ARTIFICIAL INTELLIGENCE APPLICATIONS FOR DND REAL PROPERTY

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AIM

1.   The advent of Artificial Intelligence (AI) is poised to create a global revolution that the Canadian Armed Forces (CAF) and the Department of National Defence (DND) need to be prepared for. AI presents both opportunities and significant risks for DND, and anticipating how AI can be proactively utilized and also defended against are important factors that should be considered. On behalf of DND, the Assistant Deputy Minister (Infrastructure & Environment) (ADM (IE)) manages the largest real property portfolio in the federal government and is responsible for approximately 20,000 buildings and over $26 billion worth of infrastructure assets across the country. [1] The aim of this service paper is to inform about potential applications of Artificial Intelligence to DND infrastructure and real property management.

INTRODUCTION

2.   DND's vast infrastructure portfolio is currently strained for resources and is riddled with operational inefficiencies. Managed by ADM (IE), this real property represents a wide spectrum of facilities. This infrastructure includes everything from utility works (such as water and sewers) to residential housing units and operational buildings; these structures and works range from heritage buildings that are more than a century old to brand new operational facilities with cutting edge technology. The challenges of maintaining and constructing such a large array of property in a resource constrained environment are daunting. Prior to DND consolidating its infrastructure portfolio under one custodian (ADM (IE)) in 2016, real property was largely managed through individual infrastructure silos across the department using many ad-hoc management approaches. Under centralized control, ADM (IE) can now more easily capitalize on changing technologies, including the integration of smart building automation and AI.

3.   Canada's Defence Policy, *Strong Secure Engaged*, outlines ambitious objectives for *greening* defence, and sets targets to reduce greenhouse gas emissions by 40 percent from the 2005 levels by 2030.[2] In order to achieve these goals, DND will need to capitalize on innovative solutions and new technologies to better manage its facilities and reduce wasted resources. Advances in computers and automated technologies have significantly changed the potential for how infrastructure can be managed. By leveraging new technologies in infrastructure management, DND can better focus its resources to where they will make the most impact. The intent of this service paper is to provide relevant information for consideration as DND's infrastructure portfolio postures itself for future advances in technology and AI.

DISCUSSION

4.   The general concept of AI represents a wide range of technologies and capabilities whose definitions aren't always consistent or commonly understood. However, one aspect of AI that is generally agreed upon is that "AI's innovative capabilities have never before had as great an

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opportunity to directly affect the U.S. and world economies, and its capabilities will only continue to grow."[3] Some experts have even cautioned that AI may become humanity's final invention and have argued that once AI exists, it will invent everything else.[4] In fact, this seems to be supported by recent data from the United States Patent and Trademark Office (USPTO), which indicates that it has already issued a growing number of patents for inventions developed by AI and applications are increasing exponentially.[5] It is clear that AI is gaining significant momentum and appears to be an inevitable reality of our future world; DND needs to be prepared to capitalize on these future innovations.

5.   In order to address the potential applications of AI in infrastructure management, it is important to first have a general understanding of AI and its various subcategories. Aspects of artificial intelligence have been in use for years in some of the most basic computing algorithms that are at, or above, the cognition of human-level performance. Examples of this include programs and algorithms capable of beating human players in various games, such as checkers, backgammon, and chess.[6] Increasingly, computing power has pushed artificial intelligence well beyond the capacities of human cognition and "machine learning" is an ever-evolving aspect of AI. Machine learning is defined as "a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention."[7] Machine learning has significant potential for applications to infrastructure management and, specifically, controlling utility usage within current facilities. These types of technologies are already widely available commercially and are commonly found in residential settings through products like Nest, Ecobee, and Apple HomePod.

6.   Various aspects of building automation that closely resemble machine learning are already in use in many facilities across DND. Additionally, ADM (IE) is already postured to utilize sophisticated software systems, such as VFA Facility View[8] and DRMIS facility management programs, to better control its infrastructure and manage resources. However, up to this point, actual decision making on infrastructure issues has been left to humans, despite the fact that computers and automated systems are quickly surpassing human cognitive ability to interpret and analyze the increasing amount of data available through infrastructure monitoring. Being free from human bias or emotion, AI systems would also theoretically result in more objective decisions.

