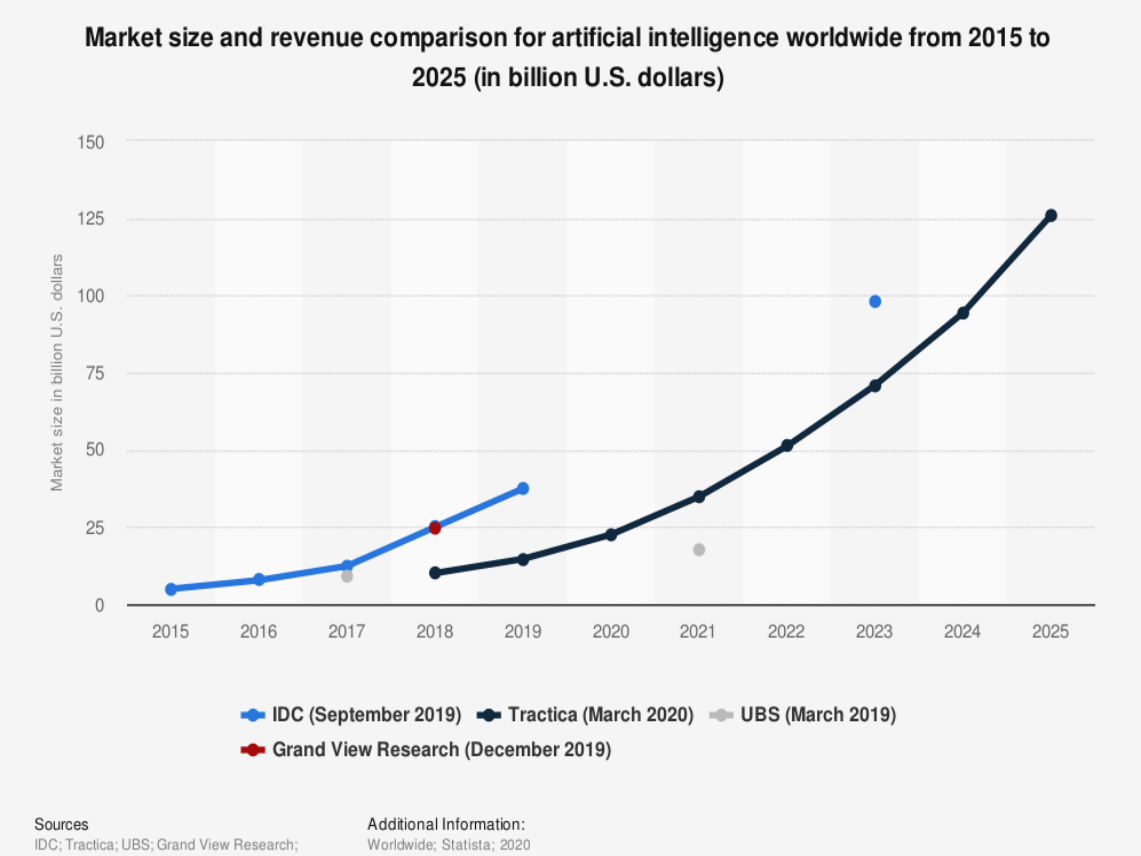
Additional Information:
Worldwide; RIETI; 2000 to 2016

Chart 9.8



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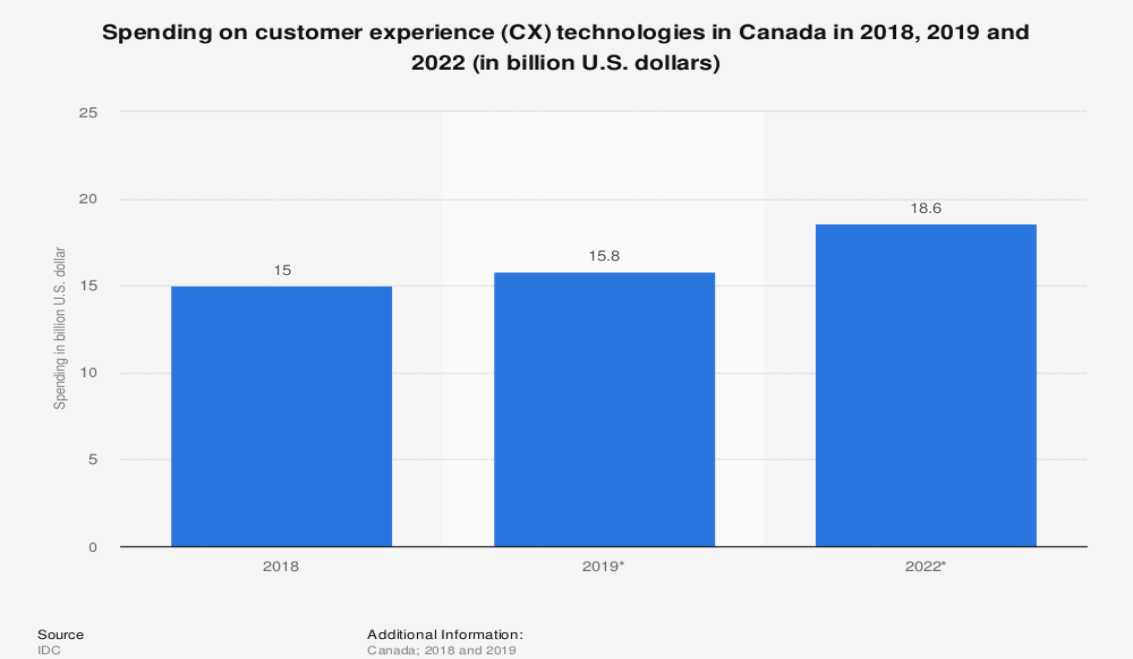

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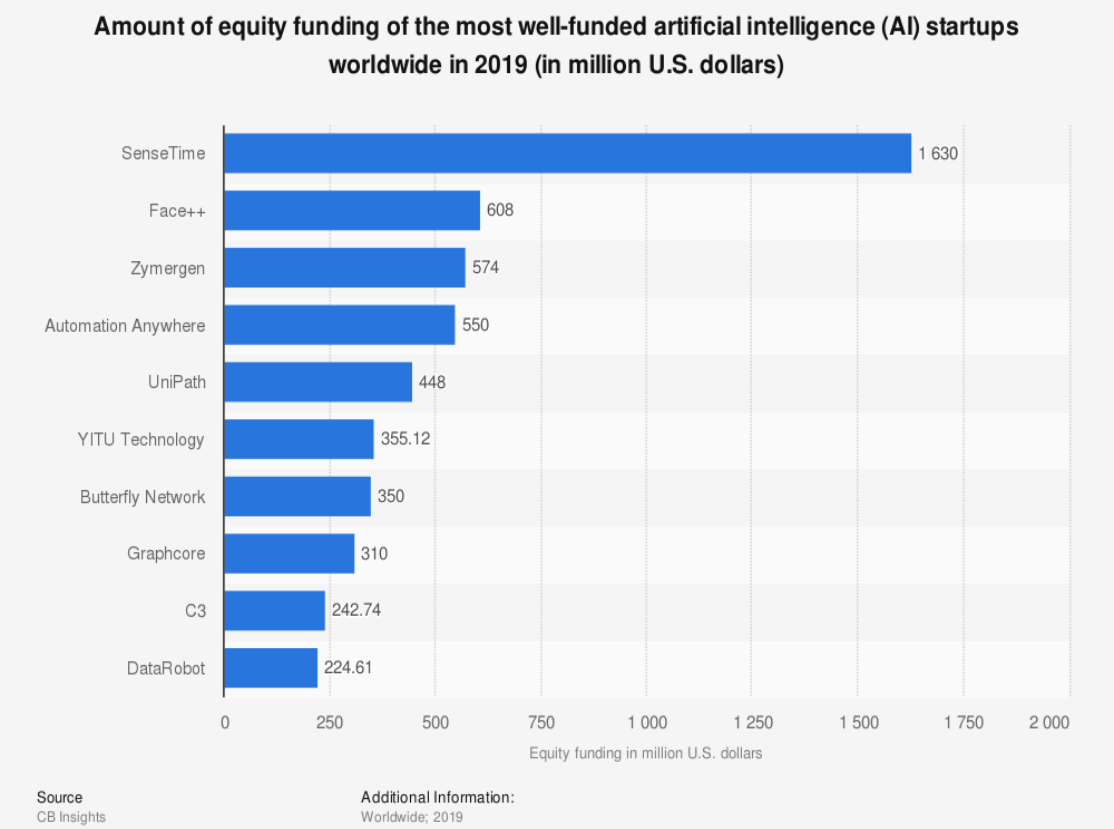

