AI AND SMART TECH IN MANUFACTURING

Northbridge® Insurance
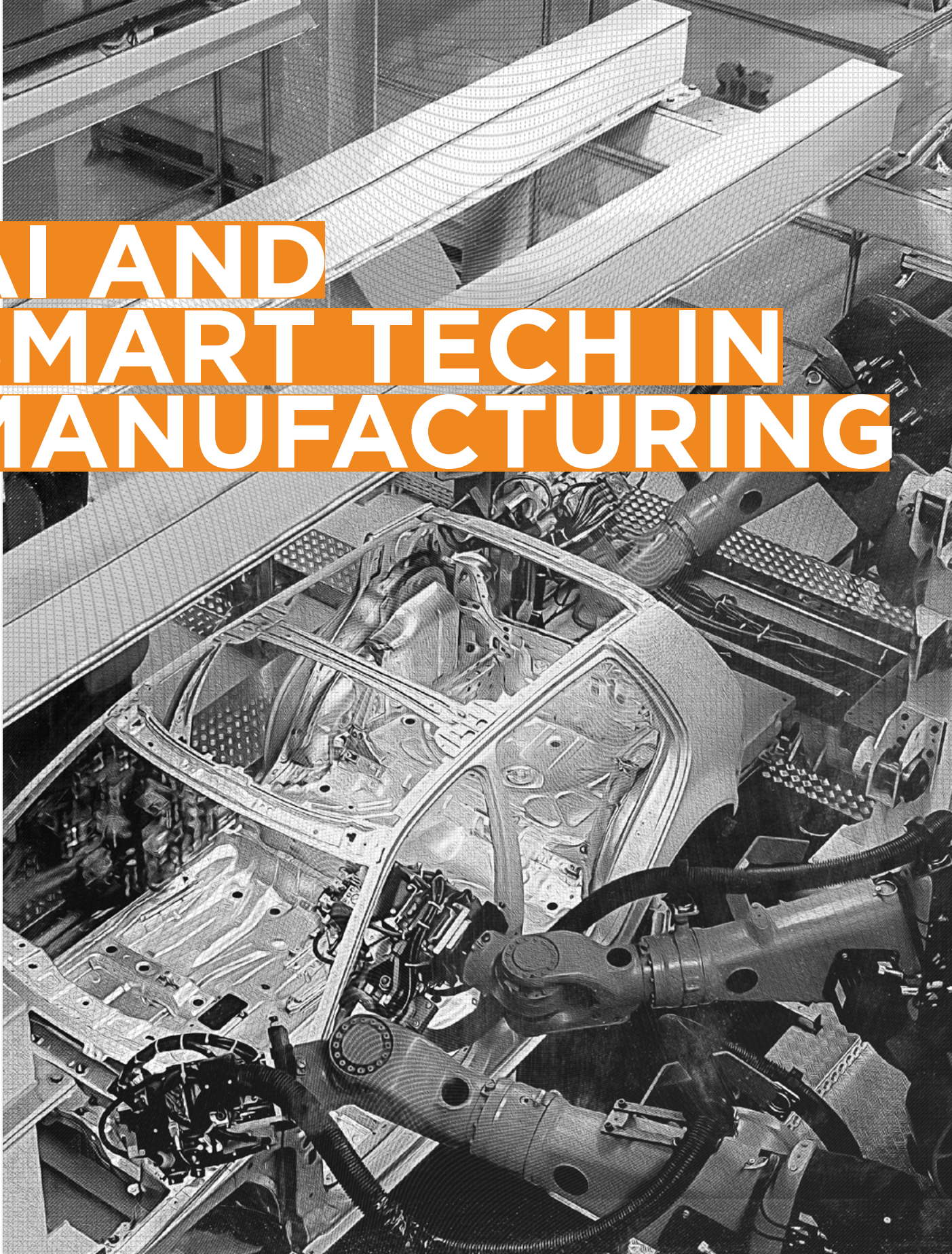
EDITOR'S NOTE

The research for this paper was conducted in late 2019, prior to the start of the unprecedented global pandemic that has significantly disrupted many industries, manufacturing being no exception. It is a snapshot in time that provides insight into the level of investment and adoption of AI and Smart Tech prior to the pandemic. Technologies that may play an important role in helping manufacturers as they plan to return businesses to normal operations as soon as possible and look for ways to leverage their investments in helping them create safer and more resilient operations for the long-term.

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EXECUTIVE SUMMARY

Canadian manufacturers are in the midst of a profound technological change that will impact the industry on many dimensions. From production workflows, labour needs, and interactions across supply chains, Internet-enabled and advanced digital technologies are reshaping manufacturing across the country.

Northbridge Insurance surveyed Canadian manufacturers who are adopting Artificial Intelligence (AI) or Smart Technologies (Smart Tech) in their production processes, as well as those who are planning to do so in the near future. Here is some of what we learned:

The use of these technologies is becoming widespread

Almost half of the country's manufacturers (48 per cent) surveyed have already adopted these technologies while another 20 per cent are in the process of doing so. Approximately 12 per cent report they are actively investigating these technologies and have plans to invest in them in the next few years. Adoption will continue as more manufacturers invest in these technologies and explore new applications.

Efficiency gains leads a long list of motivations

Cost savings are the biggest driver for adopting AI and Smart Tech, followed by opportunities to increase revenue through higher throughput, extended machinery and equipment lifespans, and more value-added products. Increased product quality, product and worker safety, and better end-customer experience are also among key motivators.

AI and Smart Tech are being used for multiple applications

Across workflows, Canadian manufacturers are using these technologies for task automation (71 per cent of manufacturers), quality control (64 per cent), predictive and preventative maintenance (59 per cent), and planning and scheduling applications (58 per cent). Generative design, the use of AI to help develop new products and components, is being used by 27 per cent of manufacturers who have adopted these technologies.

Capital and talent are key challenges

When asked to identify barriers and issues to adopting AI and Smart Tech, access to capital to pay for these investments and related equipment tops the list. Talent issues are key as manufacturers can struggle to find workers with the right skill sets to implement and use these technologies, in addition to the challenge of managing change with their legacy workforces.

INTRODUCTION: THE 4TH INDUSTRIAL REVOLUTION

For many, "manufacturing" conjures images of noisy production lines, manual labour, and hot, dusty factories. In contrast, when we think of advanced technology, sectors like telecom, medicine, and even banking are typically top of mind.

But in reality, manufacturers are adopting advanced technology at a rapid pace. Here are just a few technological innovations being used in factories today:

- Internet of Things (IoT) sensors that manage supply chains by tracking inventories and the movement of components and products through production flows

- Advanced analytics that minimize machine downtime by predicting when maintenance will be required

- AI and machine learning that generate new product designs

- Dark or "lights-out" factories that use advanced robotics instead of human workers so they don't need to light or heat their workspaces

- Augmented reality wearables that help boost the skills and productivity of industrial workers

- 3-D printing that streamlines prototyping and makes customization efficient

[1] The first industrial revolution (circa 1765) was based on mechanization and the steam engine, while the second (circa 1870), arose with the emergence of gas and electricity as fuel sources and saw the introduction of large, capital-intensive factories. The third industrial revolutions (circa 1969) coincided with the invention of the transistor and miniaturization technologies and saw the adoption of automation technologies such as robots. The fourth industrial revolution began in the early 2000s and harnesses digital and Internet technologies including the cloud, big data analytics, AI, and the Industrial Internet of Things (IIOT).

