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# Technology Readiness Assessment of Automation and Robotics in the Food and Beverage Processing Sector in Canada

FINAL REPORT

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**Technology Readiness Assessment of Automation and Robotics in the Food and Beverage Processing Sector in Canada**

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# Study Highlights

# Current Status of the Canadian Food and Beverage Processing Sector

The Food and Beverage Processing sector plays a prominent role in the global economy. It is the largest manufacturing sector amongst several countries and is a vital component in most national economies.

KPMG was mandated by Industry Canada to undertake a **Technology Readiness Assessment of Automation and Robotics for the Food and Beverage Processing Sector in Canada**. To do so, KPMG conducted interviews with over 100 Canadian and non-Canadian Food and Beverage processing operations, associations, and machine, equipment and solution providers. Focus groups with industry representatives were held to validate and augment results derived from the fact-finding and interview process. Key findings of this study are presented below.

## Current Status of the Canadian Sector

**Current Level of Automation and Robotics – Canada**

The Canadian Food and Beverage Processing sector is only partially automated, with the level of adoption of automation and robotic technologies varying across sub-sectors and firms.

For purpose of analysis, sub-sectors were grouped into the following five segments based on shared similarities in their inputs, production process, product and packaging characteristics (**refer to p. 33 and 34 for more details**).

**Table 1**

| Meat, Fish and Seafood | Prepared Meals and Others | Dry Food | Other Packaged Food and Ingredients | Beverages |
|---|---|---|---|---|
| Meat Products | Prepared Meals | Flour Milling | Breakfast Cereals | Soft Drinks and Water |
| Fish and Seafood | Fruits and Vegetables | Pasta | Coffee and Tea | Alcoholic Beverages |
| | Bread and Bakeries | Spreads | Cookies and Crackers | |
| | Dairy Products | Sugar & Sugar Products | Confectionery | |
| | | Starch, Vegetable Fat & Oil Manufacturing | Snack Food | |
| | | | Dog and Cat Food | |

**Figure 1**

# Current Status of the Canadian Food and Beverage Processing Sector
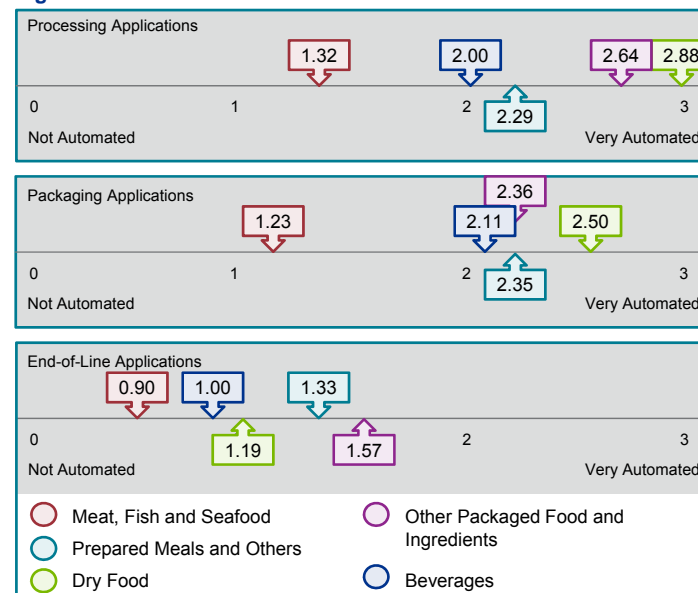
Firms operating in the Meat, Fish and Seafood segment were generally less automated than the other four industry segments across all types of applications (raw food/processing, packaging and end-of-line). Dry Food and Other Packaged Food and Ingredients segments were characterized as partially to very automated operations across all types of applications.

Raw food/processing and packaging applications were generally considered more automated than end-of-line applications. Of those firms that considered their operations as very automated in their raw food/processing applications, the majority were larger scale operations ($100 - $500 million or over $500 million in sales). Moreover, nearly 60% of these firms were subsidiaries or divisions of international companies.

Most of the firms that ranked their operations as very automated in their raw food/processing applications were publicly traded, whereas all of those that considered them as not automated were private companies.

The direct correlation between the firm size and the level of automation and robotics used in packaging applications was not consistently observed. Smaller firms sometimes ranked their packaging applications as very automated while some larger scale firms ($100 - $500 million or over $500 million in sales) ranked them as not or less automated. Cumulatively, a greater proportion of firms that ranked their operations as partially or very automated were subsidiaries of foreign companies. Most of the firms that ranked their operations as less or not automated in their packaging applications were private companies. However, the majority of publicly traded companies (93%) considered their packaging applications as either partially or very automated.

Generally, a greater proportion of larger scale firms (more than $500 million) ranked their end-of-line applications as partially or very automated. However, an important number of large-scale operations ($100 – $500 million or over $500 million) ranked

these applications as either not automated or less automated. Moreover, Food and Beverage processing firms that were subsidiaries/divisions of foreign companies were generally more automated in their end-of-line applications than Canadian-owned companies. End-of-line applications for privately-owned companies were mostly considered not automated, whereas publicly traded companies mostly ranked these applications as less to partially automated.

**Maturity of Automation and Robotic Technology**

Generally, Canadian Food and Beverage processing operations used a mix of leading-edge/new technology and older/non-leading-edge technology. While a few of the interviewed firms considered that none of their automation and robotic technologies were leading-edge, others ranked them as mostly leading-edge. The majority of interviewed firms characterized their operations as using some level of leading-edge technology.

Interviews also revealed that new, fully automated processing lines tend to co-exist with partially automated, older or manual processing lines. As such, new technologies can sometimes be employed alongside older technologies within any given plant. This suggests that Canadian Food and Beverage processors are gradually adopting automation and robotics.

**Importance of Automation and Robotics**

Although Canadian Food and Beverage processing operations are currently automated to varying extents in their raw food/processing, packaging and end-of-line applications, interviewed firms recognized the importance of adopting automation and robotics in order to compete in their local market as well as internationally.

Raw food/processing and packaging applications were mostly ranked as somewhat to very important to automate, whereas end-of-line applications were considered less important to automate on average.

**Current Level versus Importance of Automation and Robotics**

There was generally a gap between the current level of automation and robotics used by Canadian processing operations and the importance attributed to these technologies.

Across all types of applications, the gap was generally the greatest for firms operating in the Meat, Fish and Seafood segment. Comparing the various types of applications, the gap was generally the greatest for end-of-line applications for all segments of the Food and Beverage Processing sector.

**Future Investment in Automation and Robotics**

In light of the current level of adoption and the importance attributed to automation and robotics for the interviewed Food and Beverage processing operations in Canada, packaging applications were most frequently ranked as a top priority in terms of future investment across all segments of analysis.

Generally, capital investments in automation and robotics tend to involve areas that are more labour-intensive and that could generate important operational cost savings (in all forms) and productivity improvements. Whereas end-of-line applications indicated the largest gap for most of the segments of analysis, the benefits associated with automating these applications (such as using automatic storage/retrieval systems) were generally not as high as for other types of applications.