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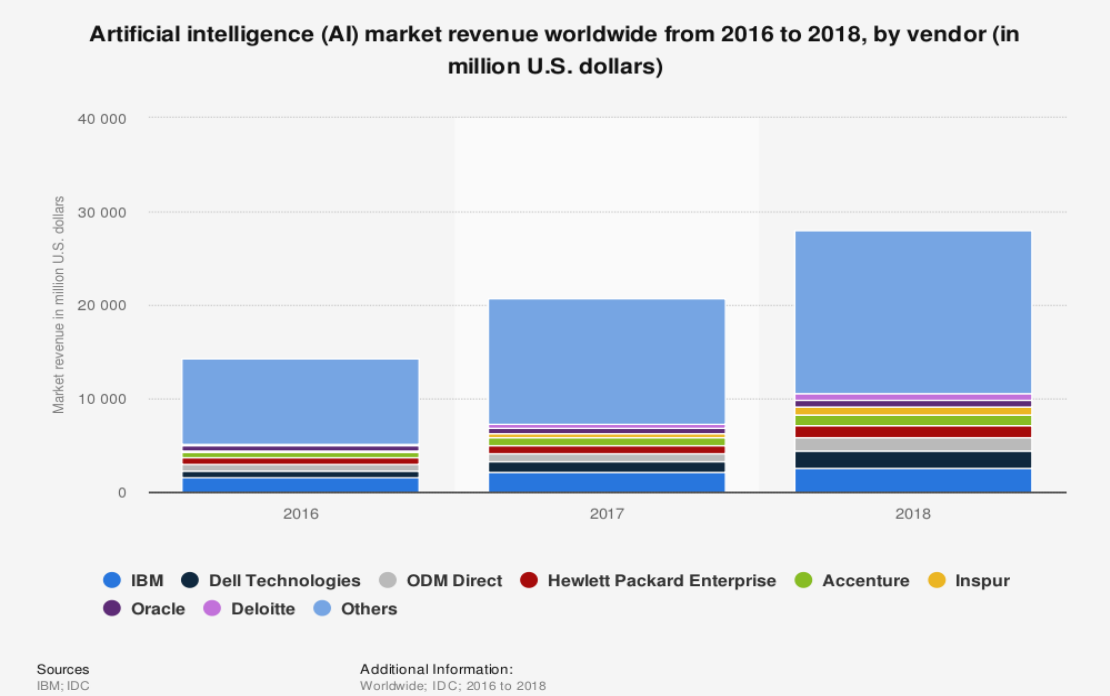

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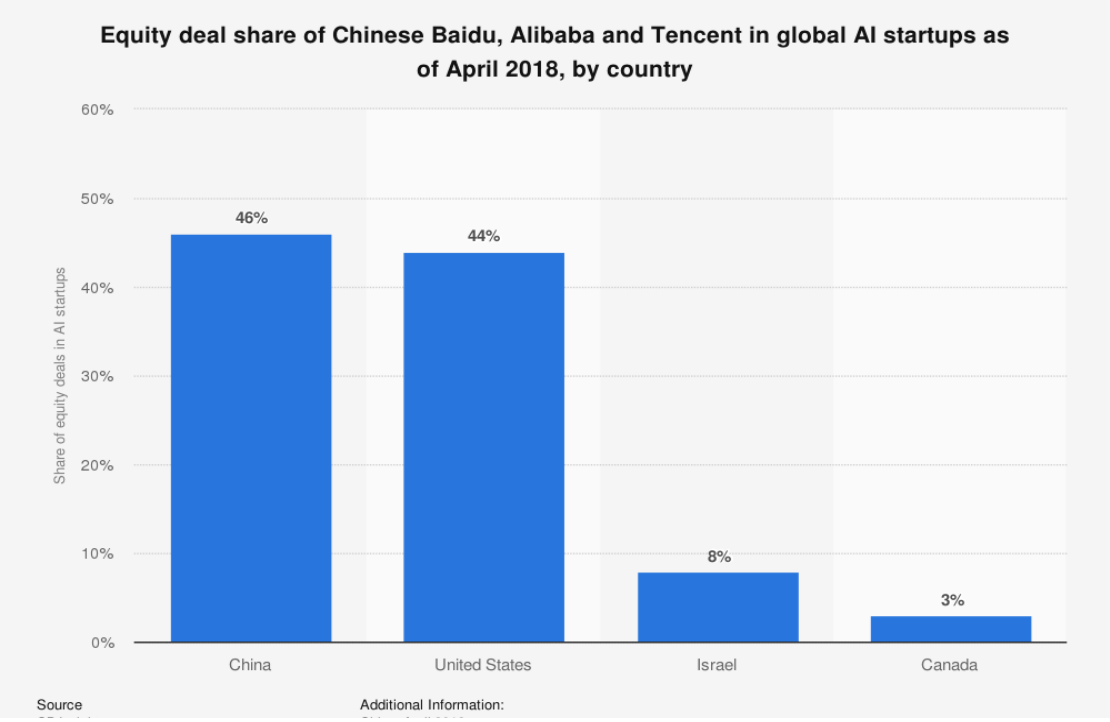

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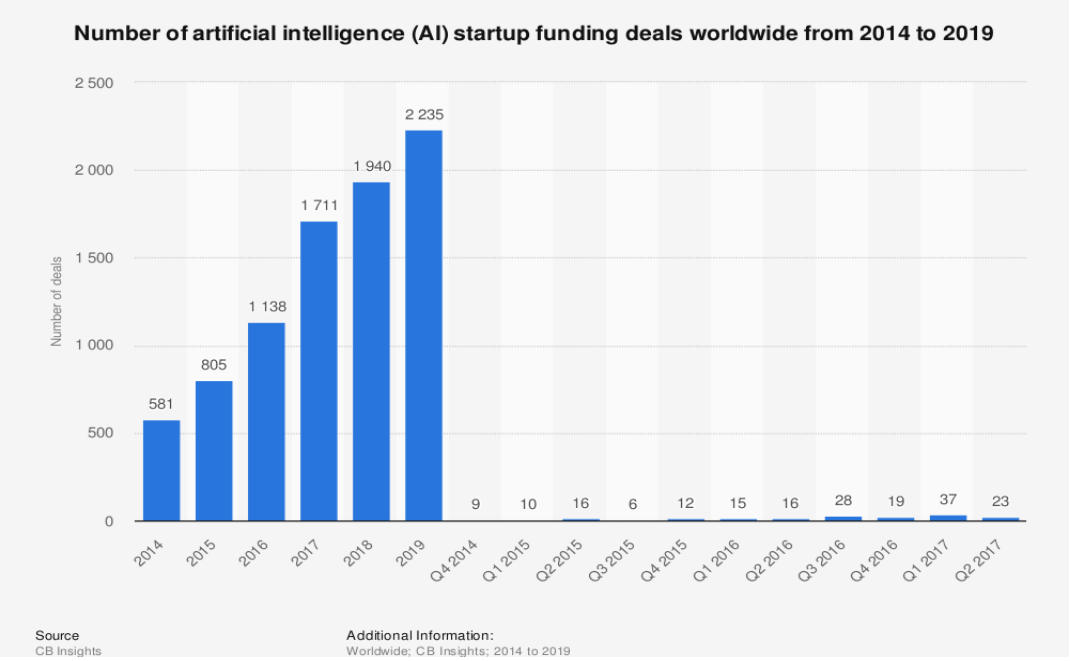