This widespread adoption of advanced digital technologies has been called Industry 4.0, or the 4th industrial revolution[1]. These fundamental technology-driven changes are making Canadian manufacturers more competitive and are driving the sector's ability to innovate and create better quality products faster and more efficiently.

50%

Reduction in unplanned outages through the widespread adoption of predictive maintenance technologies[2]

$2.9
TRILLION USD

value that could be generated by 2021 from businesses through AI, and by 2025, spending on robotic systems could reach $67 billion[3]

To help understand this rapidly changing landscape from a Canadian perspective, Northbridge Insurance conducted research with Canadian manufacturers in late 2019.

Northbridge Insurance's AI and Smart Technology Research

Northbridge Insurance surveyed decision-makers in 200 Canadian manufacturing businesses who were currently using or in the process of implementing AI or Smart Tech, or planning to invest in them in the next two years. Participants needed to be actively involved in their business' major capital investments and the businesses represented a range of business sizes and manufacturing subsectors.

Our objectives for this research were to:

- Develop a better understanding of what AI and Smart Tech mean in the context of manufacturing

- Track the adoption and readiness of AI and Smart Tech among manufacturers in Canada

- Identify challenges that these technologies pose for manufacturers

The study was informed by in-depth interviews with four AI experts and 15 manufacturers who had or were planning to adopt AI and Smart Tech in their businesses.

The research was executed by research agency Phase 5.

Reading this Report
Please keep the following in mind when reading this report:

- Total AI / Smart Tech Users refers to respondents who have already adopted AI or Smart Tech applications or are in the process of doing so.

- Potential AI / Smart Tech Users refers to respondents who have not yet adopted these technologies but are actively investigating them and have plans to invest in the next two years.

- Percentages may not add up to 100 per cent due to rounding.

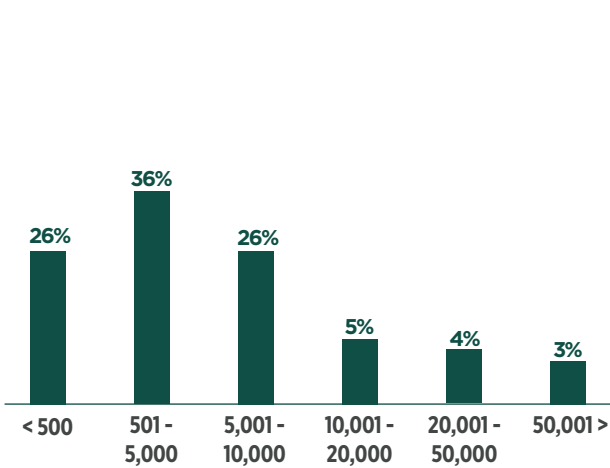[2] As cited in https://us.hitachi-solutions.com/blog/top-manufacturing-trends/
[3] As cited in https://info.microsoft.com/rs/157-GQE-382/images/EN-US-CNTNT-Report-2019-Manufacturing-Trends.pdf
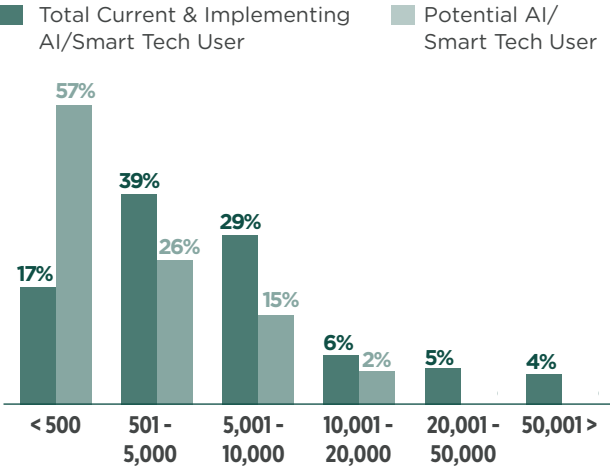
Respondent Profile

Survey respondents represent a wide range of Canadian manufacturing businesses, with the majority of respondents representing manufacturers with 10,000 or fewer employees.

As shown below, nearly 83 per cent of current AI and Smart Tech users are in firms with 500 or more employees while smaller manufacturers are more likely to be found among potential users (those considering an investment in the next two years but have yet to adopt).
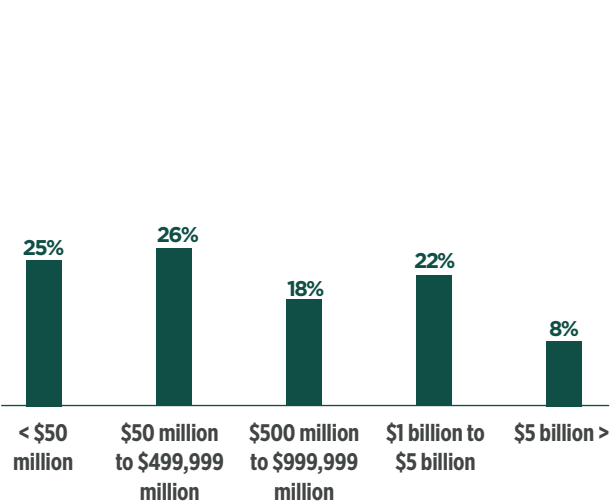
NUMBER OF EMPLOYEES

Category	Value
< 500	26%
501 - 5,000	36%
5,001 - 10,000	26%
10,001 - 20,000	5%
20,001 - 50,000	4%
50,001 >	3%

NUMBER OF EMPLOYEES BY SEGMENT

Total Current & Implementing AI/Smart Tech User | Potential AI/Smart Tech User

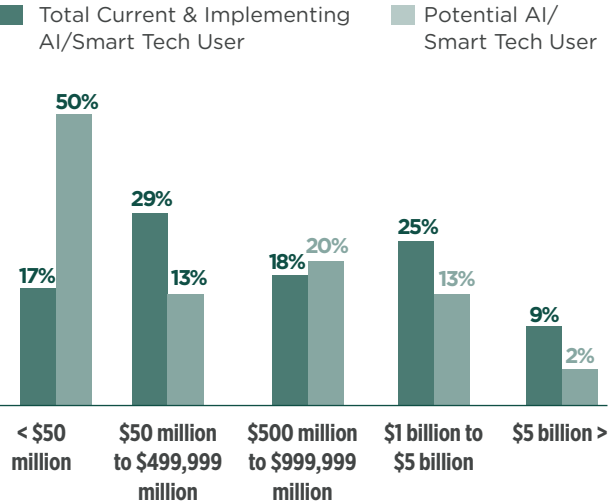| Category	Total Current & Implementing	Potential
< 500	17%	57%
501 - 5,000	39%	26%
5,001 - 10,000	29%	15%
10,001 - 20,000	6%	2%
20,001 - 50,000	5%	
50,001 >	4%	