**International Benchmarking**

All of the stakeholders who were interviewed (including food and beverage processors, automation and robotics suppliers, as well as domestic and international industry associations) agreed that Canada is lagging behind most European countries in its level of automation and robotics. For the United States (US), there was less of a consensus, with the exception that generally, American operations tend to be larger in scale and accordingly more automated.

Greater similarities between Canada and its European and American counterparts were observed for more standardized / larger scale productions and segments of analysis. However, the gap also decreased when compared to emerging countries for such type of productions.

A number of sub-sectors were identified as lagging behind their European and/or American counterparts. These included:

- Meat;

- Fish and Seafood (mostly Europe);

- Beverages; and

- Flour Milling.

However, there were also instances where Canadian processors ranked their operations as leading-edge and similar to their most automated competitors. These included:

- Fresh Fruits and Vegetables;

- Bread and Bakery;

- Snack Food;

- Pasta;

- Sugar and Sugar products; and

- Starch, Vegetable Fat and Oil manufacturing.

Although the observed lag varies depending on the firm, the sub-sector and the region of comparison, Canadian Food and Beverage processing operations generally used at least some level of automation and robotics and the lag stemmed from:

- the extent to which existing technologies are used; and

- the maturity of the technology currently used.

# Lags in the Canadian Food and Beverage Processing Sector

### Lags in the Canadian Sector

**Applications to Further Automate**

A number of applications were identified in each segment that could benefit from the development of automation and robotic technologies and/or greater adoption of existing technologies.

Some of these applications were common to most segments.

### Table 2

| Raw Food/Processing Applications |
| --- |
| Initial material handling and feeding into lines |
| Transport/handling between the various applications |
| Vision technology for quality and content inspection/control |
| Automatic wash down applications/cleaning applications |
| Automatic and vision guided process control |
| Continuous processing (versus batch) |
| Automatic reconfigurable mechanism |

| Packaging Applications |
| --- |
| Automatic weighing and primary packaging |
| Automatic case packing |
| Automatic palletizing and pallet wrapping |
| Automatic loading and unloading of packaging machinery |
| Automatic loading of packaging material |

| End-of-Line Applications |
| --- |
| Automatic or semi-automatic storage/retrieval system |
| Integrated and automatic tracking of products |
| Integrated control of quality from production to distributor/customer |

Others were specific to segments or sub-sectors.

The majority of the identified common or segment-specific applications already have existing solutions available and Canadian Food and Beverage processing operations would benefit from adopting these technologies to a greater extent.

However, the extent to which such solutions have been developed varies across the different segments and sub-sectors of analysis, contributing to the gap between the "current" level and the "desired" level of adoption of automation and robotics.

**Meat, Fish and Seafood**

The Canadian Meat, Fish and Seafood segment is currently lagging in its level of automation and robotics compared to other segments, but also compared to its international counterparts. This lag is reflected in the measured gap (importance level minus current level) and is partly attributed to the lack of solutions directly applicable to the sub-sectors' processing activities. Notably, the sub-sector specific applications that were identified as areas needing improvement are facing challenges in the adaptation of already existing solutions. Implementation of solutions developed abroad is not always successful. Interviews provided a number of examples of solutions that were adopted from abroad and adapted to companies' operations but yielded unsatisfactory results. For the Fish and Seafood sub-sector, several species-specific applications in the raw food/processing and packaging applications currently lack any readily available solutions.

# Lags in the Canadian Food and Beverage Processing Sector

When considering the applications needing improvement common to most sub-sectors, the Meat, Fish and Seafood segment generally had the highest level of adaptation and development requirements compared with other segments. This statement is generally true for raw food/processing and packaging applications, but less so for end-of-line applications.

## Other Segments

For the majority of raw food/processing and packaging applications identified as common areas of improvement, the measured gap (importance minus current level) tend to be much less than for the Meat, Fish and Seafood segment. This is mainly due to the greater availability of existing technology and the lower requirements that may be involved in the adaptation of these technologies when imported from abroad.

However, product-specific robotics applications and flexible automation and robotics solutions are generally under-developed and represent important areas of future development.

Solutions for end-of-line applications already exist for the most part and only require adaptation to meet firm specific requirements.

End-of-line applications do not always need to be automated. For instance, just in time operations would not derive as much value from fully automating the storage and retrieval of inventory as operations that constantly hold important inventory (e.g. Dry Food segment).

Moreover, certain raw food/processing applications are generally not automated because there would be little value in doing so. An example would be the handling/addition of minor and micro ingredients.

## International Benchmarking

### Meat, Fish and Seafood

A general evaluation of the global Meat Processing sector suggests that it is lagging behind other Food and Beverage Processing sub-sectors in its level of adoption of automation and robotics. However, there have been substantial improvements, research and development over the past few years, and Europeans and Americans are leading the trend for change. Interviews suggested that Canadian Meat Processing operations are lagging behind European (e.g. Germany) and American counterparts, particularly in the raw food/processing and packaging applications.

Meat processors in Europe and the US have developed and use several technologies that are only partially adopted by their Canadian counterparts.

The Fish and Seafood Processing sub-sector is also considered to be lagging behind the other sub-sectors globally. However, interviews suggested that countries like Japan, Iceland, Norway and Denmark have adopted automation and robotics to remain competitive against the highly labor intensive model adopted by China and other Asian countries. However, greater similarities are observed between US and Canadian fish processors in terms of automation of their various applications.

Internationally, there is still room for improvement. Some species (e.g. crab and shellfish) and some applications remain labour-intensive, particularly in terms of raw food/processing and packaging applications.

**Prepared Meals, Bread, Fruits and Other**

Interviews indicated that Canadian Food processing operations in this segment are similar or lagging behind their European and American counterparts. The level of automation and robotics for raw food/processing, packaging food and end-of-line applications tend to be higher for European countries like France and Norway. The segment shows similarities with the US, with greater lags observed in the packaging and end-of-line applications.

However, Canadian food processors in this segment are not all lagging behind their international counterparts, with some processors using leading-edge technology across all types of applications and beyond (e.g. harvesting).

Generally, frozen products (including frozen meals, fruits, vegetables, bread and bakeries) tend to display more automation and robotics than their fresh equivalents. There are exceptions to this statement. Notably, specialty meals are typically produced in lower scale than other types of food in North America. As such, the raw food/processing applications of these productions are usually less automated than in Japan, Taiwan and China, where most of their raw food/processing application technology is developed.

**Dry Food, Other Packaged Food and Ingredients and Beverages**

Canadian Dry Food, Other Packaged Food and Ingredients and Beverages processors are similar or lagging behind their European and US counterparts, but generally more automated than operations in emerging countries. Scale of operations and labour cost and availability account for some of these differences.