7.   A critical component of any organization's ability to make sound decisions is the accuracy and trustworthiness of the related data that is available. In a recent Business

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[3] Matthew Melancon, "The USPTO's Sisyphean Plan: Increasing Manpower Will Not Match Artificial Intelligence's Inventive Capabilities," *Texas Law Review* 96, no. 4 (2018): 873.

[4] Bret Swanson, "Beyond the Hype on Artificial Intelligence: The Reality of Intelligent Infrastructure and Human Augmentation" *AEIdeas* (blog), (25 April 2018), https://search.proquest.com/docview/2030539461?accountid=9867.

[5] Melancon, "The USPTO's Sisyphean Plan…", 873.

[6] Ibid, 875.

[7] SAS Institute, "Machine Learning," accessed 12 Oct 2018. https://www.sas.com/en_ca/insights/analytics/machine-learning.html.

[8] Accruent, "VFA Facility View," accessed 14 October 18, https://www.accruent.com/resources/brochures/vfa-facilityview. VFA Facility View is the name for computer software and VFA is not a known acronym in this context.

Information Review survey of business professionals, data quality, trust and confidence in data, were identified as concerns in the context of artificial intelligence.[9] DND is faced with similar struggles obtaining timely, relevant data. Over the past five years, many bases and wings across Canada have embarked on various projects to install utility metering to more accurately measure its consumption of electricity, gas, and water. Prior to this, typical bases would have only a few (and in many cases just one) utility meters measuring utility usage as it entered the base; no further fidelity on individual facilities was possible to determine where most utilities were being used or lost. A lack of data in this field significantly impacts DND's ability to intelligently monitor energy and make improvements through smart building systems or automated controls. With valid data being analyzed by AI or by a sophisticated building control system, patterns of utility usage can be determined and automatic (human-free) decisions can be made to optimize use of a facility. Significant energy savings could be realized and, in turn, greenhouse gas emissions could be reduced by improving the availability and accuracy of utility data.

8.   Many of the CAF's large bases and wings have annual utility costs approaching $10 million and these costs are forecasted to continue to rise.[10] The high rate of energy demands from many of the larger and newly built operational facilities are outpacing the small incremental improvements that are being made in greening DND's infrastructure. Research estimates have indicated that energy costs can be reduced by 20-30% with proper monitoring and controls, and savings of up to 15% in maintenance expenses can be achieved as a direct result of improving inefficiencies.[11] Small changes like ensuring lights are turned off during non-working hours and heating or cooling is adjusted in unused work spaces all add up to significant utility reductions. In addition to the aforementioned applications of automated building controls, AI has the potential to increase the efficiency of building maintenance programs. For example, the use of software like VFA Facility View categorizes each asset within a given building system, determines which components of the system are critical for the overall infrastructure health of a building, and determines intelligent maintenance programs that improves overall efficiency. This prevents the type of short-sightedness that is often encountered with assets like changing ventilation filters when an entire air exchange system is due to be replaced only a month later. Considering ADM (IE)'s large infrastructure portfolio, the potential efficiencies to be gained through targeted use of AI and automated control software would equate to tens of millions of dollars in annual savings in utility and maintenance costs.

9.   As AI applications take hold on infrastructure management, important consideration should be given to Human Resources (HR). Initial AI implementation will likely involve automated management and control systems within facilities and not full robotic execution of tasks; building maintenance tasks may be identified or prioritized by computers, but actual task execution will still be conducted by a human technician. As these systems evolve, there will be an increased importance of digital and information literacy for human employees. Many

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[9] Denise Carter, "How Real is the Impact of Artificial Intelligence? The Business Information Survey 2018," *Business Information Review* 35, no 3 (2018): 99.

[10] Information based on anecdotal knowledge by the author from previous experience working within Real Property Operations for ADM (IE).

[11] Christopher Perry, "Smart Buildings Save Energy and Improve Occupant Comfort," *ACEEE* (blog), 20 December 2017, https://aceee.org/blog/2017/12/smart-buildings-save-energy-and; Prabhu Ramachandran, "AI and IoT are the Future of Facilities Management," *Forbes Middle East* (blog), 18 March 2018, https://www.forbesmiddleeast.com/en/ai-and-iot-are-the-future-of-facilities-management/.

information professionals anticipate that AI solutions will require the enhancement of current skills rather than the acquisition of new ones.[12] Additionally, the demand for building controls and automation savvy employees will continue to increase and is an area that should be further explored by DND's HR professionals. In order to responsibly implement AI and machine learning systems, ADM (IE) will need to continue to attract highly-talented, capable employees by offering competitive salaries and other positive employee benefits.