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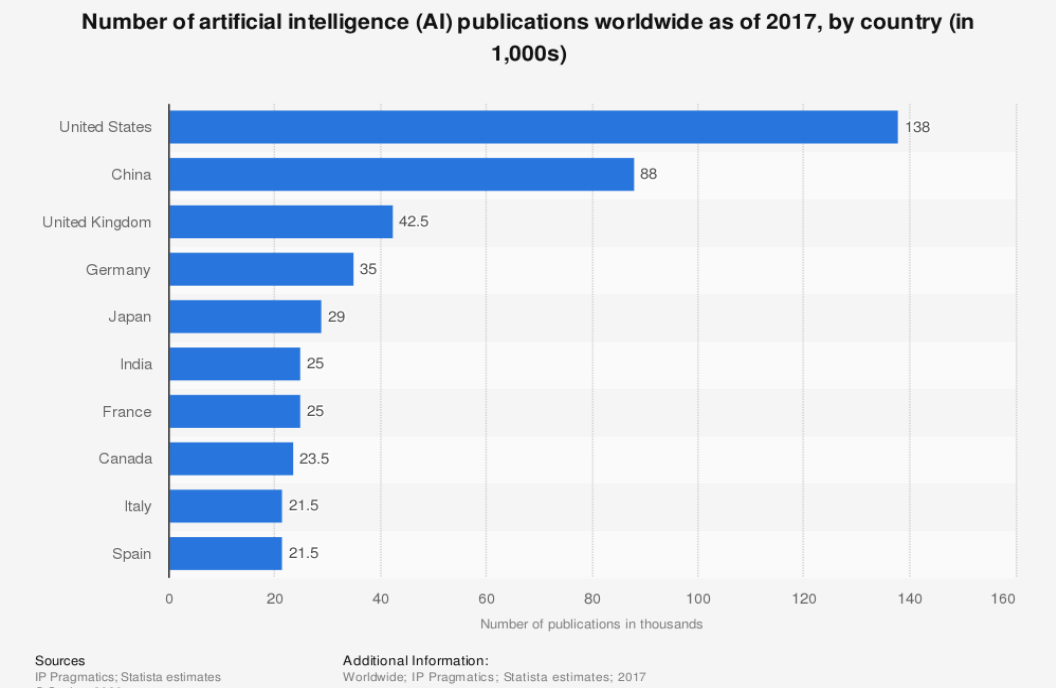

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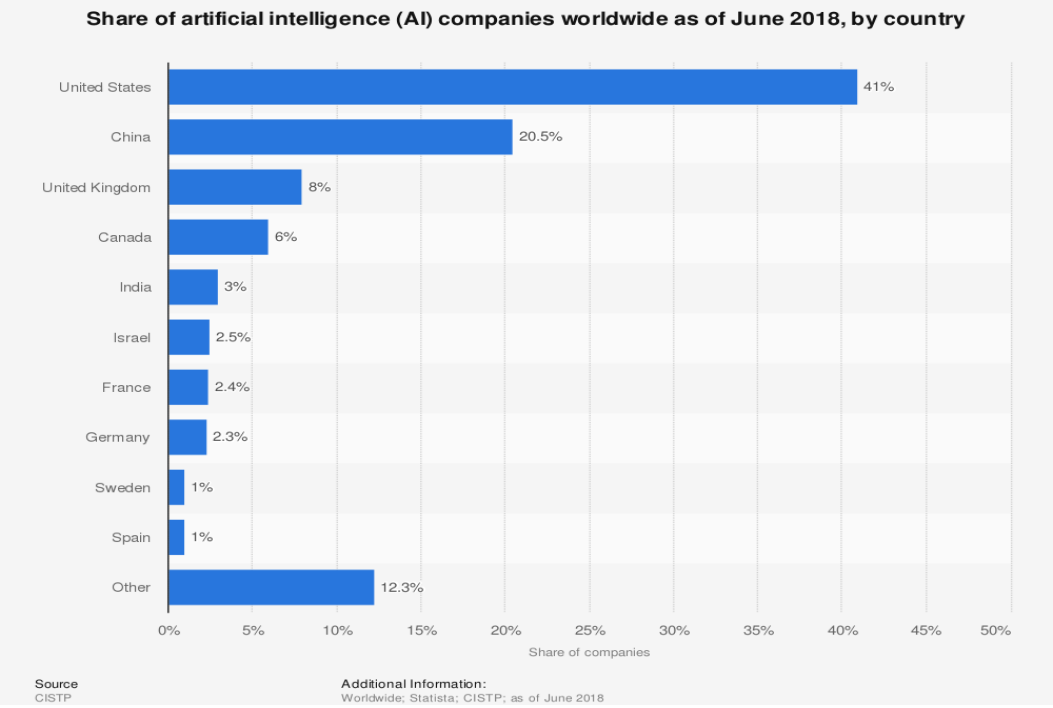

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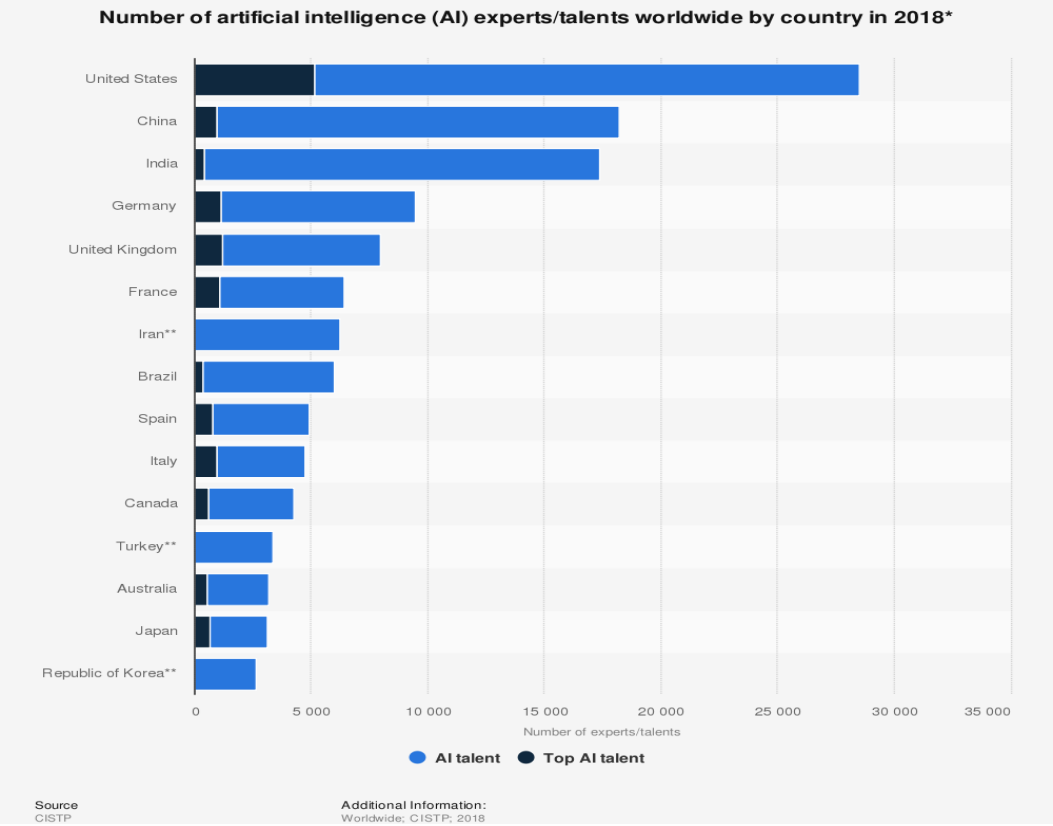