## Understanding the Gap

A number of factors were identified as key drivers or barriers of automation and robotic for the Food and Beverage Processing sector in Canada, accounting for some of the differences across sub-sectors and countries. Key drivers included: cost savings, productivity, efficiency, product quality and safety, labour cost and availability, scale and culture. Key barriers included: automation and robotics cost and return on investment (ROI), skilled labour availability, capacity and infrastructure, volume, culture, availability of solutions and seasonality, amongst others. The impact of these differentiating factors are highlighted below.

### Cost Savings, Productivity, Efficiency, Quality and Safety

Production-related factors (e.g. cost saving, productivity and efficiency) were generally considered top drivers of automation and robotics for Canadian and non-Canadian processing operations.

Cost savings and product safety and quality (consumers) were considered close drivers in terms of importance, with the common objective being to produce safe products of quality at a competitive price. In segments where product differentiation is important, innovation and consumer preferences were also considered key drivers.

### Manual Labour Cost and Availability

Generally, labour cost saving was an important driver. The decreasing availability of manual labour and the changing and aging demography of available labour was also recognized as a key factor influencing the adoption of automation and robotics. Firms also valued the importance of improving working conditions and providing a sound work environment to employees.

Whereas the availability of manual labour is affecting the entire Food and Beverage Processing sector, the harsh work environment provided by the Meat, Fish and Seafood segment exacerbates this issue as these sub-sectors are facing challenges attracting labour. Attracting and keeping labour requires an adjustment at the operational level to reduce the use of manual force for heavy lifting and other difficult tasks.

Manual labour was an important source of differentiation between Canadian and European countries. Some European countries (e.g. France) have had to face the issues regarding cost and availability of labour before it became an issue in Canada. Moreover, some of these countries also face strict labour legislation that acted as a driver of automation and robotics.

The US are also increasingly facing the issues related to labour cost and availability.

For emerging countries, labour tends to be readily available at a lower cost than in Canada, the United States and Europe. This driver was thus attributed less importance than in developed economies. Yet, labour availability issues were mentioned in some of these regions, as was the rising cost of labour.

### Automation and Robotics Cost and ROI

Cost of automation and robotics (e.g. initial cost, cost of training, maintenance, etc.) and the ROI were generally considered top barriers of automation and robotics for Canadian and non-Canadian processing operations.

### Skilled Labour

The difficulty to find skilled labour to operate and maintain the equipment purchased abroad and integrated by foreign engineers is another challenge faced by the sector. As Canadian Food and Beverage processing firms are looking to increasingly adopt automation and robotics, the shortage of skilled labour creates a barrier for which there are limited immediate solutions.

While governmental incentives are in place to assist in training labour for the required skills, the limited supply of skilled labour for the whole sector translates into another challenge in the retention of employees, rising further the cost of automation and robotics.

**Capacity and Infrastructure**

Canada also differs from other countries in its capacity to automate and adopt robotics. This capacity relies on the availability of skilled labour who can operate the automation and robotics, of engineers trained to the demands of the sector and of infrastructures that promote, develop and integrate automation and robotics in the Food and Beverage Processing sector.

The US and Europe's capacity to adopt automation and robotics in the Food and Beverage Processing sector is greater than in Canada. The infrastructure needed to support automation and robotics in the sector has been in place for a while in Europe and more recently in the United States. Most machine and equipment providers (including automation and robotics) are located in Europe and major investments have been made by both the private and public sector to support advancement in this field. Communication and collaboration between the private and public sector and between Food and Beverage processing firms, machine builders and academia are also part of the infrastructure that has enabled those countries' current level of automation and robotics in the sector. Universities have sector-specific engineering programs providing skilled labour to develop, integrate and maintain these technologies.

With the potential exception of Japan, Canada is likely to be at par or above the other countries of scope in terms of capacity. Although Canada is not a large producer of automation technology and robotics, it has several of the other elements needed for the creation of a solid infrastructure that would promote automation and robotics in the Food and Beverage

Processing sector. The capabilities are present and the climate is favourable to enterprises looking to become or remain competitive in their sub-sector.

**Volume**

Standardization of production allows for greater volume of production and greater use of automation and robotics. Volume has thus been a differentiating factor of automation and robotics across the various Food and Beverage Processing sub-sectors. Notably, firms operating in the Dry Food segment and in the Non-Alcoholic Beverages sub-sector tend to be more automated in their raw food/processing and packaging applications than sub-sectors that involve or require greater variability in these applications.

Volume is also a source of differentiation with other countries. The market serviced by American Food and Beverage processing firms is much larger than in Canada. As such, the volume of production tends to be greater for American companies than their Canadian counterparts. Given that scale plays an important role in the viability of investments in automation and robotics, the larger scale of American Food and Beverage processing firms is a factor that distinguishes American firms from Canadian ones. The gap tends to be present even for most automated sub-sectors like confectionery and soft drinks. Subsidiaries of large international companies compete internally for capital investment. The hurdle rate that must be achieved is more easily attainable when operating entities have the volume that justifies the investments.

Population in European countries is more dense than in Canada and each country is in relatively close proximity to one another. The distance that must be traveled to reach the target market is significantly different than in Canada and as such, Food and Beverage processing operations in European countries tend to produce a larger volume than their Canadian counterparts.

For other countries, volume of production varies significantly and remains an important source of differentiation, although the relationship between scale of operation and level of automation and robotics is not always observed in emerging countries.

**Culture**

The culture of companies (i.e. management) and of countries can play a differentiating role in the level of adoption of automation and robotics in the sector. Notably, interviewed processors indicated that some Canadian operations are clearly using leading-edge technology while others are lagging.

Differences between Canada and the US also stem from corporate culture and management's level of risk aversion. Interviews pointed towards American companies being more inclined to adopt technology that is riskier/less proven, whereas Canadian enterprises would be inclined to keep the technology currently used given that it is functional, sufficiently efficient and productive. In this sense, the observed lag between Canada and the US, with regards to the adoption of automation and robotics as well as the associated R&D, can be attributed to some extent to their differences in corporate culture.

Manufacturing culture is a key differentiating factor for the Canadian Food and Beverage Processing sector compared to some European countries. Whereas Canada has several viable economic sectors that contribute to the health of the country (including natural resources), these European countries have had to rely on manufacturing (food and beverage) to a much greater extent. In order to ensure the competitiveness of this sector, the public and private participants of these European countries have encouraged a culture towards innovation, automation and robotics, becoming specialized in Food and Beverage Processing.

Considering countries that were part of the old USSR, operations that are moving to these countries are typically Greenfield projects, such that a mix of leading-edge and very old operations might be observed.

**Availability of Automation and Robotics Solutions**

A source of differentiation for the Meat, Fish and Seafood segment is the limited availability of proven technology for the sub-sectors. Automation and robotics developers have only recently begun to create technology and adapt existing solutions to meet the requirements of firms in these sub-sectors. The harsh environment (low temperature, thorough and daily wash downs of equipment) inherent to these sub-sectors, as well as the food and safety standards explain the observed lag in the adaptation of technology compared with other sub-sectors.