10.   A major stumbling block encountered thus far with initial implementation of building automation and control systems is the communications networks required to provide proper functionality. Any increase in AI or machine learning initiatives will continue to strain existing networks and challenge government policy in establishing information communication systems. For example, many bases and wings currently have sophisticated control systems in newly constructed buildings that operate insularly within a singular facility.[13] That is, a building's status (temperature, humidity, energy use, etc.) can only be monitored and adjusted from within the building and not monitored remotely. For a number of reasons including physical network infrastructure and security policies, ADM(IE) has had challenges getting these buildings online and communicating with a central controller. To enable future success in implementing AI systems (and, more pressingly, current building automation control systems), significant oversight and resources will be required to establish more robust communications networks.

11.   The potential efficiencies that could be realized by implementation of AI systems in infrastructure also have significant threats in ensuring the security of communication networks. US Officials have identified that we are at a "historical turning-point in protecting infrastructure from an ever-increasing level of sophisticated threats…[and] stressed that the advent of 'the internet of things' and digitization of infrastructure have enlarged the 'attack surface'…for hackers to exploit."[14] With autonomy of machines increasing and their ability to make decisions free of human input, so too does the risk increase that these systems are attacked and used in nefarious ways. In an address to the U.S. House of Representatives' Subcommittee on Energy, Under Secretary of Energy Mark Menezes noted, "Our goal is to counter their machines with our machines and with our artificial intelligence but it's an ever-escalating battle…we don't even know what the future threats are."[15] As AI systems are implemented, specific attention needs to be given to network vulnerabilities to ensure our infrastructure assets are secured. Significant operational impacts could occur should building systems be compromised and infiltrated; the effects of something as simple as turning off the power in an airplane hangar could have serious military ramifications for strategic aircraft and personnel.

12.   Implementing AI frameworks to better manage infrastructure should also not be done without a thorough analysis of the important ethical considerations that are frequently debated when implementing new AI technologies. In a military context, primacy of operations is an important principal that any system needs to adhere to, and often times this may conflict with an AI controller that is programmed to do what is best for the longevity of the infrastructure or to

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[12] Carter, "How Real is the Impact of Artificial Intelligence…", 99.

[13] Information based on anecdotal knowledge by the author from previous experience working within Real Property Operations for ADM(IE).

[14] Andrew Coffman Smith, "Lawmakers Explore Artificial Intelligence, Energy Infrastructure." *SNL Power Policy Week* (21 March 2018).

[15] Ibid.

adhere to energy efficiency guidelines. Similarly, human life and safety needs to be treated as an ultimate priority and should not be sacrificed in trying to achieving optimum infrastructure performance. These ethical concerns continue to be central in any discussion about AI, and they should be comprehensively explored further before any decision on implementation of AI is made.

CONCLUSION

13.   The potential for AI systems to be applied across DND's infrastructure portfolio is substantial. If leveraged correctly, AI and machine learning are poised to improve how facilities are managed and maintenance resources are allocated. Specifically, utility cost savings of up to 30% have been estimated if DND implements more robust energy monitoring systems at bases and wings across the country. Existing building control and automation systems can be better utilized through dedicated efforts to improve the overall communications networks and move these control systems online. Scant engineering resources can be better managed to optimize efficiency of infrastructure maintenance tasks. Undoubtedly, technological advances and the evolution of AI are going to challenge the status quo in the future and DND needs to be prepared to capitalize on these across its infrastructure portfolio.

RECOMMENDATION

14.   The primary step for any advanced building automation system or AI framework is to establish the ability to collect useful, accurate infrastructure data; any future system will only be as good as the information that is feeding into it. It is recommended that further resources and efforts be directed to ensuring ADM(IE)'s facility monitoring networks and metering systems are well established across its diverse infrastructure portfolio. Additionally, it is also recommended that a standardized approach to building automation and controls be established at the strategic level to ensure interoperability across all of ADM(IE)'s assets in the future.

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