A similar pattern emerges in terms of revenue, with most current AI and Smart Tech manufacturers having revenue of $500 million or more while nearly half of potential users have revenues of less than $50 million.
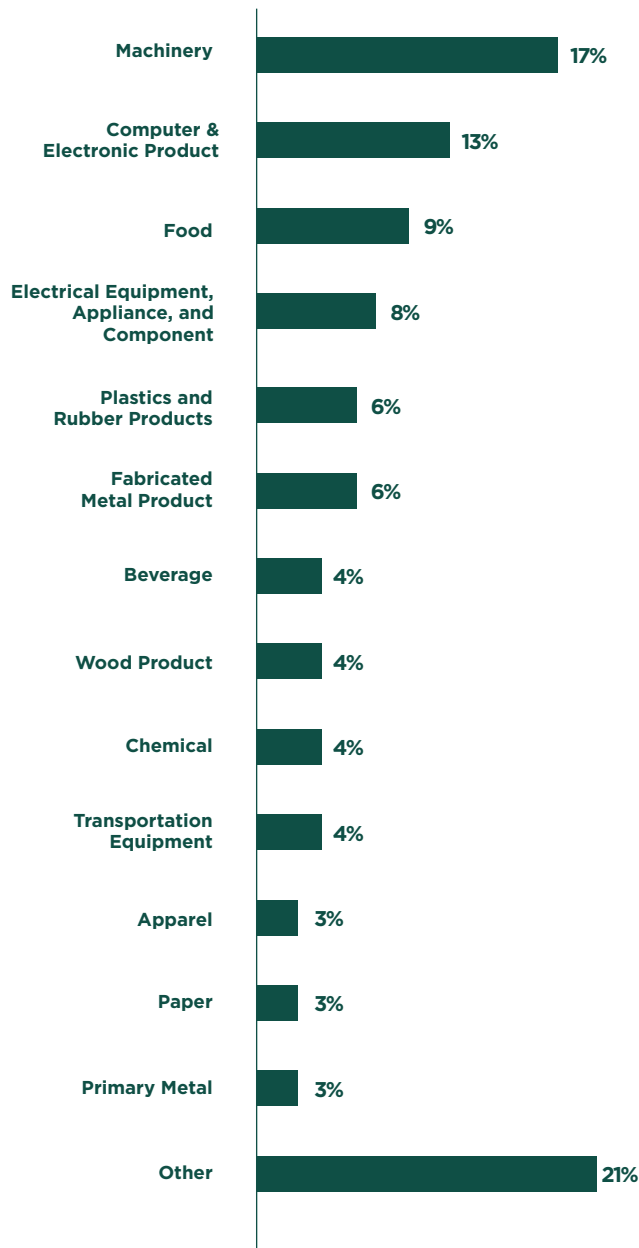
TOTAL ANNUAL REVENUE

Category	Value
< $50 million	25%
$50 million to $499,999 million	26%
$500 million to $999,999 million	18%
$1 billion to $5 billion	22%
$5 billion >	8%

TOTAL ANNUAL REVENUE BY SEGMENT

Total Current & Implementing AI/Smart Tech User | Potential AI/Smart Tech User

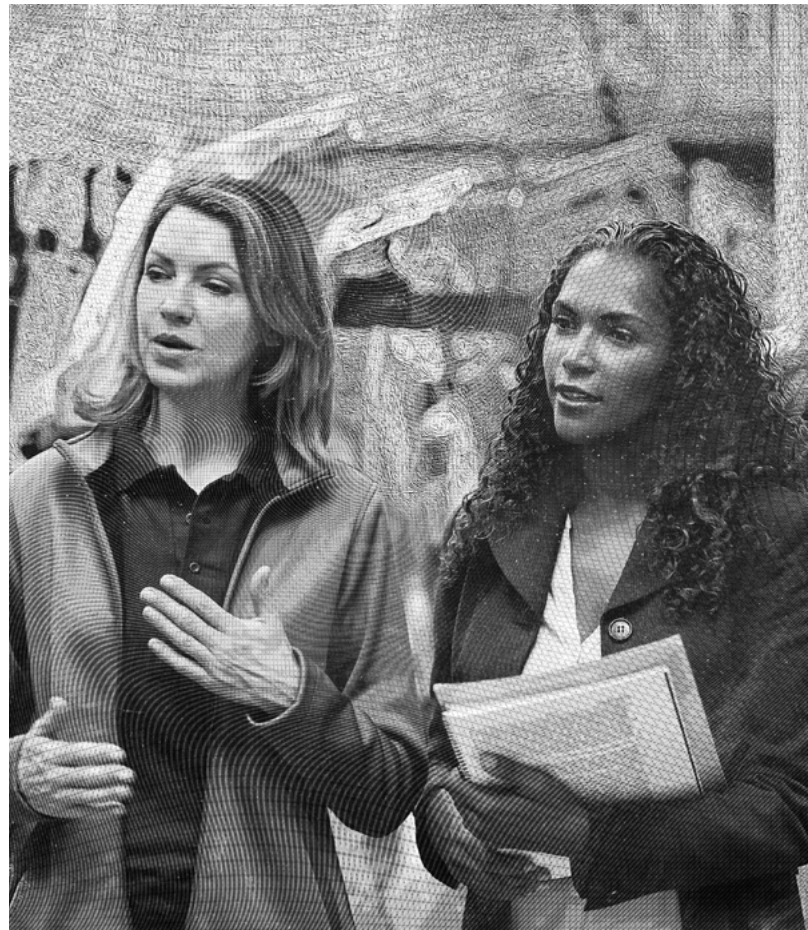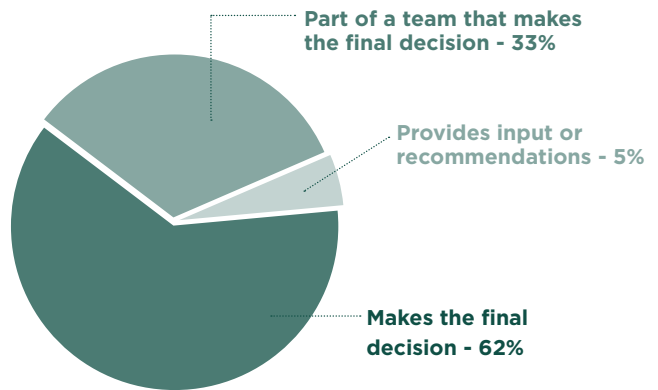| Category	Total Current & Implementing	Potential
< $50 million	17%	50%
$50 million to $499,999 million	29%	13%
$500 million to $999,999 million	18%	20%
$1 billion to $5 billion	25%	13%
$5 billion >	9%	2%