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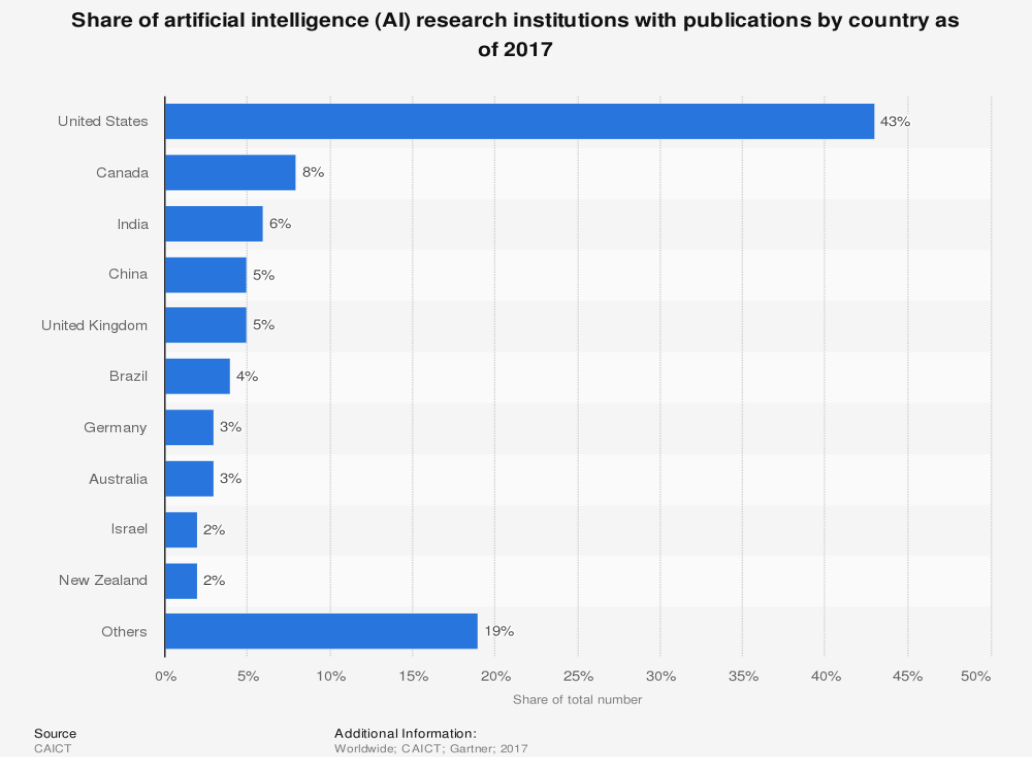

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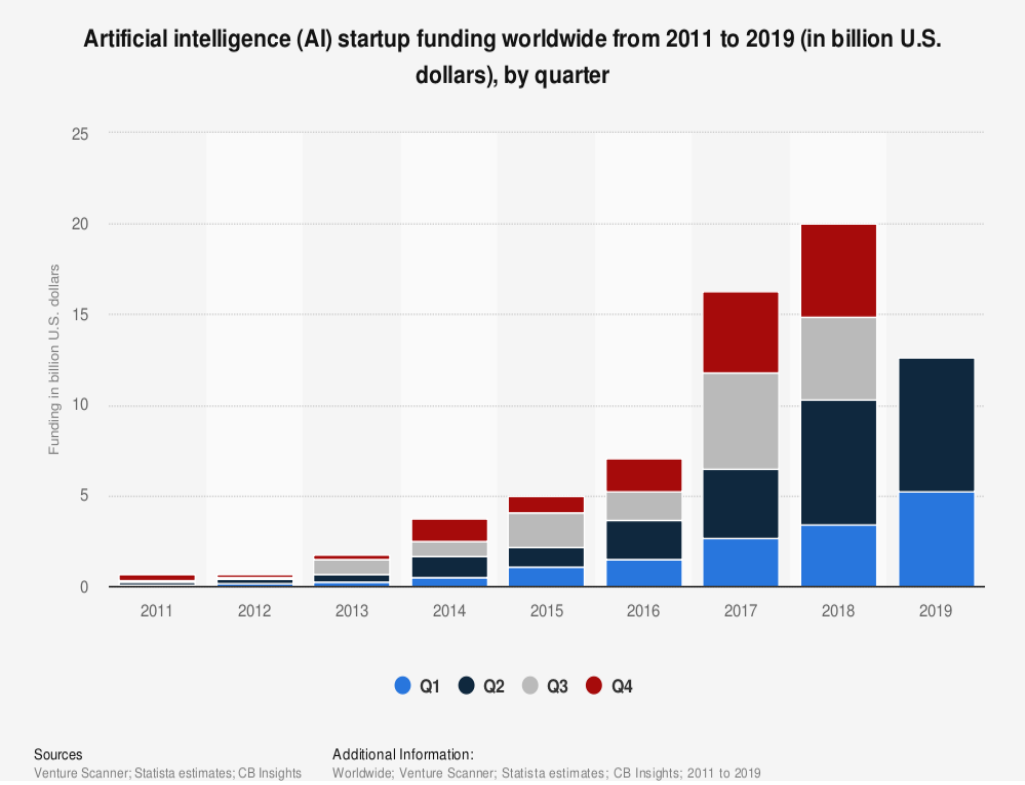

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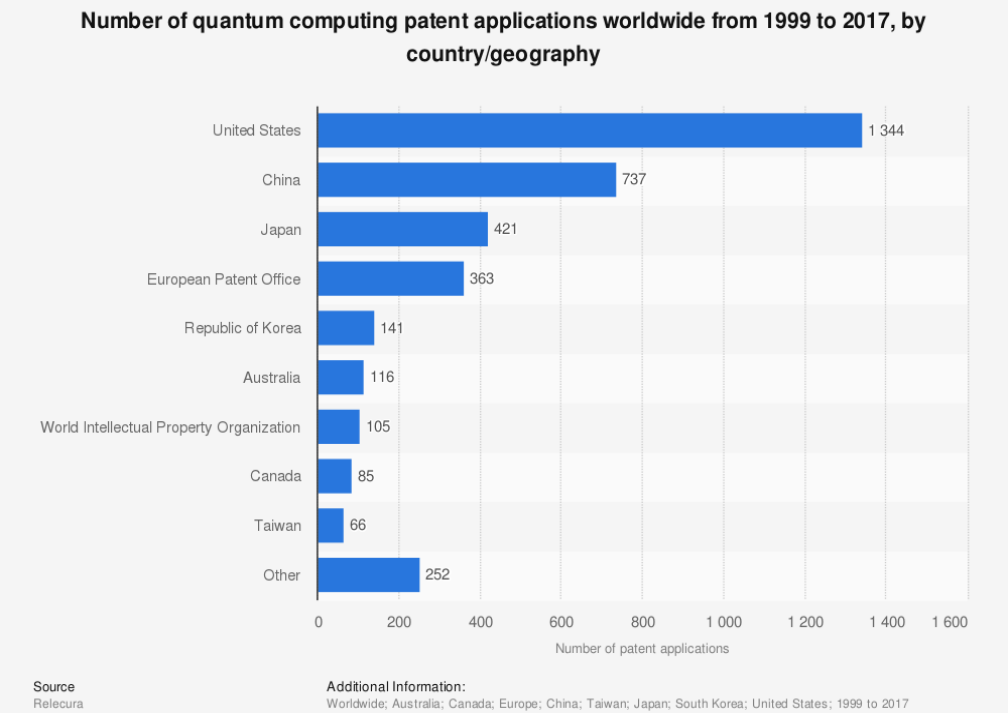