Moreover, the transfer of technology from another country can prove itself to be difficult and challenging, especially for primary meat processing and fish and seafood processing operations.

There is no guaranty that the technology can be properly implemented and adjustments are often required which add on to the costs of adopting these technologies. Although adjustments are generally needed with automation and robotics, the variability of inputs, the varying food health and safety requirements (by country) and the relatively young market for automation and robotics in this segment add another layer of difficulty to an already existing barrier.

**Addressing Variability**

Beef and pork add another challenge for the Meat Products sub-sector. The slaughtering and primary processing of these animals tend to be more difficult to automate due to the weight and variations in the size of animals within a given species.

This variability in the size of livestock was mentioned as a barrier to the transfer of existing technology. In some instances, the solution created in another country could not adjust to the variability in the size of livestock in Canada.

Such variability in size also exists within any species of fish. While the sorting according to size is sometimes done mechanically, the preparation of the fish prior to processing remains highly manual partly due to that variability in the anatomy of each fish.

**Custom versus Standard Solutions**

Overall, there is a need for more customized solutions (as opposed to standardized ones) within Canada to address the needs of the market. Given that Canadian Food and Beverage processors are mostly characterized by variable and shorter production runs, there is a need for increased flexibility with minimum change over time.

**Legacy versus Greenfield Plants**

The Canadian Food and Beverage Processing sector also faces important challenges related to its older legacy plants. Existing infrastructures/legacy plants often lack the space and flow/configuration required by more recent automation and robotic technologies. Thus, the adoption of automation and robotics by Canadian Food and Beverage Processing generally occurs incrementally, unless new plants are built. In this case, plants are generally designed to implement available technologies. This difference in infrastructure of the various plants can explain observed gaps in automation and robotics within sub-sectors and between Canada and other countries.

**Food Safety and Quality**

Food safety has different implications across the various Food and Beverage processing sub-sectors. The concerns are generally the greatest for meat, fish, seafood and other fresh

produce like fresh fruits and vegetables that are prepared and packaged for direct consumption.

The importance of quality is also much more important for fresh fruits and vegetables than for canned products because the shelf life is much shorter for these products and due to consumers expectations (bruised fruits will not be purchased by consumers, and this loss is absorbed by processors, not consumers or distributors). The high quality and safety requirements for fresh produce has been a driver of automation and robotics for this sub-sector. Firms have increasingly adopted technology that helps reduce the time between harvesting and consumption/purchase, increase productivity, reduce direct contact between employees and food products and overall improve the quality of the products.

Food safety and quality is also a differentiating factor between Canada and emerging countries. As consumers increasingly demand safe products of quality and as governments increasingly regulate the sector, the gap in automation and robotics amongst Food and Beverage processing firms is likely to decrease between Canada and these developing countries.

**Seasonality**

Seasonality is another challenge faced by Fish and Seafood processors. The cost of automation and robotics is more difficult to justify as the technology adopted is rather specific to the species processed. Wild fish/seafood processing is seasonal and so is their processing. Any return on investment will be affected by this seasonality and is thus an important challenge faced by firms looking to automate their operations.

Seasonality brings about another concern and challenge for the Fish and Seafood sub-sector. By providing a protective environment for seasonal employment, legislation is creating another barrier to the adoption of automation and robotics.

Seasonality also poses an issue for fresh Fruits and Vegetables processors. Since fruits and vegetables production is seasonal in Canada and that the window of time from harvesting to the grocers market is narrow for fresh produce, there is a temporary peak in production that must be addressed with either increased labour or automation. While temporary labour can address the temporary needs associated with seasonality, this option is becoming less attractive as the working population continues to change. On the other hand, increasing automation can also mean that for most of the year, processing plants are working under optimal capacity, with only these short periods where they operate at full capacity. This challenge is common to all processors of seasonal food and beverages, including confectionery.

### Profit Margins

The size of the margins for any given sub-sector can also be a differentiating point in automation and robotics, driving increased adoption of technologies that allow for small improvements of margins. Fresh fruits and vegetables are one example. However, the maturity of the sub-sector also plays a role in determining whether investments in automation and robotics can be done to improve slim margins.

### Availability of Technology – Applications

The availability of automation and robotic technologies for the Food and Beverage Processing sector varies across the various types of processing applications. Notably, the packaging applications tend to have a variety of automation or robotic options available. Labeling, secondary packaging and palletizing are less specific to the sub-sectors and as such can be applied to wider range of operations. However, these solutions tend to be standardized, large-scale options that are mostly adopted by larger operations, which can partly explain why these are not consistently adopted amongst Canadian Food and Beverage

processing firms. Additionally, primary packaging and most of the raw food/processing applications tend to be sub-sector specific, if not product specific. This is one of the reasons why automation and robotics has lagged in the Food and Beverage Processing sector (especially Food) compared with other industries. While the Food Processing sector is considered an area of current and future growth for the adoption and development of automation and robotics, it is still lagging behind the automotive industry.

### Sub-Sectors/Applications

The sub-sector of activity affects the differences between Canada and non-European and non-US countries. For instance, soft drinks and water processing is typically similar in automation and robotics across countries, with a small downward bias for economies where low-cost manual labour is readily available. However, these economies are gradually upgrading their operations, reducing the gap in automation and robotics with developed countries. Overall, bulk processing operations (e.g. rice) are more likely to be fully automated in the raw food/processing applications, whereas the level of automation in packaging applications varies to a greater extent.

### Distributor/Wholesalers

The high concentration of food distributors in Canada also plays a role in the adoption of automation and robotics by Food and Beverage processing firms. Price competitiveness is increasingly important and automation and robotics can sometimes help Food and Beverage processors achieve the lowest price for a given quality of products. Contracts are drafted over increasingly shorter periods, adding an additional source of pressure on prices. The requirements from distributors are also service-based, with data on product specificities and quality available to distributors in real-time. In this sense, the demands from distributors are also acting as a driver of automation and robotics.

# Understanding the Gap

**Adjustments and Re-Engineering**

An important challenge (for the Food and Beverage Processing sector) that results from some of the aforementioned barriers and other challenges is the need for adjustments and re-engineering in most automation and robotic technologies transfer. Because there is no such thing as "off-the-shelf" solutions except (maybe) for some software, the adoption of automation and robotics in the sector is more expensive, difficult and less certain than in other manufacturing sectors.

The little capacity and infrastructure available in Canada for technology adjustments and re-engineering further aggravates this issue, contributing to the observed lag between Canada, European countries and the US.

### Solution Pathways

In order to achieve the required level of technological development, but mostly, the required level of technological adoption to move the Canadian Food and Beverage Processing sector to a globally competitive position, a number of strategies, partnerships and other solution pathways should be considered.

Whereas government and regulations can act as enablers and facilitators for many of these solution pathways, the desired outcome is only achievable with the participation of all parties involved.