Respondents represent a wide range of manufacturing subsectors, with machinery, food, and computer and electronics manufacturers occupying the top three spots.
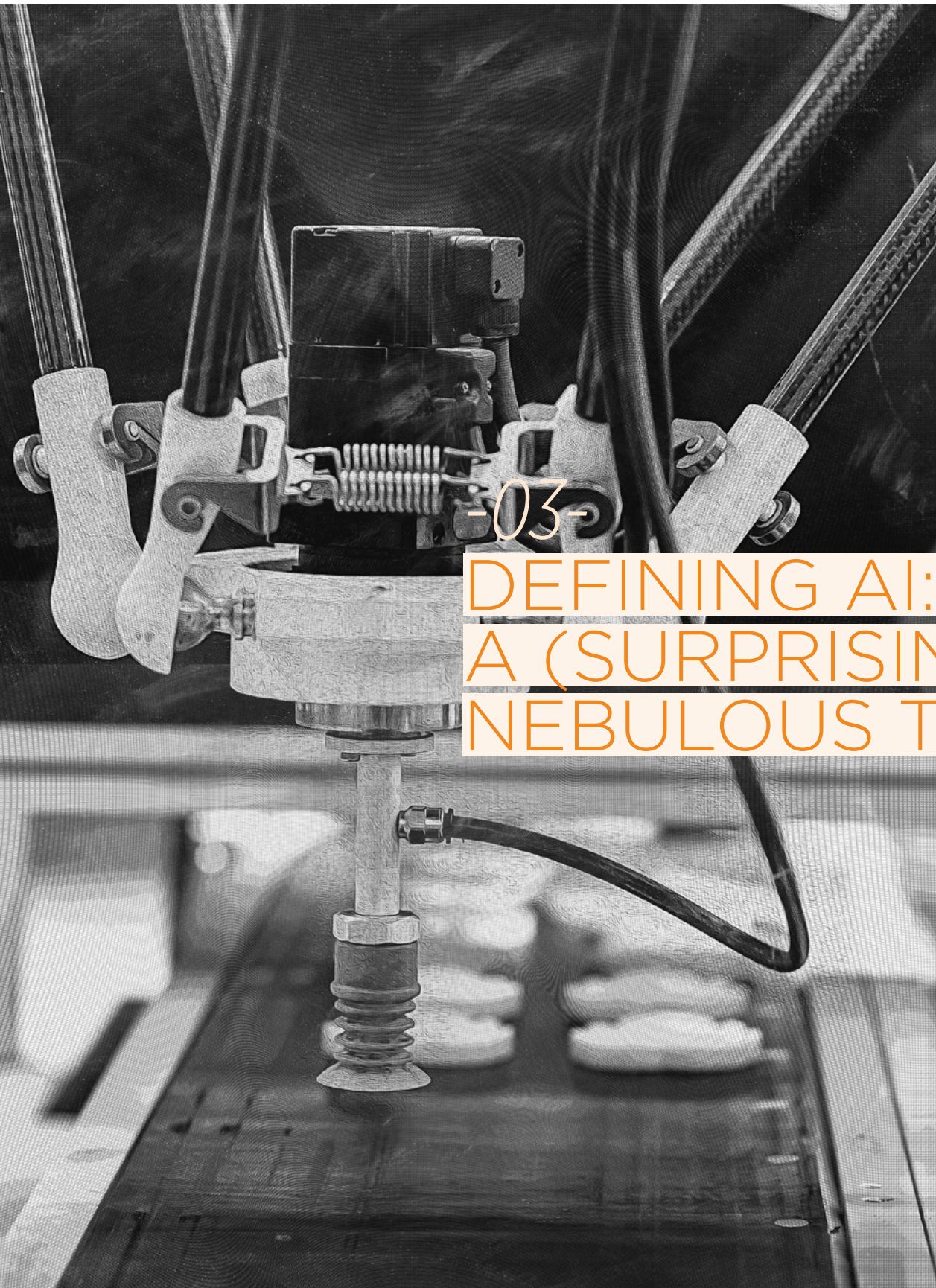
All respondents had input on decision-making with 69 per cent making the final decision on AI and Smart Tech investments and 28 per cent being part of a decision-making team. The remainder provided input and recommendations.

MANUFACTURING SUBSECTOR

Subsector	Percentage
Machinery	17%
Computer & Electronic Product	13%
Food	9%
Electrical Equipment, Appliance, and Component	8%
Plastics and Rubber Products	6%
Fabricated Metal Product	6%
Beverage	4%
Wood Product	4%
Chemical	4%
Transportation Equipment	4%
Apparel	3%
Paper	3%
Primary Metal	3%
Other	21%

DECISION-MAKING ROLE

Part of a team that makes the final decision - 33%

Provides input or recommendations - 5%

Makes the final decision - 62%

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DEFINING AI:
A (SURPRISINGLY)
NEBULOUS TERM

In contrast to the precision of the underlying digital technologies, there is no cut-and-dry consensus on what AI means. Our research found that AI often means different things to different people in the manufacturing sector. Add related concepts like Machine Learning, Deep Learning, Smart Tech, Internet of Things, and Big Data into the mix, and it's perhaps less surprising that manufacturers have varying interpretations.

Smart Tech, for the purposes of this study, is defined as any advanced technology used in the manufacturing process that simulates intelligent behaviour by using conditional logic, but requires no actual learning from past data. Examples of this type of technology could include automation where robots perform repetitive tasks, or machines that are programmed to turn on or off based on sensor input. These technologies have been used by some manufacturers for decades but because they simulate smart behaviour, they are sometimes grouped in with AI.

AI refers to technologies that can correctly interpret external data, learn from that data, and use those learnings to achieve specific goals through flexible adaptation. Examples of AI in manufacturing include robots that use image recognition to navigate to and sort items in a plant and algorithms that analyze big sets of consumer data to generate new product ideas. A key differentiator of AI is that these technologies can learn, adapt and make decisions that used to require human participation.

Related Terms

Conditional Logic
Advanced technology that uses algorithms programmed by a human using conditional logic requires no actual 'learning' from past data. This type of technology drives most factory automation. While many consider this to be 'smart' technology, many do not consider it true AI.

Machine Learning
This refers to algorithms that can read data, learn from the data, and modify behaviour based on the learnings. However, these algorithms rely on structured data. As an example, to learn to recognize a specific component part in a manufacturing process, images with different elements of the component would need to be tagged.

Deep Learning
These technologies are similar to machine learning, but can handle unstructured data. For example, to 'learn' to distinguish one component from another, the algorithm understands independently without the need for the images to be tagged with labels.
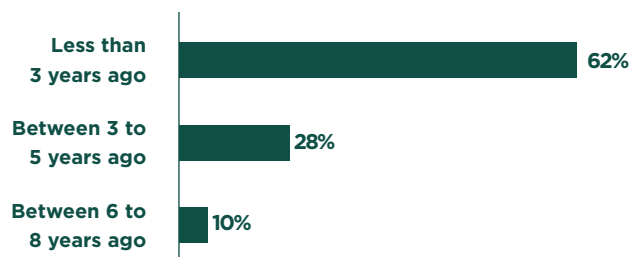
AI AND SMART TECH ADOPTION

While past studies show that Canadian manufacturers are lagging behind other countries in adopting AI and Smart Tech, our research suggests that this is changing, and quickly.