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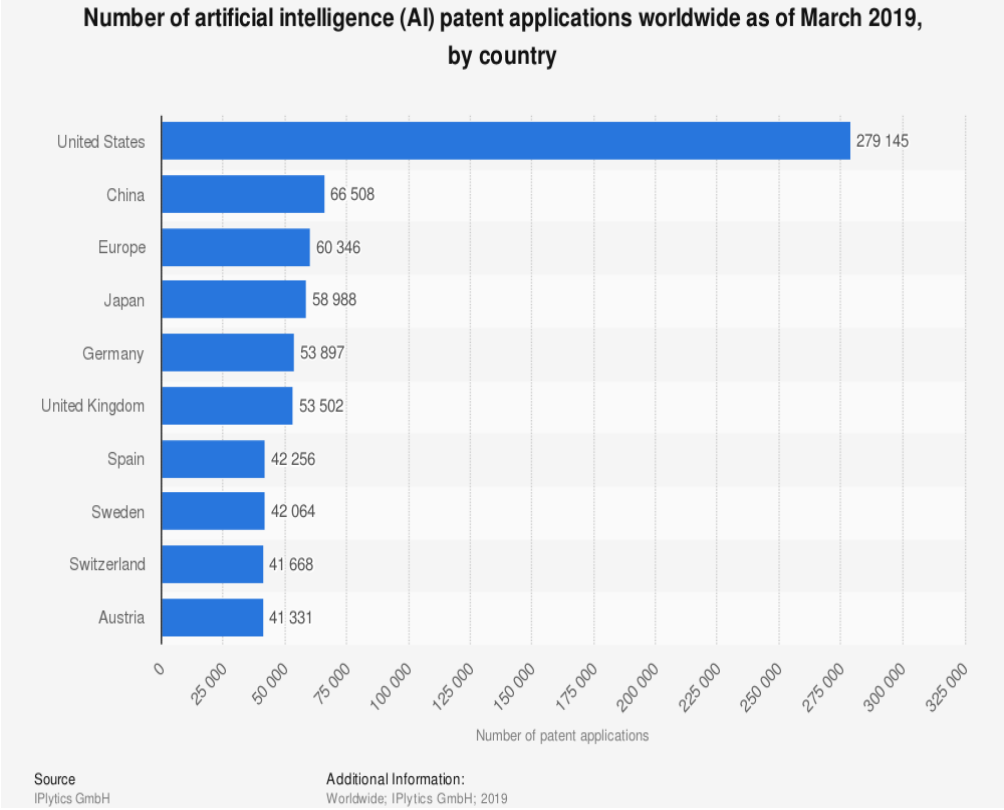

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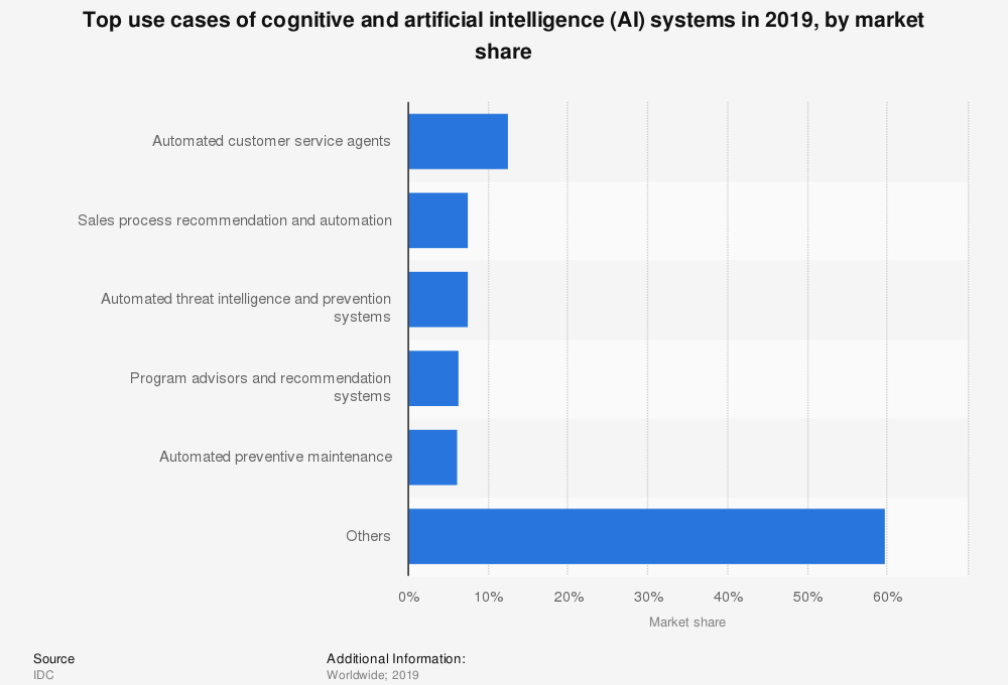

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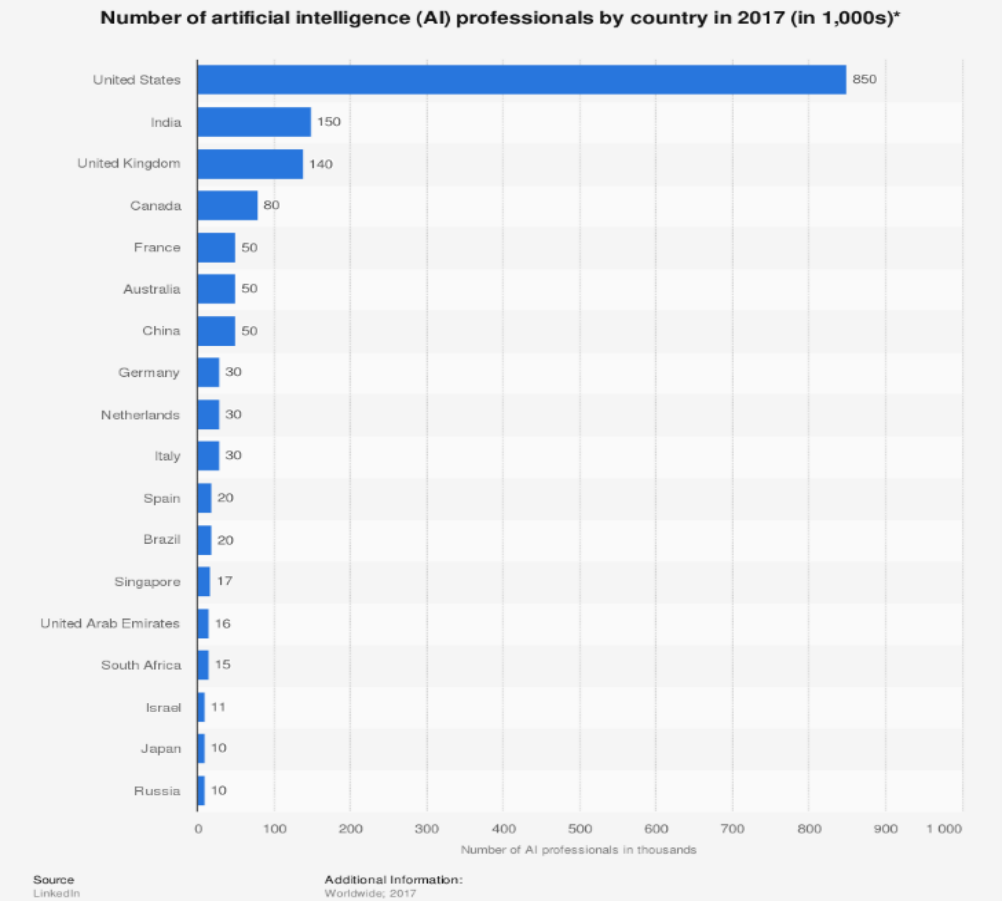

Chart 9.23

9.2 Interview Questions

Sections

Success factors of an AI ecosystem

Success factors of an AI startup

Growth factors/ingredient for an AI ecosystem

Growth and sustainability for an AI startup

Value chain

Types of AI

Talent, knowledge spill over, funding, and client

1. What are the most significant challenges the A.I industry faces, and why?

2. What are the main success factors/ingredient require to not only to survive as an AI startup but to strive

3. What ingredient is needed to create a thriving ecosystem to which AI firms can innovate, strive, and sustain?

4. How do you or your firm measure innovation and success

5. What is the 'Achilles heel' of the AI industry and a given firm operating within the industry?

6. What is a must-have in order to gain success as a start-up in the AI industry

7. Does demand a particular industry or dependent on AI at driving force of innovation and growth for the AI industry? Is so why, and if not, why?