### Solution #1 – Targeting the Applications to Automate

Although not all processes/applications may be targeted at once to improve the overall technology readiness of Food and Beverage processing operations in Canada, sound corporate strategies can include a structure of investment in automation and robotics that identifies those areas that would benefit most from increased automation and robotics. Whereas some applications would be best adapted from existing technologies developed abroad, others may require research and innovation for the development of "Canadian-made" solutions. Immediate needs may easily be identified. However, a clear understanding of the development, innovation and adjustments that may be required for the various applications is key to the identification of the appropriate targeting strategy of a firm/plant.

### Solution #2 – Building Collaboration Between Industry, Academia and Government

The current infrastructure surrounding automation and robotics in the Food and Beverage Processing sector in Canada is currently composed of a few Universities and other knowledge institutes, integrators, testing centres and very little in terms of equipment builders. Importantly to note, these parties tend to act independently of each other, with isolated events of partnership.

As mentioned in the Gap Analysis section of this report, one of the key differentiating factors for countries that have successfully adopted automation and robotics as part of their global strategy for the Food and Beverage Processing sector has been access to information and support. Thus, in order to build a sound infrastructure that encourages automation and robotics in the Food and Beverage Processing sector, more of these players composing the current infrastructure are needed, as well as greater communication, and information and expertise sharing between industry, as well as academia and government.

Public-private partnerships are essential to drive R&D and innovation. Although there are currently several partnerships between Canadian Food and Beverage processing firms and knowledge institutes, universities and technology centers, there are several opportunities for improvement, including the need for a facilitator that could educate with regards to the various institutions/enterprises that exist, the type of work that can be performed and the milestones to achieve it. Although the incentives for private companies to participate in these partnerships are not always clear (with some companies that prefer to keep their R&D confidential), their participation is needed in order to build a Canadian capacity for automation and robotics in the Food and Beverage Processing sector. Moreover, given that most technology is developed and built outside of Canada, consideration should also be given to partnerships with non-Canadian equipment providers.

Further, the creation of a skilled labour work force that can service the Food and Beverage Processing sector in their expansion towards greater automation and robotics is essential. One of the key barriers to automation and robotics across all sub-sectors remains the availability of labour that can operate and perform the maintenance of the technology. The following considerations were identified in order to address this shortage by working collaboratively:

# Solution Pathways

**Building Collaboration Between Industry, Academia and Government (cont'd)**

- ensuring awareness of existing labour training initiatives among processors and providing adequate firm-specific support in identifying the right programs;

- providing sector-specific programs for the training and retention of skilled labour, including the development of post-secondary education programs for machine/automation operators, engineering as well as internships focused on the Food and Beverage Processing Sector; and

- raising awareness of the importance and attributes of the sector among the labour force.

**Solution #3 – Attract Foreign Investment**

To enhance private investment in R&D and innovation by international firms, it is important to ensure Canada's competitiveness as a suitable investment location for enterprises that are active internationally. A number of large multi-national firms are choosing European counties such as Germany and the Netherlands (to name a couple) as their home of production and innovation due to the attractive tax structures and proximity to R&D and automation and robotics developers amongst other reasons. Although Canada may not have the current capacity to develop automation and robotic technologies to the level observed in these regions, it can be an attractive location for other reasons.

# Introduction

# Introduction and Objectives

## Introduction

The Food and Beverage Processing sector plays a prominent role in the global economy. It is the largest manufacturing sector in several countries and is a vital component in most national economies.

Yet, Food and Beverage manufacturing operations are still highly manual in nature, especially for small and medium enterprises (SMEs). The sector is lagging behind other manufacturing sectors in its level of adoption of automation and robotics. The use of automation and robotics has long transformed manufacturing in nearly every industrial sector, increasing efficiency and enforcing consistency to provide a vast range of affordable and reliable products[1]. Food processors have only recently joined the trend for various reasons that include the inherent variability of inputs and products that makes difficult the automation of processes as well as the incompatibility of robots with food hygiene and safety.

A number of drivers have prompted the gradual uptake of automation within the sector. Various sources[2,3,4,5,6] highlight the decreasing availability of suitable low-cost labour, existing and eminent legislations on employees' health and safety directives and line security, the increasing demand for assuring hygiene and consistency of products quality, the increase in some commodity costs, the need for reducing environmental externalities, as well as requirements for product traceability and other commercial advantages.

Drivers for change often arise from the market itself, while legislative and demographic factors still play an important role. With an increasingly global market for food and beverage processed products and a growing number of free trade agreements between various countries, the use of automation and robotics has become imperative to the competitiveness of firms operating in the Food and Beverage Processing sector.

## Objectives of the Study

KPMG was mandated by Industry Canada to undertake a **Technology Readiness Assessment of Automation and Robotics for the Food and Beverage Processing Sector in Canada**. The study had for main objective to determine:

- the current level of use of automation and robotics in selected sub-sectors of the Canadian Food and Beverage Processing sector;

- whether the selected Canadian Food and Beverage Processing sub-sectors are leading or lagging behind their global counterparts in the adoption of automation and robotics (international benchmarking) and the implications of this situation for the sub-sectors' ability to compete and gain competitive advantages in the global market place;

- the applications for which the selected Food and Beverage Processing sub-sectors would benefit from a greater adoption of automation and robotics in Canada and the level of development of existing technologies for the targeted applications; and

- the potential areas of future technology development of automation and the next steps for the future development of robotics for applications in Food and Beverage processors that could put the industry at the leading-edge of automation and create competitive advantages for Canadian firms.

# Methodology and Scope of the Study

## Methodology

In order to address the objectives previously outlined, KPMG used the following approach, based on four main phases:

### Table 3

| Phase I - National Assessment | Perform an assessment of the current level of use of automation and robotics amongst Canadian Food and Beverage processing firms |
|---|---|
| Phase II - International Assessment | Perform an assessment of the current level of use of automation and robotics for the selected countries and perform a comparative analysis with their Canadian counterparts |
| Phase III - Technology Assessment | With the help of experts, perform a technology readiness assessment of automation and robotics for the selected Canadian Food and Beverage processing sub-sectors |
| Phase IV - Validation | Validate the findings by way of focus groups gathering industry representatives |

## Phase I – National Assessment

In collaboration with Industry Canada and Agriculture and Agri-Food Canada, Food and Beverage processing sub-sectors were identified to ensure approximately 80 percent of the entire sector's gross domestic product (GDP) contribution was represented.

The sample was selected to reflect the importance of these sub-sectors, as well as the geographical distribution of the sector in Canada, which is mostly concentrated in Quebec and Ontario.

Other factors that determined the scope of this study included economic and strategic considerations.

An interview guide was developed using research findings to address the inquiries pertaining to the level of adoption of automation and robotics by Canadian Food and Beverage processors.

