APS1049 – Manufacturing Digitization: How Canadian manufacturers can remain competitive on a global scale

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Executive Summary

The Canadian manufacturing sector was once a major part of the global market. Recent economic hardships paired with development in countries such as China, India, and Vietnam have caused the Canadian sector to shrink considerably. However, Industry 4.0, and the technologies associated with it, have the potential to turn the tide in Canada if employed appropriately. **The primary goal** of this report is to identify how Canadian manufacturers can implement Industry 4.0 technologies to improve profitability and shareholder value through enhancements in operational efficiency. **This will be accomplished in three stages:** (1) analyze the Canadian manufacturing sector to determine which industries are ripe for digitization, (2) assess global industry leaders to gain insight into the applications of these technologies, and (3) provide key takeaways, recommendations, and risk mitigation strategies for manufacturing executives in Canada.

Chapter 1 answers the 5Ws regarding the project. It details the purpose of the project, the **importance of the topic, the end goal, and the project scope**, as well as a high overview of how to achieve the project objectives. The section also outlines the resources that will be used throughout the project and how research and information will be collected. The stakeholders are also identified to explicitly identify who this report is targeting.

Chapter 2 outlines the **advantages of digitization**. It begins with an in-depth overview of the four industrial revolutions to provide context regarding how manufacturing has progressed. The following two sections of the chapter talk about the advantages that are inherent in the next industrial revolution (Industry 4.0) and the technologies associated with this revolution. The use of these technologies **reduces cost and waste while simultaneously improving quality and throughput**. This then begets greater profitability and encourages better growth prospects. The chapter concludes with an outlook on where the global manufacturing sector is headed over the next two decades.

Chapter 3 explores the landscape of Canadian manufacturing. It begins with an overview of the history of manufacturing in Canada, followed by an analysis of some of the key trends in Canada, and then the current state of Industry 4.0 adoption in Canada. The overarching conclusion from these sections is that **Canadian manufacturing has fallen steeply from its height 2-3 decades ago**. The global financial crisis crippled an already weak sector which still has not fully recovered. The final portion of this chapter investigates the various industries in Canadian manufacturing to determine which have the greatest digitization potential. The conclusion was that **food production and processing, transportation equipment manufacturing, and fabricated metal production are the ripest industries for digitization**.

Chapter 4 presents an analysis of three companies – **Tesla, Nestlé, and GPV** – based on six manufacturing KPIs, to substantiate the impact of digitization on an organization. These six KPIs are: (1) Throughput, (2) Capacity Utilization, (3) Downtime to Operating Time Ratio, (4) Defect Density, (5) Inventory Turnover Rate, and (6) Non-Compliant Event Rate. The results of the analysis are summarized below.

Tesla was one of the pioneers in adopting emerging digital technology, and this has proved to be a lucrative decision for them. The **extensive use of robotics and automation technology** to automate more than 75% of their production line has resulted in a massive gain in their manufacturing throughput which increased from 200 cars/week to 5,000 cars/week. Since most of their equipment is retrofitted with several sensors providing real-time data, they were able to implement predictive maintenance in their factories. The use of **Big Data and artificial intelligence has helped them reduce downtime, increase capacity utilization, and improve inventory turnover rates**. Their success has pushed other automotive manufacturers to move towards this approach, as the advantages far outweigh the challenges. Even the non-compliance event rates have reduced drastically due to the use of augmented reality for better training and IIoT systems to mitigate

any issues before they can result in catastrophe. Additionally, they are one of the only auto manufacturers that has given attention to greener supply chains and is committed to the production of green technologies in North America.

Nestlé is the largest food manufacturing company in the world. The company has been investing in digital transformation at all levels of its business. Currently, Nestlé has 100 factories equipped with collaborative robots and 60 warehouses that are fully automated. Additionally, Nestlé has created **digital academies and centers of competency to accelerate the pace of digital transformation**. The digital transformation of Nestlé has shown a number of benefits in recent years, especially since the COVID-19 pandemic. The use of AR technology has kept Nestlé's factories operating smoothly and delivering new investment projects on time. Automation of the palletising of the capsules has allowed Nestlé's factories to achieve higher pallet quality and improve conditions for their workers. The implementation of **IIoT solutions has helped Nestlé meet the demands of the future by tracking customer behaviour, and subsequently improving its inventory management**. Additionally, the adoption of blockchain technology has allowed to Nestlé enable full transparency through its supply chain and reduce food frauds and food waste.

GPV is a leading European electronic manufacturing service provider, and it has its own fabricated metal facilities to produce wires and other metal parts for its electronics business. A combination of **autonomous transport robotics and cyber-physical systems have helped the organization improve manufacturing throughput by 10%**. Additional robots can further increase this number. Production schedule is visualized through augmented reality, cyber-physical systems, and traditional display technologies. As such, managers can make better decisions to effectively utilize production capacity. GPV has also installed many sensors on major equipment which monitor their condition through IIoT. **Preventative maintenance is then carried out to reduce downtime and extend equipment service life**. Additive manufacturing greatly reduced defect density of delicate parts as well as prototype manufacturing. All defected items are traceable to allow further research and reduce defect rate in the future. IIoT and cyber-physical systems optimize production schedule to the predicted market demand and thus reduce unnecessary inventory. Lastly, GPV monitors production facilities in real time and resolves any non-compliant events at a very early stage.

Chapter 5 lays out **digitization challenges, mitigations, assessment rubric, technical recommendations, and a high-level action plan**. The three critical challenges regarding digital transformation are high capital investment, insufficient training of personnel, and difficulty of system integration. Additional digitization challenges include a lack of industry standards, data security, disruption of existing production, change in management structure and irrelevant technologies. Five high-level mitigations are listed as general change management strategies. These methods include careful evaluation of technology deployment, garnering commitment, seeking external help, clear organizational communication, and detailed financial planning. A transformation rubric on a scale of 1-4 is developed to guide companies through this change. Technical recommendations on how to improve each KPI are also discussed in this chapter. A high-level action plan has been formulated based on Kotter's 8-step change model to provide manufacturers with a pathway for their transformation journey. In essence, this action plan highlights the role of planning prior to undertaking such a project and allocating enough resources for smoother transition into the new industrial era.