8. How does A.I affect the innovation of SME outside the cluster and SMEs inside the cluster?

9. What are the timelines for growth, turnaround, commercialization, innovation, new ideas and how does it affect the firm performance, industry, and sustainability of the ecosystem

10. From a scale 1 to 5, how significant are the following in order to sustain the AI cluster locally and compete internationally for years to come:

I. Government influence

II. Funding

III. Talent

IV. Collaboration with other industries locally

V. Collaboration with global industries

VI. Location

VII. Firm structure

11. What are the must-haves for a thriving AI Ecosystem, and why?

12. How do does your firm and other firms attract talent, finance, and customers?

13. How does the value chain affect the success of the firm?

14. What specific industry is the most important to the success of the AI ecosystem, and what is the low hanging fruit?

15. What AI focus initiative and implementation is essential for the survival, growth, and success of the firm, industry, and ecosystem.

16. What specific talent is a must-have for the success of the firm and industry?

17. How does the firm received funding and at what magnitude, frequency, and level and why?

18. Does the firm collaborate with a specific industry, sectors, government, and vendors, and if so, on what level?

19. What specific AI is being engineered, and why? How do you commercialize AI, and how are AI priced vs. it cost?

20. Who is the primary decision maker for the firm structure, strategy, product development, research, and next steps?

21. What are the survival rates of a new AI firm, and why?

22. How do firms fail in the ecosystem, and why?

23. When do you expect to start seeing positive cash flow/profit from day 1 of startup?

24. What are the major challenges in the firm and ecosystem you and other AI firms encounter?

25. What is the average firm size inside the AI industry and why

26. What are your biggest competitors inside and out of the ecosystem?

27. What level of collaboration do you have with other AI firms, and why?

28. What other support or challenge you encounter outside or inside the firm, industry, and ecosystem?

29. Does taking a firm inside the ecosystem to IPO stuns innovation, growth, or prosperity to collaborate? Why or why not?

30. Describe specific types of firms that are made up inside the ecosystem, including structure, innovation strategy, retrain, size, culture, financing, and reputation.

31. What does a firm needs to have and not have in order to attract bigger players for acquisition or support

32. Do big players play a key role inside the ecosystem and if so can you describe what that role is

33. Does other AI firm support other startup or directly compete against?

34. How important is market share, and at what stage is market share becomes important or less important?

35. What is this ecosystem's main product/service offering, and why?

36. How can being local and thinking global becomes an advantage inside the ecosystem or, is having multiple locations globally creates a competitive edge? Why

37. How can a firm enter the ecosystem successfully from start to finish?

38. What characteristics are must-haves not only to survive the first five years but sustain the immediate changing environment?

39. How would you describe the AI ecosystem? Please provide its pros and cons?

40. Is AI another dot com era, or should we expect something else?

41. How would you set up a new AI ecosystem that is best in class should one need to be created next year, and where should it be located to be optimum continuously?

9.3 Global Artificial Intelligence Startup Database

Global-Artificial-Intelligence-Database-

9.4 Interview Response and Answers

Success Factors for AI Startup

F1	Suggested that a defined AI goal, big data, talent, and financing is the epicenter of an AI startup success. While other factors are a detriment to any startup success, AI startups are slightly different where data is the new currency.
F2	Attested to more applied proof of concept in the machine and deep learning is needed, along with a visionary co-founder who knows what works and what does not work, funding and research collaboration are some fundamentals of a successful AI startup
F3	Confirmed that the need for a system with the ability to operate complex IT system, big data, out of the box idea, talent to drive the idea, funding the idea and the talent to sell the vision from start to finish.

F4	Maintained the view where government involvement accompanied by competitive pressure, managerial expertise, vendor partnership, seed capital, and AI compatibility are the factors to sustained an AI firm within the Canada ecosystem or any AI ecosystem to that matter.
F5	The notion that startups must choose the right project to go after, then choose the right people to your team, following decide how to use AI/ML augment or automate. However, F5 did not stress the importance of financing or government involvement, which F5 claims as not as necessary in the startup phase compared to having the idea of making the idea into a useable format.
F6	They are suggested that it is a double size effort inside and outside the firm. The inside factors are the talent, excellent leaders, and brilliant minds to get projects from stage 1 to commercialization in an acceptable time frame. On the other side, a startup needs a great support system for success. These include promising financing over an extended period, excellent talent management and recruitment, an adaptive idea that is patent protected, clients that are already bought into the concept, and realistic delivery time. Follow up to ensure your product does what it said it would do to edge reputation. All in all, a sound business model is needed.
F7	It has made the claim that success factors are rooted in supply and demand of the market, adaptive ideas and rapid production and deployment of the AI. It was finding the right AI project to work on by way of aligning demand to the market. The most straightforward AI project in demanding industries such as media and marketing is more feasible for AI startup during the initial stage. The longer an AI project takes to get friction, the more chances that AI firm will not succeed. Academic research and passion

	for a specific project from founders must be placed aside or align with the market demand and the current level of supply for that particular AI offering. Innovation needs to be absolute; however, innovation needs to derive from market understanding and not concentrate on "too early adoption" of a project. This means that AI can be used in today's climate that will help tomorrow's challenges and not a concept that is too early for the market, which needs to sit on the shelf due to nonexistence of particular hardware or software that is not yet supported.
F8	However, the right product and innovation, affordability, and the right climate as a market shift is a foundation of continuum success factor claimed F8. Building a relationship with vendors inside and outside the ecosystem is also an ingredient. Industry knowledge within the area/industry your startups' targets at selling to (industry knowledge not just within AI but within the client-specific industry or your target audience). Create a deep adoption for AI transition and the ROI, understanding the client's challenge and solve that problem efficiently. Business savvy, financing, and mastery of vision and execution of that vision are vital parts for success factors.
F9	Robust access to resources and supportive entrepreneurial culture within the ecosystem argues F9. These resources range in order of priority- entrepreneurial acceptances, funding over the next five years, talent, access to infrastructure, big data, and compute power, vision, and speed to market. All these are descriptive success factors of an AI business model that need to be flexible in changing the environment. Startups are versatile to change business models towards market conditions compared that or more substantial firms. The innovation process within a startup is also part of shifting gears

	inside and outside the business model and ecosystem to adapt quickly and swiftly to succeed and grow.
F10	They were suggested that finance, talent, collaboration, client, and delivery on the promise is underpinning for AI startup's success measures. Furthermore, know how to measure the system or process a firm aims to improve, an expert within AI technology, data, talent acquisition, vision, and relationship building is vital. Getting an idea is just a start, but getting the idea to clients is another challenge itself. Build it, and they will come does not always equate success. Building and proving it works and integrating it is another. Knowing the client and having a competitive advantage inside the firm, the ecosystem, or outside is a must. The reinvention of innovation is a competitive startup advantage, but more is required either through niche position, demand market, network, research, public and private actors, or all the above.
F11	Suggest that being part of the value chain, proximity to talent, appropriate R&D, and a robust business model are critical success factors. Having an entrepreneurial drive through the founder is the priority. The characteristic of the founder is one element of the success factor of an AI startup. Resources are next, along with a defined environment that promotes AI, entrepreneurship, and openness.
F12	Argued that AI firms must be part of an ecosystem that is coercive, openness to collaborate, access to capital, talent, and open atmosphere to innovate without boundaries. Having an openness to AI near the ecosystem, which is part of the supply chain, is also crucial. Knowledge and self-regulation to build trust and reduce ambiguity outside the firm play a major role in the success of AI startups.