The objectives of the interview guide were to:

- assess the level of adoption of automation and robotics by Canadian firms;
- identify the types of applications for which Canadian Food and Beverage processors in the selected sub-sectors are currently using automation and robotics;
- determine the factors explaining the current level of adoption of automation and robotics, including drivers and barriers;
- identify gaps in the availability of automation and robotics for the selected sub-sectors in Canada;
- identify applications for which firms would benefit from a greater use of automation and robotics.

Canadian firms representing the selected sub-sectors were identified. Short phone interviews (of approximately 30 minutes) were conducted with these firms to gather qualitative information about their:

- operations;
- level and importance of adoption of automation and robotics;
- relevant technology and areas of research and development;
- drivers and barriers to the adoption of automation and robotics.

These firms represented only a sample of the sector, and not an exhaustive list. Moreover, the original list took into consideration geographical and sub-sectors representation. However, interviews were on a voluntary basis. The sample contains a total of **106** Canadian Food and Beverage processing operations across Canada.

Additional interviews (**7**) were conducted with sector-specific associations and other market participants such as machine and equipment/solution providers.

### Phase II – International Assessment

The objectives of the international assessment were to:

- compare the level of adoption of automation and robotics in the selected Canadian Food and Beverage Processing sub-sectors with other countries;

- identify the automation and robotic technologies used in the selected Food and Beverage Processing sub-sectors in other countries and compare the advancement of these technologies used in Canada;

- identify the factors driving the adoption of automation and robotics in the selected Food and Beverage processing sub-sectors in other countries and highlight how the use of these technologies helps firms to gain competitive advantages in their markets;

- identify "best practices" in the adoption of automation and robotics in the Food and Beverage Processing sector in other countries; and

- determine, based on information gathered during this fact-finding process and the interviews conducted with Canadian companies, whether Canadian firms in the selected sub-sectors are leading or lagging behind firms in other counties and discuss the implications of this situation for Canadian firms' ability to compete in the global market.

In order to benchmark the adoption of automation and robotics by Canadian Food and Beverage processing firms in the identified sub-sectors, a number of countries for which the Food and Beverage sector has adopted automation and robotics as part of their business models were identified with the collaboration of Industry Canada and Agriculture and Agri-Food Canada.

Additional criteria for the selection of countries of interest for this study included their commercial interaction with Canada, the importance of the Food and Beverage Processing sector for the country and the country's contribution to global geographical representation. The countries and regions included in the scope of this study included:

- United States
- Germany
- Italy
- France
- Netherlands
- Iceland
- Japan
- China
- Australia
- Emerging countries

Relevant information about the countries of interest is presented in **Appendix II**.

Based on reviewed literature and on the aforementioned objectives, interview guides were developed for the following types of participants.

**Food and Beverage Processing Firms:** The interview guide for firms with non-Canadian operations was derived from the one used for Canadian Food and Beverage processing operations. It allowed for a comparison of the level of automation and robotics, the identification of drivers and barriers to such adoption, as well as the identification of technologies used.

# Methodology and Scope of Study

**Automation and Robotics Suppliers for this Sector:** The interview guide for automation and robotics suppliers aimed at addressing the drivers and barriers to the adoption of automation and robotics by Food and Beverage processing firms, identifying the technology used by firms in this sector and any gap in the development and use of these technologies between Canadian and international firms.

**International Automation and Robotics Associations:** The interview guide for international automation and robotics associations aimed at identifying any gap in the use of automation and robotics amongst Canada and other selected countries, identifying relevant trends in the Food and Beverage Processing sector, and addressing the drivers and barriers to automation and robotics that firms in this sector must face.

A total of **15** interviews were conducted with non-Canadian Food and Beverage processing operations, which were complemented by interviews with **6** international associations and machine, equipment and solution providers who provided a qualitative assessment of automation and robotics in the sector. Additional relevant information for the assessment was gathered from interviews with Canadian associations, solution providers and Food and Beverage processing firms.

## Phase III – Technology Readiness Assessment

The objectives of the technology readiness assessment were to:

- assess the level of technological readiness of existing automation and robotic technologies for the applications previously identified;

- identify potential areas for the development of technologies in automation and next steps for the development of robotics for the Food and Beverage processing applications previously identified, and those that could put the industry at the leading-edge of automation; and

- discuss potential areas of research and development (R&D) and innovation pathways that could be explored to develop leading-edge automation and robotics solutions for the Canadian Food and Beverage Processing sector. This includes discussing the risks involved in R&D in these areas, as well as strategies and potential partnerships to achieve the required level of technological development.

In order to address the objectives above, individual phone interviews were conducted with subject matter experts, based on a developed interview guide.

Participating members were identified in collaboration with Industry Canada, based on their relevant expertise. A total of **13** interviews were conducted with Canadian and International associations and machine, equipment and solution providers.

## Phase IV – Validation

Two focus groups were held with industry representatives (associations, firms and government) to validate preliminary findings from the previous phases of this project. A presentation highlighting these findings was used to conduct the focus group.

## Sub-Sectors

The following sub-sectors were included in the scope of this study:

- Meat Products
- Fish and Seafood
- Dairy (excl. ice cream and fluid milk)
- Fruits and Vegetables
- Flour Milling
- Breakfast Cereals
- Confectionery Products
- Sugar and Sugar Products
- Cookies and Crackers

- Snack Food
- Prepared Meals
- Pasta
- Coffee and Tea
- Bread and Bakery
- Soft Drinks
- Alcoholic Beverages
- Starch and Vegetable Fat and Oilseed Processing

# Methodology and Scope of Study

Relevant information about the selected sub-sectors of interest is presented in Appendix I.

This list was not restrictive and other sub-sectors were included. Participation was on a voluntary basis.

# Limitations and Disclaimer

## Limitations

The reader should consider the following limitations inherent to the methodology used for this study.

**Sample Size:** The total sample size for the national (Phase I) and international (Phase II) assessments of this study is such that not all sub-sectors of the Food and Beverage Processing sector are equally represented. Moreover, sub-sectors were identified to cover approximately 80% of the sector's total contribution to Canadian GDP.

**Geographical Representation:** Interviews provided qualitative information on Canadian operations across the various provinces. The original list of firms to be contacted accounted for geographical distribution and the respective importance of the sector in each province/region. However, interviews were on a voluntary basis and the final sample does not necessarily reflect fair regional distribution. Similarly, for international interviews, the sample of interviews conducted and the qualitative information gathered were not uniformly distributed across all sub-sectors and countries.

Please refer to **Appendix IV** and **V** for sample distributions by size and geographical areas.

## Disclaimer

The literature review and document analysis were derived from government industry information (websites and other publications), think-tanks, automation and robotics associations, academia, case studies (available from technology integrators and machine builders), KPMG and peer industry reports and other publications. For this reason, the reader will understand that although KPMG performed a thorough literature review, covering a broad range of information sources, it may be subject to omissions. In addition, observations were based on research and phone interviews from participating Canadian and non-Canadian Food and Beverage processing firms, machine equipment and solution providers as well as international automation and robotics associations. These companies were selected to reflect, at best, the sub-sectors selected.