Our survey of Canadian manufacturers shows that eight in 10 have made, are making, or are planning to make a near-term investment in AI or Smart Tech. Almost half of the country's manufacturers (48 per cent) surveyed have already adopted these technologies while another 20 per cent are in the process of doing so. Slightly lower down the adoption curve, some 12 per cent report they are actively investigating these technologies and have plans to invest by the end of 2021.

Adoption of these technologies is poised to get deeper within firms as well. Some 85 per cent of manufacturers who are currently using AI plan to add additional applications, the vast majority within the next two to three years.

Most investments in these technologies have been very recent, with more than 60 per cent saying their most recent investment was made in the past three years.

TIMELINE OF MOST RECENT AI AND SMART TECH IMPLEMENTATION

Less than 3 years ago	62%
Between 3 to 5 years ago	28%
Between 6 to 8 years ago	10%

48%

Canadian manufacturers have **adopted** these technologies.

20%

Canadian manufacturers **are in the process** of adopting these technologies.

12%

Canadian manufacturers are **actively investigating** these technologies.

Adoption Drivers

Manufacturers and AI experts identified multiple factors driving adoption of these technologies. The following emerged repeatedly:

Increase efficiency and productivity
Manufacturing decision-makers identify process inefficiencies they feel could be addressed through technology. For example, frequent downtimes caused by machinery malfunctions were cited by several decision-makers we interviewed. These issues seem endemic: According to CB Insights, world-class manufacturers operate at 85 per cent of their theoretical capacity, yet the average operate only at around 60 per cent.

Forward-thinking leadership
Owners and C-suite executives who have an early adopter mindset, sometimes gained from exposure to these technologies in other countries, are key to driving decisions. In some cases, a take-over or merger results in new leadership who are interested in reviewing production processes.

Demographic shifts
Generational changes are encouraging manufacturers to consider AI and Smart Tech in different ways. As skilled Baby Boomer workers retire, manufacturing businesses are finding it difficult to replace them, causing them to look to technology as a substitute. On the other hand, younger workers who do enter the field are more likely to be in tune with new technologies and their potential benefits. Younger generations are also more likely to lead start-ups that don't have capital already invested in older technologies and are therefore more open to considering advanced technologies from the get-go.
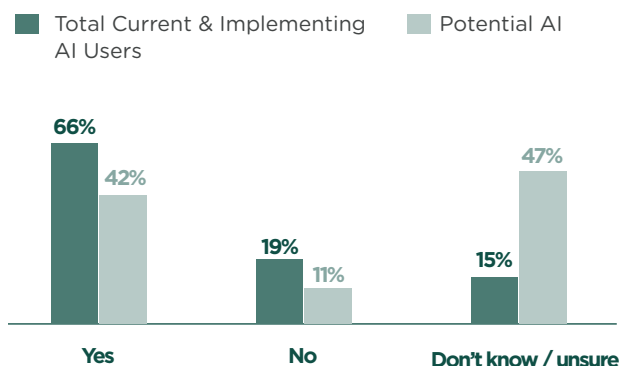
Competitive pressures
As more firms adopt these technologies, pressure is applied to others to stay competitive. Among our survey respondents, 71 per cent of current AI users think they are ahead of their competitors from a technological perspective, compared to just 44 per cent of those who are just exploring these technologies.

Vendor influences
Nearly two-thirds of Canadian manufacturers who have adopted AI indicate that third-party vendors in their supply chain are also using these technologies. This exposure could be influencing their adoption of AI and Smart Tech. In contrast, significantly fewer respondents who had not implemented these technologies were aware if their vendors were using them.

DO YOUR THIRD-PARTY VENDORS USE AI TECHNOLOGY?

■ Total Current & Implementing AI Users   ■ Potential AI

	Yes	No	Don't know / unsure
Total Current & Implementing AI Users	66%	19%	15%
Potential AI	42%	11%	47%

"

We have laser-guided technology that can cut the meter readers to our specifications. We wanted to be more efficient, and we wanted to save costs and produce more... This has given us an opportunity to grow at a faster pace.
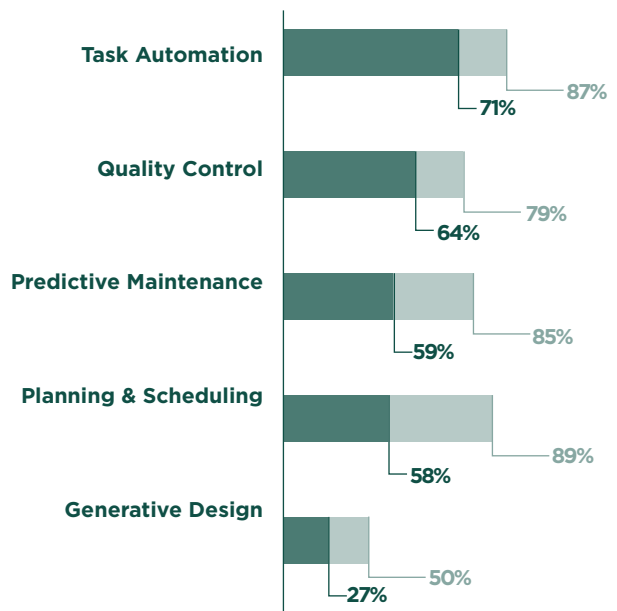
Equipment Manufacturer

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AREAS OF INVESTMENT

Canadian manufacturers are using AI and related Smart Tech across manufacturing workflows, from product design to process automation and machinery maintenance.

While task automation using robotics or the Internet of Things is the most widespread, only generative design is being used by fewer than half of AI and Smart Tech-enabled manufacturers.

AI / SMART TECH APPLICATIONS

■ Total Current & Implementing AI/Smart Tech User   ■ Expected Total Adoption

Task Automation
71%
87%

Quality Control
64%
79%

Predictive Maintenance
59%
85%

Planning & Scheduling
58%
89%

Generative Design
27%
50%

Task Automation

As shown in the graph above, task automation is the most common area of investment for these technologies. Some 71 per cent of manufacturers who have or are implementing AI and Smart Tech are automating tasks that used to be done by human workers, while another 16 per cent of manufacturers plan to invest in these applications in the future. Task automation covers a wide range of activities including sorting parts or packages, picking and moving goods in production lines, cutting materials and assembling components or products, or checking raw materials such as ingredient temperatures in food manufacturing. Automation helps manufacturers improve quality and consistency, reduces labour input costs, and increases speed and overall efficiency as machines can often run 24/7.