F13	Suggest that continuous innovation metrics to sustain and grow startups is a crucial element. Financing and bridging concept that aligns and complement the current business model. Startups should align themselves as if they are acquired and not going head to head with leading AI giants. This can be done with proper relationship building, knowledge sharing in the economy, and market—vendor and allies' partnership inside and outside the ecosystem. Access to big data and other resources is a must. Furthermore, location helps with retaining talent, knowable, and acquiring the innovation process and building off existing technology infrastructure.
F14	Argued that AI startups need tangible ideas to keep up with the hype of AI, deliver on the hype. AI startup firms need to close the gap between research and practicality; strong knowledge in AI is not enough but must be business savvy. The openness for knowledge sharing inside and outside the ecosystem.
F15	Claimed, the main ingredients are clients, clients, and more clients. Then start with the idea by adapting what the client needs/requirement. The business model should be reverse since most AI delivery is cloud-based and not anything physical. Figure out what the client requirements are based on market demand and current business model challenges. Then, Followed by figuring out how to deliver the solution to the client and what resources are required. That is in terms of capital structure, data, and various metrics and AI policies to help with a clear sight of innovating, commercialization, and deployment of AI.
F16	Suggested that AI startup needs an idea and understanding of delivering something like Microsoft words to the world on a cost-effective basis. Most AI startup founders have

	the smarts within the industry but lacking business intelligence, financing, gaining resources, and collaboration. All need to create a successful and sustainable startup.
F17	Argued that AI startup firms need clients, a robust business model that is realistic, define unique research, cost-effectiveness, partnership, and close connection with the value chain, vendors, and large corporation. F17 further suggested that necessary talent and financing to fund the project and firm structure in the initial stage to delivery is needed.

Growth Factors/Ingredient for AI Ecosystems

F1	Suggested that the need for openness to collaborate, government influences, funding, promotion of immigration, cost reduction mechanism, and climate control for research and development for a more robust application of AI. The ecosystem should be more robust together when collaborating on a single project for AI for the sake of the ecosystem and working on useful technology to efficiently implement, developed, distributed, affordable, and commercialized.
F2	It also argued that all firms collectible is working together on specific projects/research and a divide collaboration between research and application. F2, further argued that the ecosystem must have supporters/actors as a movie has actors to drive the vision across to the audience and influence the buy-in of critics. This vision is mastermind by the producers (financiers), creative director (scientist), writers (developers/coders), and director (CEO-founder) and so on. In essence, there is a team of both behind the scene

	and in front of the cameras working endlessness in various roles, or frequently one actor takes on multiple roles [actor and director] and does whatever it takes to make the movie come together. An AI ecosystem needs a team of actors and production crew working on the same script cohesively in the right location with the right climate and delivering the right result to that specific audience and choosing the right location that is welcoming for the ecosystem, usually around either the talent, the financiers, supply chain, clients, or all. Continuous improvement on the infrastructure to reduce cost and increase efficiency is diabolical to the ecosystem as well as removing red tape for firms to gain access to necessary resources.
F3	Suggested that AI ecosystem requires constant innovation through R&D centers, immense partnership with outside the ecosystem, collaboration with industry leaders in given industries including healthcare, finance, ecommerce, technology, and neighboring ecosystem including other parts of Canada and the US to gain access to trend, projects, research and most importantly talent and finance. This must be done through stakeholders and the formation of a body/committee/ambassador that serves as the face of the ecosystem. The ecosystem also needs more unicorn firms to lead and attract talent, finance, governance, innovation, and market disruption and acceptance for other firms to strive and distribute knowledge and collaboration.
F4	Argued that the ecosystem needs partnerships from a large corporation and government agencies for commercialization and adoption of AI. The ability to attract and retain the world's top AI talent, access to breakthrough technology and innovation through knowledge spillover, collaboration, partnership, and transfer of knowledge. Firm structure to sustain growth through effective strategy and innovation (competitive

	advantage inside and outside the ecosystem). Discipline founders, CEOs, and executives with business understanding on the technology side, firm's capability, and ability to meet and exceed expectations and deadline of AI projects. Tangible application with demand clients. The ecosystem must be centrally located inside an environment that promotes organic growth through socio, and cultural acceptance of AI, government presence, and involvement not only from a policy standpoint but also lifting ambiguity for startup firms to exist, innovate, sustained, and grow. Lastly, the ecosystem needs to be subject experts in given industries and clients with deep pockets who likely to keep funding the ecosystem through financing, collaboration, and or acquisition of resources and talent.
F5	It also argued that the AI ecosystem most steer clear from uninteresting projects but rather drive innovation through market condition applications. Further resources for cost reduction within the ecosystem, the need for a refine infrastructure that supports increase compute power, and increase the visibility of talent in AI and business savvy executive with a background in AI. The ecosystem also needs consistency in growth and influence power through the development of commercializing applications on a larger scale, publication on the ecosystem to attract clients, and collaboration (resources gathering to feed the ecosystem). Stakeholders with the same interest inside and outside the ecosystem and firm structure with characteristics to continuously innovate quick and fast turnaround on said innovation. Increase the stability of startups through increase support at an early stage by partnering up with unicorn or thriving ecosystem, and large tech giant.

F6	Argued that the ecosystem needs to make innovation the driver of growth and not financing or talent. Furthermore, F7 argued that innovation diffusion-collaboration within an ecosystem is systematic for growth and sustainability. The birth of born global firms which should make up the majority of the ecosystem is a must. Competitive advantage and organic growth and sustainability are also crucial. The ecosystem will need access to necessary resources as with any ecosystem; however, the aim is for self-efficient, self-dependent, and overall market dominance through impactful disruption. An ecosystem must be depending on its environment for survival; however, the environment must also be dependent on the ecosystem over time for growth. Firms and the ecosystem must understand and take the necessary risk to unlock the full potential of innovation and gain maximum competitive advantage inside and outside the environment of the ecosystem.
F7	Suggest that the need for creating efficiency, new jobs, goods, and services from AI clusters influence growth. Growth is when the ecosystem creates a demand for its product/services and organically injects itself into the value chain and further provides a bi-product of its process that the environment around it can benefit from. It can be in the form of job creation, reduction in cost, the formation of other clusters, and the ecosystem.
F8	Claim that holistic government policy to allow AI firms to freely innovate and test technology, and ecosystem self-regulatory process in place for the promotion of such innovation and R&D. Moreover, policies that protect AI patent rights globally and increase local competitiveness but protect global customer rights. Retain and promote AI talent with flex immigration policy and stimulate growth through sustainable

	resources, including collaboration, quantum computing power, talent acquisition, collaboration, knowledge sharing, and global impact through the ecosystem application and job creation inside and outside the ecosystem.
F9	This indicates that the need to increase the talent pool of brilliant minds in AI, experience entrepreneurs, business research applications, development, implementation, collaboration outside the cluster, active actors and networks to support the growth of the ecosystem.
F10	Suggest that a strategic market segment to service, government involvement with influence policy and increase funding—the need to bridge the gap between research and use cases to make technology create value.
F11	Claim that active programs outside the ecosystem that act as a vessel within the value chain of the ecosystem—they need for better AI applications, and more born global firm structure and government readiness to adapt. The way to grow is to convince AI is the key to solve a particular problem. For example, be the firm that does the photo filtering with AI for Snapchat. That is, move towards what the market is demanding, not necessarily what you believe is needed. i.e., Photo filters, for Instagram and Facebook are more successful with AI application because it is simple and use by the millions of people and is reasonably simple things and simple to implement. Simple offering to the mass and having a collaborative ecosystem.
F12	Suggest that talent, funding, global customers, local government contracts, knowledge sharing, access to necessary resources and the promotion towards large firm who are drivers of change and innovation acceptance is key factors for ecosystem growth.