Moreover, interviews aimed to provide qualitative evidence of the technology readiness of the Food and Beverage Processing sector in Canada. As such, the reader will understand that the current report is qualitative in nature, rather than quantitative.

The reader will note that the mandate given to KPMG did not give room to provide an exhaustive study of all Canadian and international players within the Food and Beverage Processing sector. Consequently, the conclusions for this study are from a non-random sample, which can potentially involve a risk of inaccurately representing the sector. The companies and associations have all voluntarily and freely participated in this study.

The reader should also note that the information contained therein was gathered through a literature review as well as phone interviews. Therefore, the information contained in this report does not reflect the views of KPMG, but reflects the information gathered throughout the process.

# Context

**Food and Beverage Processing Sector**

**Canada – Importance of Sector**

The Food and Beverage Processing sector plays a prominent role in the Canadian and global economy, contributing to the gross domestic product (GDP) and employment of several countries (**Appendix II**).

The Food and Beverage Processing sector is the largest manufacturing sector in Canada in terms of GDP contribution and employment. It contributes 1.7% to gross value added (2012)[7] – including tobacco - and provides employment to 249,104[a] Canadians (16.7% of total manufacturing employment, including employees and self-employed). This sector is crucial to the economic activity of all provinces, though the degree of importance varies according to the sub-sectors of activity and the province of interest. Ontario and Quebec together account for approximately 57.5% of the processed food and beverage sales[8], whereas Western provinces account for 29% and Atlantic Provinces for about 7%[9,10].

**Canada – Key Trading Partners**

Canada's Agriculture and Food and Beverage processors rely on export markets[11,12]. In 2012 exports of processed food and beverages accounted for 25% ($24.1 billion) of production value[13].

The Canadian market is significantly exposed to the United States, with two thirds (67%) of Food and Beverage processing exports[14,15] going to the US market (2012). The US is also the primary source of processed food imports (60%) in Canada (2012)[16]. Key drivers to this trade significance include the geographic proximity as well as the North American Free Trade Agreement (NAFTA), which contributes to the close integration of the Canadian and US economies[17].

China has been rising in importance for the Canadian Food and Beverage Processing sector, representing the second largest export market (9%) for Canadian processed food and beverages (2012) and the third largest source of imports (3%)[18].

Food safety is an important and growing concern for Chinese consumers. As such, China represents a significant market opportunity for Canadian Food and Beverage processors given the strict quality standards they must comply with and their overall reputation of "high quality" for their food products[19].

Other important export destinations include Japan (6%) and the European Union (3%). Whereas Japan has historically been one of Canada's top three export markets, imports from this region represented less than 1% of total processed food and beverage imports to Canada in 2012[20].

As for the European Union (EU), it remains the world's largest exporter and importer of processed food and beverages[21,22]. Historically, the EU has been the second largest source of imports to Canada and one of the country's top five export markets[22,24]. However, when the Comprehensive Economic and Trade Agreement (CETA) is ratified and takes effect, bi-lateral trade in processed food between Canada and the EU is likely to increase. It could then create important growth opportunities and challenges for Canadian Food and Beverage processing firms.

**Importance of Sector to Trading Partners**

The Food and Beverage Processing sector also plays an important economic role for some of these trade partners.

For instance, the sector contributes just over 1.0% to the US gross value added (2012) and accounts for 14% of all US manufacturing employment (or 1.5 million)[25].

Moreover, Food and Beverages is the European Union's largest manufacturing sector in terms of turnover, value added and employment[26]. The sector contributes 1.9% to EU gross value added (2010), or 12.9% of the manufacturing share of added

- **The global Food and Beverage Processing sector underwent significant changes and growth over the last few years**

- **Automation and robotics has gradually been adapted to the sector's specificity**

- **To remain competitive in an increasingly global market for Food and Beverage Processed products, firms are likely to consider new avenues to manage input cost, productivity, efficiency and changing demand, including automation and robotics**

value. Food and Beverages is also the EU's largest manufacturing sector in terms of direct employment, contributing to a share of 15% (or 4.2 million) of manufacturing jobs.

**Global Trends**

Over the last few years, the global Food and Beverage Processing sector underwent significant changes and growth. Notably, a number of global players consolidated[27], affecting the productivity requirements for competitiveness and the footprint distribution. This consolidation is expected to continue and scale of operations is expected to gain importance.

Moreover, the middle class in emerging countries represents a growing and viable market for Food and Beverage processing firms globally[28].

Another important trend has been the gradual adoption of automation and robotics to the sector's specificities, addressing productivity, diversity and food health and safety requirements[29]. Yet, Food and Beverage processing operations remain highly manual, especially for small and medium enterprises (SMEs). Food processors have only recently joined the trend. Reasons for this lag include the variability inherent to the nature of the products[30] that can make difficult the automation of processes. The incompatibility of robots with food hygiene and food safety was also an important reason for the slower adoption of these technologies by several Food and Beverage Processing sub-sectors[31].

However, a number of drivers have prompted the gradual uptake of automation within the sector. Various sources highlight the decreasing availability of suitable low-cost labour, existing and eminent legislations on employees' health and safety directives and line security, the increasing demand for hygiene and consistency of product quality, the increase in some commodity costs, the need for reducing environmental externalities, as well as requirements for product traceability and other commercial

advantages. In order to remain competitive in an increasingly global market for Food and Beverage Processed products, firms are likely to consider new avenues to manage input cost, productivity, efficiency and the changing characteristics of demand. Automation and robotics can help address some of the challenges faced by Food and Beverage processing firms.

The following table highlights some of the key trends that are expected to govern the sector globally over the next few years[32]:

**Table 4**

| | |
|---|---|
| **Plant Efficiency** | Achieving plant efficiency through environmental actions, new technologies, further consolidation and plant optimization |
| **Product Differentiation** | Offering product differentiation to address changing demand (health conscious, exotic and functional products and formats) |
| **Food Safety and Quality** | Growing importance of food safety and quality standards as a result of the changing worldwide demand (ageing and health conscious population), the growing middle class of developing countries, and the scarcity of food resources which are protected by higher standards |
| **Long-Term Growth** | Developing markets to offer long-term growth opportunity for Food and Beverage Processing sector |
| **Sustainability** | Growing sustainability of the Food and Beverage processing operations (waste reduction, efficient use of resources, social responsibility, green strategies) |
| **Scale** | Scale of operations to gain importance (in order to remain competitive) as consolidation and acquisition continue |

## Global trends in automation and robotics include:

- ❑ **Relocating plants closer to demand and increasing the use of automation and robotics**

- ❑ **Decreasing (real) cost of robot and increasing cost of labour are expected to drive the adoption of automation and robotics**

- ❑ **Growing need to increase production efficiency, product quality and consistency, flexibility of manufacturing**

### Automation and Robotics

The use of automation and robotics has essentially transformed manufacturing in almost every industrial application. The increased efficiency and product consistency from automation has resulted in a vast array of affordable and reliable products, addressing stringent market demands[33,34]. Over the next few years, the trend towards the increasing level of automation and robotics is expected to continue, as demand grows to meet needs from more sectors and additional geographical regions[35].