Quality Control

About two-thirds of respondents are using AI and Smart Tech for quality control, and another 15 per cent expect to do so. Manufacturing companies use visual inspection tools to help detect defects more accurately and faster than human inspection can achieve. This ensures that parts are cut precisely, that correct materials are used, and that components meet quality standards. Quality control applications improve safety and usability and can help manufacturers improve their bottom lines by minimizing returns and warranty claims.

Predictive and Preventative Maintenance

More than half of respondents are using these technologies to minimize wear and tear on machines and equipment. AI can help predict when maintenance will be required by using sensors to collect data on temperature, battery levels, physical wear, and other indicators. Predictive maintenance applications can drive significant cost savings by reducing downtime and extending the lifespans of machinery. Some manufacturers (in the machinery space, for example), are embedding these technologies into their products to provide value to end customers while providing data that can be used to optimize designs in subsequent models.

Planning and Scheduling

These applications of AI and Smart Tech touch a variety of tasks across the manufacturing process, including:

- Predicting inventory needs based on demand cycles, weather, input costs, resource availability, etc.
- Planning and scheduling orders to optimize efficiency and output
- Analyzing workflows and recommending optimal processes, staffing, scheduling, machinery use, etc.

These solutions help ensure manufacturers:

- Have the right input materials on hand, when they need them
- Reduce waste related to over-production
- Lower costs by optimizing ordering processes (anticipating price fluctuations, identifying suppliers, etc.)
- Optimize use of machinery and equipment

Generative Design

These applications leverage AI to help create new design ideas for products or components. Examples include:

- Using large sets of purchasing data to identify new flavours or recipes in food and beverage manufacturing
- Using AI to design component schematics
- Using AI to identify optimal materials for parts of components

While these applications help manufacturers save engineering and R&D time and improve product quality, so far, adoption has been modest. Just 28 per cent of respondents using or implementing AI for design applications.

"

I have been forecasting using AI models and they give me information on what you need to be ordering, when you need to be ordering it, what suppliers are best and where you can get the best price... Now, I get stuff at the right time as opposed to waiting two to three weeks.
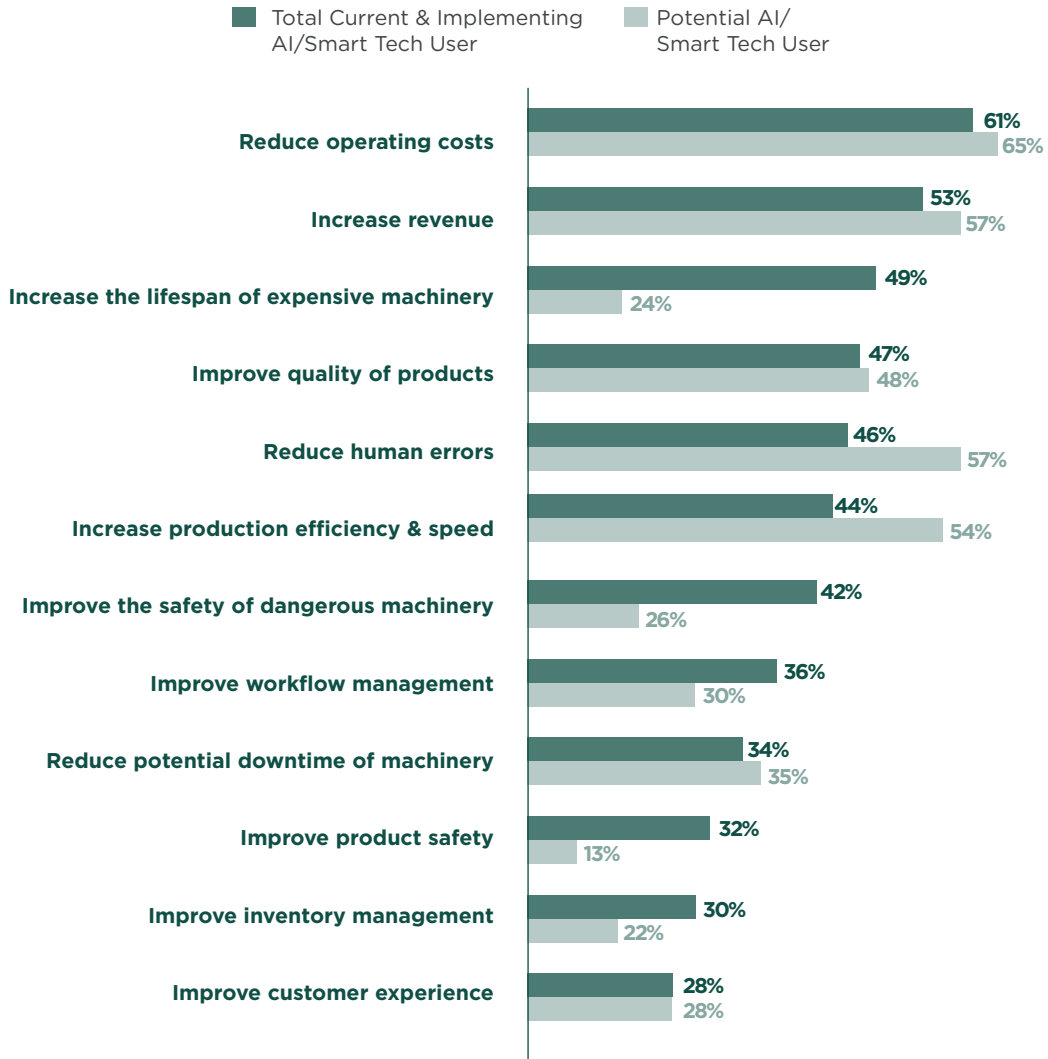
Food and Beverage Manufacturer

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MOTIVATIONS FOR ADOPTING AI AND SMART TECH

While AI and Smart Tech can help manufacturers in a variety of ways, money is the key underlying motivator, both in terms of lowering operating costs and generating revenue.