F13	It also suggests better access to more talent, enormous cost-effective infrastructure for firms to strive, motivated clients, robust value chain, better access to information, collaboration with more universities and other ecosystems globally, and create a competitive advantage for Canada. Canada needs AI leaders on the front line on current trends, including self-driving vehicles, drones, and robotics.
F14	Argued that the AI ecosystem should create and identify a more specialized field or industry and technology to become subject experts in. Innovation should be on the passenger seat of market demand and wiliness and openness for knowledge and technology sharing. Moreover, the lack of technology trust, transition, and disruption need to disappear almost wholly to achieve maximum growth within an ecosystem. Supporters and critics must be bought-in to some degree, including all levels of government, private enterprises, and removing red tape for startups to operate are factors that are crustal for growth.
F15	Stated that collaboration of everyone is needed- the higher you go, the high-level vision you get. The collaborative stakeholders work with market feedback that affects the vision and directed to the people who interact with the vision. Market traction is super essential for growth. AI firms must prove something works super-fast and useful very quickly and collectively. Alongside these factors, the ecosystem needs access and policy for big data, free-market for financing, talent, apparatus that can support next-generation technology, which is moving from practicality to application deployment fast.
F16	Suggest IA Ecosystem must provide a large enough niche that conveys and complement everyday life to get an edge before moving towards 'goliath' projects and next-generation AI. In such, location and proximity plays a role in the growth and need to be

	strategically aligned to magnify growth opportunity for operators inside and outside the AI ecosystem. Next, the relationship with the large investor group, universities, talent agencies, and clients are ingredients for growth. Good tech is also essential to build and deliver fast on-time before the next big thing hits. Talent is the top factor for location decisions, i.e., a way of life, wages, taxes, and immigration integration.
F17	Stated that growth through the creation and demand for jobs within the ecosystem, attract the right talent by choosing to work on exciting projects with a defined life-cycle influence growth. Moreover, attract and partner with various actors outside the ecosystem, including car manufacturers aerospace, Google, Facebook, Amazon, local manufactures, government contracts for long term lucrative opportunities, i.e., smart city transformations. Next is the openness for innovation and transformation; government policy that promotes innovation; talent, and knowledgeable entrepreneurs to grow startups to unicorns. Furthermore, robust infrastructure to promote compute power, big data, focus on the specific industry including entertainment and social network, information and storage, and retrieval (Google, for example); and for hardware production focus on robotics and flying drones, robots. These will be position well to benefit the greatest from AI and to magnify growth collectively in the ecosystem.

Value Chain Innovation

F1	Stated that complement of other vast firm offerings in the easily integrated industry, which are an industry with low to no physical assets and who use technology as part of the current business model.

F2	Suggest the AI value chain must follow a defined process which may include, the design phase- optimize product design based on predicted customer behavior, optimize product/service designed based on desired criteria Source and market phase- optimization. Store and Deliver phase- reduce delivery time, improve efficiency. Sell phase- analyze, improve conversions. Use phase- increase efficiency.
F3	Claim that value drivers are: design, source/makes, sell, and use. Industries that are part of the value chain are industries that depend on technology and others that use technology to disrupt, including healthcare, telecommunication, and financial.
F4	Argue the growing concerns around the levels of risk associated with adopting AI, including counterfeiting, regulations, privacy, and lack of transparency. Firms that are deploying AI in heavily regulated industries, including banking and healthcare, may face roadblocks accessing data under privacy policies.
F5	Suggest ML offering to firms can show why some solution is destined to be optimal. However, some firms that offer AI within the ecosystem are concerned that some model decisions made by DL and RL systems may not always be justified and understood in making decisions and accountability more opaque by end-users understood and justified, making decision-making and accountability more opaque to the user. That is, numerous risk associated with AI models which can become harmful. For example, if an AI model targets the wrong clients in an ad campaign 7 percent of the time, then minimal harm is done, however, if a military uses AI face recognition to identify civilian in a war, being wrong 7 percent of the time is not a risk the military is willing to make. All these associated risks can be amplified deeper in the value chain, as networks of supplies are not often well adverse to mitigate them compare to better resources buyer firms.

F6	Claim AI Firms must take into account the acceptance ratios of clients for new AI advancement. While face recognition for a retail client to greet customers as they walk in the store is not necessarily acceptable by customers. Customers value privacy, and it is essential to treat customer data privacy with the utmost consideration and care. These factors are at strain within the value chain and become a barrier to AI potential.
F7	However, suggest some industries with physical products or infrastructure assets that are physical are at a more profound challenge in adopting AI, which limits the types of client and industry AI aim at servicing. This is in comparison to clients/industries with light to no physical assets and infrastructure. This scenario makes the demand for AI less dependent on firm structure unless the AI firms fully understand the industry and understand the areas of the business model to which AI can be implemented seamlessly.
F8	Argued that self-learning logistics software, AI for warehouse, supply chain optimization in manufacturing are some areas within the value chain for AI optimization and opportunity for long term engagement.
F9	Claimed, however, that self-learning robotic arms, fault detection by sound, and exoskeleton Robo-mate are part of the value chain that is rapidly growing and mainly untapped by Canadian AI firms. Furthermore, managers within firms are looking for efficiency in the areas of marketing for online shopping during the 2020 pandemic, and some creative directors seeking out ways of assessing the optional of business ideas. The integration to plugin with security, scanners, and sensors is optional of AI utilization within the value chain.
F10	Suggested that value chain enhancement within e-commerce is on the rise as of 2020, self-isolation with people shifting in recent time with the comfort of doing everything

	online. That is, these firms need AI to help find more efficiencies in the supply chain and back-office, where ordering items for the customer will be easier for customers, and delivery time decreases. The shorten lead time will eventually lower cost for the firm, which can past it down to the customer and organically competes with platforms like amazon. Other industry would be healthcare where AI with the right direction and support, will reinvent medicine in ways where AI can analyze and collect information from medical records; social medial, sensors place on the patient and genomic data to better help doctors with efficient diagnose, determine prognoses, plan treatment and even help create new medicine. AI believes that future AI-based systems will lead to a reinvention of medicine.
F11	Argued that that business to business is the main transaction; however, more firms are focus on business to customers while fewer firms are going after business to business as the business to the client sector.
F12	Suggested that the value chain must be self-regulated to be consistent, ethically responsible, driver of innovation, speed to market to match market conditions, security, acceptances, build off of existing IT platform as part of the value chain.
F13	Indicate that given the speed of AI advancement and continue breakthrough in research, it is unclear what industry will generate the most demand and what technology will create the highest value. However, value and demand are not on the same hand but work in different parts. Value in the sense of creating and leading significant transformation, job creation, waste reduction, and process enhancement. However, the high demand for AI for add-on for social media applications turns out to be more profitable than value-creating in the value chain in the short term. In that, companies that benefited from

	automation need to show how AI will create value for their customers; however, companies look at AI firms to prove that concept if they outsource AI.
F14	Argued that the value chain needs to consider effective AI Application Strategy, Data Analysis, Longer-term Implications, Human Talent, acceptance of AI, and policy within a specific industry to support technology advancement and its underpinnings.
F15	Claimed that the value chain seeks to have higher efficiency and productivity, cost reduction, faster innovation cycle, improved matric, full acceptance and loyalty, fast speed to market [currently lacking], improve customer satisfaction and approval—Furthermore, the need for increased profitability and capturing acceptable ROI over shorter capitalization. Lastly, reliability and ease of use are expected throughout the value chain from AI users.
F16	Suggest that business front office are primary drivers of the value chain, including marketing, sales, and customer services, then middle offices including R&D, production, supply chain, and procurement then by BackOffice, including finance, HR, security, organization administration, and management.
F17	Argued that pricing is a cost-benefit analyst and the automation part of existing parts. Provide something that reduces cost is a factor, but first, firms must invest in the solution.

9.5 List of Data Sources

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9.6 Participant Summary

Study ID	Gender	Age	Occupation	Education Level	Years of Experience	Location
F1	M	43	Founder and CEO	PhD	3	Toronto
F2	M	33	Data Scientist	Bachelors	5	Toronto
F3	M	39	Founder	PhD	6	Toronto
F4	F	40	Founder and CEO	Masters	7	Toronto
F5	M	Not Avaialble	Scientist	PhD	Not Avaialble	Montreal
F6	M	35	AI developer	Masters	4	Montreal
F7	F	46	Co-founder and CEO	PhD	18	Montreal
F8	M	Not Avaialble	Director	PHD	20	Toronto
F9	M	Not Avaialble	SVP	Masters	7	Montreal
F10	M	Not Avaialble	Engineer	PhD	11	Toronto
F11	M	Not Avaialble	Engineer	Bachelor	5	Toronto
F12	M	Not Avaialble	Scientist	PHD	4	Toronto
F13	M	Not Avaialble	Founder and CEO	Masters	6	Montreal
F14	M	Not Avaialble	QA Lead	PhD	2	Toronto
F15	M	Not Avaialble	Developer	Masters	2	Toronto
F16	M	Not Avaialble	Project Manager	Masters	9	Toronto
F17	M	Not Avaialble	Founder and CEO	Bachelors	4	Toronto