Well over half of the opportunities identified by Canadian manufacturers are expected to impact their bottom lines by reducing operating costs. Increasing revenue is the second most sought-after benefit. Other benefits of adopting AI and Smart Tech include increased safety of both machinery and end-products and providing a better customer experience.
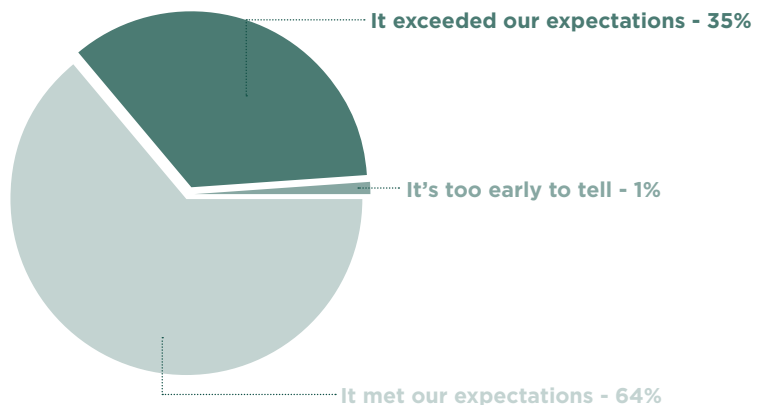
While motivations are largely similar to existing users, potential AI / Smart Tech users seem less motivated by extending machinery lifespans and improving product safety, and more motivated by opportunities to increase revenue.
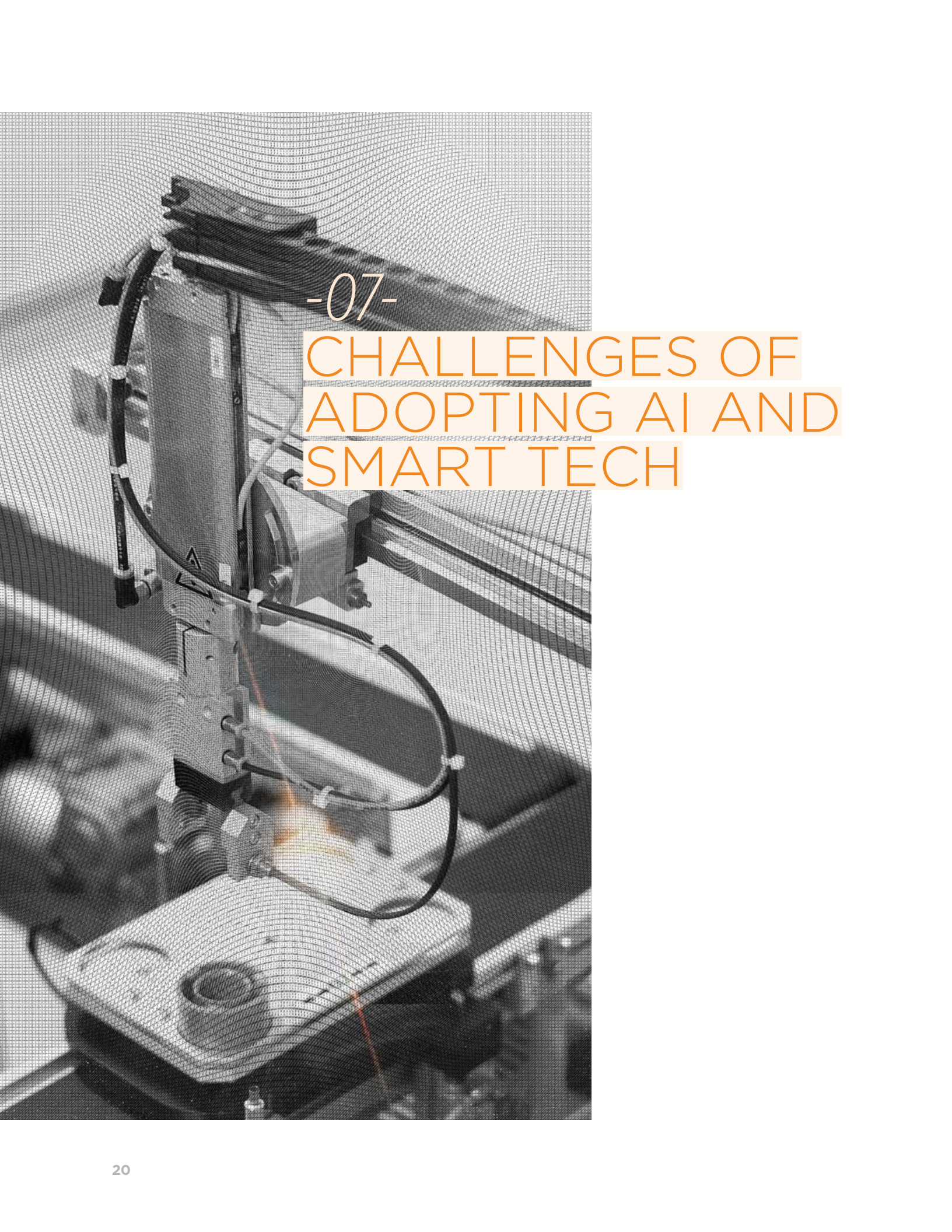
MOTIVATIONS FOR ADOPTING AI / SMART TECH

- ■ Total Current & Implementing AI/Smart Tech User
- ■ Potential AI/ Smart Tech User

Motivation	Total Current & Implementing	Potential AI/Smart Tech User
Reduce operating costs	61%	65%
Increase revenue	53%	57%
Increase the lifespan of expensive machinery	49%	24%
Improve quality of products	47%	48%
Reduce human errors	46%	57%
Increase production efficiency & speed	44%	54%
Improve the safety of dangerous machinery	42%	26%
Improve workflow management	36%	30%
Reduce potential downtime of machinery	34%	35%
Improve product safety	32%	13%
Improve inventory management	30%	22%
Improve customer experience	28%	28%

AI and Smart Tech implementations seem to be delivering on at least some of the benefits manufacturers are seeking. When asked about their most recent implementation, 64 per cent said it met their expectations while another 35 per cent indicated that their expectations were exceeded. Only 1 per cent said it was too early to tell.

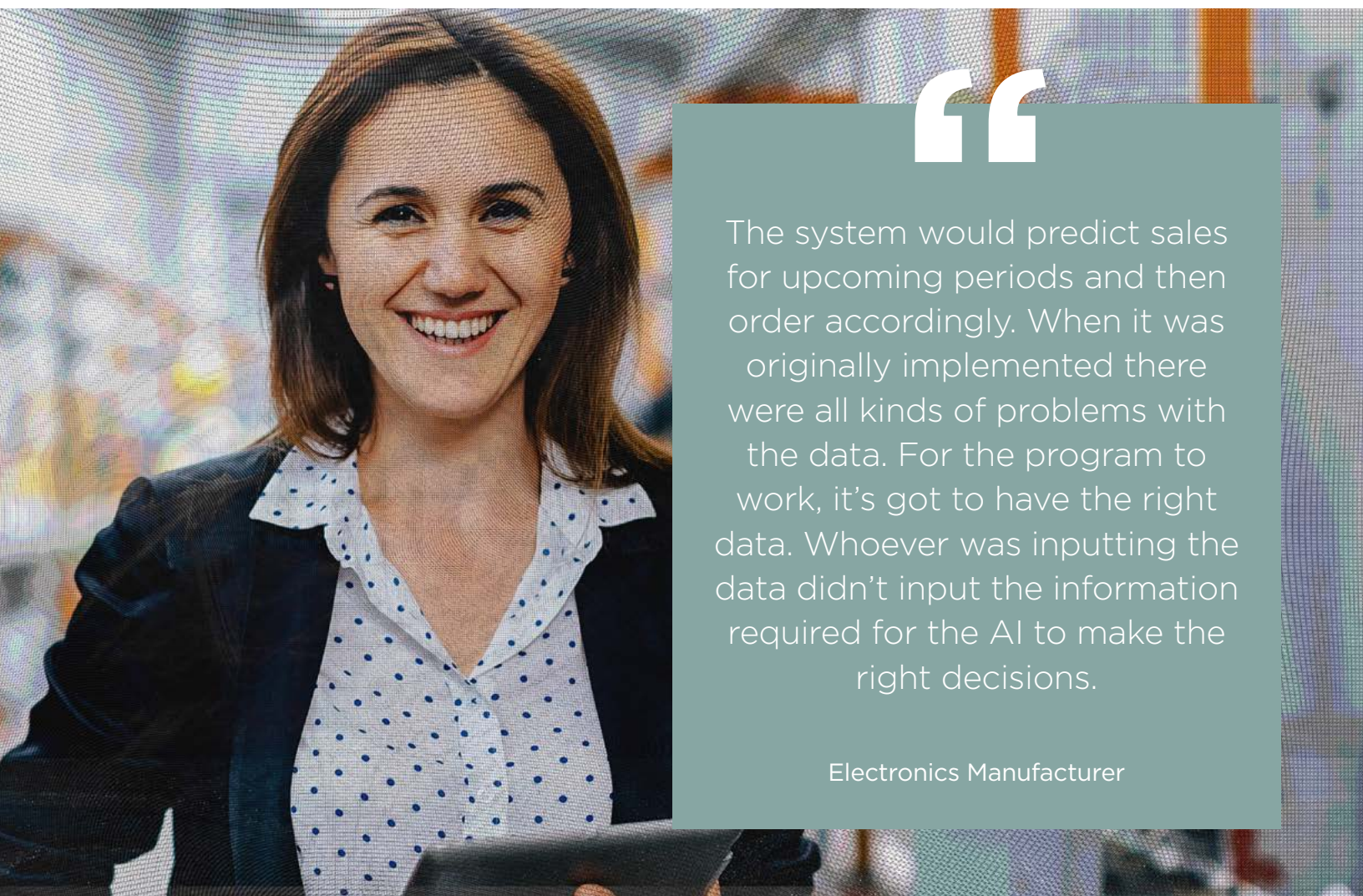## HOW MOST RECENT AI TECH IMPLEMENTATION STACKED AGAINST EXPECTATIONS

- It exceeded our expectations - 35%
- It's too early to tell - 1%
- It met our expectations - 64%

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CHALLENGES OF ADOPTING AI AND SMART TECH

Capital

Finding capital to implement and maintain new technologies is a key barrier. Both upfront and onboarding costs can be high for these technologies and finding sources of funding can be a challenge for smaller businesses. If integrating AI or Smart Tech means replacing legacy machinery, risks and timelines can increase.

Complexity

Dealing with technological complexity when implementing AI and Smart Tech applications was cited as a challenge by 41 per cent of AI and Smart Tech users. Many AI technologies need large datasets to work properly and manufacturers may have to put the infrastructure in place to collect the right data in the right way. Moreover, advanced AI applications need to "learn" from datasets, which can take time, and trial and error. Interestingly this challenge was less likely to be identified by potential AI users who are still in the investigation stage.

> "
>
> The system would predict sales for upcoming periods and then order accordingly. When it was originally implemented there were all kinds of problems with the data. For the program to work, it's got to have the right data. Whoever was inputting the data didn't input the information required for the AI to make the right decisions.
>
> Electronics Manufacturer

> " Another reason manufacturers are struggling is simply talent and know-how. To do a lot of the more advanced AI requires PhD level or Master's level computer science, so it's not an easy technology to get right. And at the same time, it also requires a lot of industry insights and subject matter expertise that a new PhD won't have.

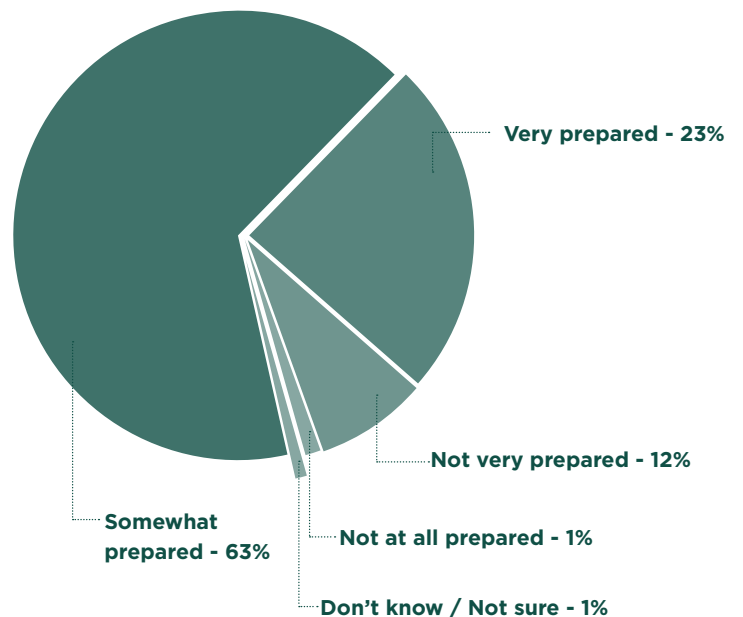Matt Killi, AI industry expert

Talent issues

Manufacturers cite a range of people-related obstacles that need to be addressed to successfully implement AI and Smart Tech. These include resistance to change, training costs, and lack of technical expertise.

Preparing for the future

Over a third of respondents identified cybersecurity as a potential barrier to AI implementation while another 15 per cent cited potential legal liabilities if the technology does not work as promised. Again, these challenges are more top of mind for manufacturers who have or are in the process of implementing AI compared to those who are investigating these technologies.

Given these challenges, it is perhaps not so surprising that only 23 per cent of respondents felt completely prepared for integrating AI into their manufacturing processes. The majority (63 per cent) say they are only somewhat prepared, while almost one in 10 admit to feeling unprepared.

PREPAREDNESS OF AI / SMART TECH INTEGRATION

Very prepared - 23%

Not very prepared - 12%

Somewhat prepared - 63%

Not at all prepared - 1%

Don't know / Not sure - 1%

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CONCLUSIONS

Here are some of the key take-aways from our research:

Smart Tech and AI are becoming mainstream

Manufacturers are already implementing or planning to implement these technologies into their workflows and growth is expected to accelerate in the near term. What's more, Canadian manufacturers are using these technologies for multiple applications, including task automation, maintenance, quality assurance, planning, and generative designs.

Costs and skills are a key challenge

Accessing capital to purchase these technologies and potentially replace existing machinery is a key challenge. Findings skilled workers to implement and work with these technologies is another obstacle facing Canadian manufacturers.

Cost savings, revenue and quality are the main drivers

Finding ways to create efficiencies and increase product quality and revenues is motivating adoption of AI and Smart Tech by Canadian manufacturers. Looming labour shortages as existing workforces age and retire are another consideration.

Multiple areas of investment

Task automation tends to be early on the adoption curve as manufacturers focus on robotics and IoT to create more efficient production processes. However, investment in predictive maintenance, quality control, and planning and scheduling are expected to grow quickly. Generative design, where AI helps manufacturers create new components and products, is expected to occur late in the adoption cycle.