New York based technology research firm ABI Research[36] anticipates that the global market for industrial robotics will increase from US$5.2 billion in 2010 to US$8.8 billion in 2015.

Some of the global trends in automation and robotics for the manufacturing industry are highlighted below.

### Relocating Closer to Demand and Increasing Automation

A growing trend amongst manufacturers from developed countries is the relocation of their plants in close proximity to demand and innovation[37]. An inevitable outcome of such relocation would be increased automation and robotics, especially for countries with high labour costs that cannot compete with the labour-intensive model of China and other emerging economies.

### Cost of Robots versus Cost of Labour

The real price of robots has significantly decreased over the past decade and this trend is expected to continue as new labour-cost saving technologies are developed[38]. The assembly and production of robots in China are also expected to increase, which should put downward pressure on the real price of robots[39]. Moreover, cost of labour has been increasing both in minimal wages and benefits amongst OECD countries[40] as well as in emerging economies (including China)[41]. Combining these trends in robots prices with labour costs, firms are expected to increasingly adopt automation technology and robotics.

### Incentives for Automation and Robotics

The manufacturing industry is a very competitive market and thus the pressures to shift towards increased automation and robotics are growing[42]. The following are just a few of the numerous incentives to automate and use robotics:

- ✓ increasing production output rates;
- ✓ improving quality and consistency;
- ✓ increasing flexibility in product manufacturing;
- ✓ improving quality of working conditions;
- ✓ reducing material waste and increasing yield;
- ✓ saving space;
- ✓ reducing costs;
- ✓ creating jobs.

However, there are still challenges that must be addressed with regard to robotics. These include increasing the ability of existing technologies to adapt to changing demand (increased variability) while facilitating the use/transfer of these technologies (minimal engineering requirements), improving vision systems and sensors, and increasing the integration of robots to achieve a single point of operation[43].

### Automation and Robotics in Food and Beverages

The global market for automation and robotics in the Food and Beverage Processing sector is forecasted to continue growing over the years. While some countries have been adopting and developing technology for that sector for a number of years, some sub-sectors have only recently been added to the pool of candidates for automation and robotics[44]. Food health and safety concerns were one of the main reasons for the observed lag. However, there was also an important lack of applications to many of the Food and Beverage manufacturing processes.

- **Europe uses the most robots in the Food and Beverage Processing sector**
- **The trend is growing globally, with key drivers including:**
- **Cost and availability of labour**
- **Diversity of products**
- **Safety and hygiene**
- **High quality and convenient food**
- **Emerging middle class**

**Automation and Robotics in Food and Beverages (cont'd)**

Discrepancies in automation and robotics for the Food and Beverage Processing sub-sectors are also observed geographically and amongst firms of any given sub-sector.

According to the International Federation of Robotics (IFR), Europe is the region that uses the most robots (20,001 units in 2012) in the Food and Beverage Processing sector[45]. However, the trend is growing and not only within Europe.

In terms of 2012 sales, the following countries have installed the greatest number of robots for Food and Beverage processing applications[46]: United States (672 units), Italy (614 units), Germany (588 units), Japan (584 units) and China (482 units)[b].

**Table 5**

| Country | Shipments 2012 (units) | Shipments Food and Beverage Industry 2012 (units) |
|---|---|---|
| **World** | **159,346** | **4,900** |
| **North America** | **26,269** | **888** |
| **Canada** | **1,749** | **167** |
| **USA** | **22,414** | **672** |
| Mexico | 2,106 | 49 |
| Brazil | 1,645 | 12 |
| Argentina | 180 | 29 |
| Australia | 1,214 | N/A |
| **China** | **22,987** | **482** |
| **Japan** | **28,680** | **584** |
| **Europe** | **41,218** | **2,533** |
| Netherlands | 810 | 124 |
| France | 2,956 | 315 |
| **Germany** | **17,528** | **588** |
| **Italy** | **4,402** | **614** |
| Norway | 91 | 16 |
| Sweden | 1,016 | 58 |
| **South Africa** | **337** | **22** |

*Source: IFR Statistic Report (2013)*

A number of drivers are likely to further increase the use of automation and robotics by Food and Beverage processing companies in the future. These include:

✓ increasing cost of labour and availability of manual labour (changing skill set of available workers);
✓ increasing diversity of food and beverage products (which increases demand for flexible automation);
✓ increasing safety and hygiene requirements;
✓ increasing demand for high quality and convenient food;
✓ growing working population ("middle class") in emerging countries.

Growth markets for the use of robotics are expected to include frozen and chilled food, ready meals, confectionery products and primary meat products[47].

**Automation and Robotics in the Canadian Sector**

According to IFR statistics, the Food and Beverage Processing sector is the second largest manufacturing market for robotics[c] (9% of 2012 robot sales) in Canada, just after the automotive industry.

**Figure 2**
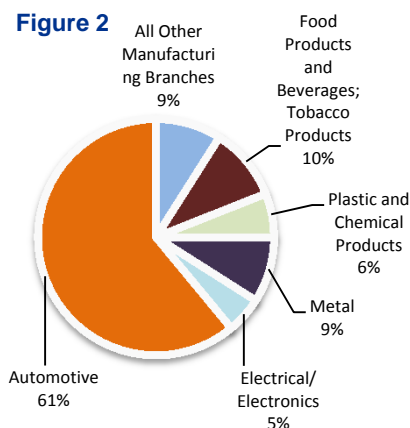
| Application Areas | Canada Shipments 2012 (units) |
|---|---|
| Handling Operations / Machine Tending | 830 |
| Welding and Soldering | 612 |
| Dispensing | 142 |
| Processing | 61 |
| Assembling and Disassembling | 67 |
| Others | 30 |
| Unspecified | 7 |
| **Total** | **1,749** |

*Source: IFR Statistic Report (2013)*

# Context

- **The Canadian Food and Beverage Processing sector represents the second largest market for robots**

- **Canadian processing firms are consolidating and reorganizing their production facilities to become more globally competitive**

Although the IFR has only recently began to report separate robot sales for Canada (previously reported under North America only, which comprised Canada, United States and Mexico), the trend towards robotics in the Food and Beverage Processing sector has been increasing since 2011, especially for use in pick-and-place, packaging, and palletizing[48].

This trend towards robotics is just an example of the growing importance Food and Beverage processors are attributing to innovation and technology. A recent report (2013) produced by the Alliance of Ontario Food Processing (AOFP) indicates that, over the last few years, a "cultural shift has taken place" where Food and Beverage processing firms are actively seeking access to new technologies and opportunities to innovate. Moreover, the Canadian Food and Beverage Processing sector invests about $2 billion annually in capital expenditures[49], with about 80% of the total invested in machinery and equipment.

**Factors Affecting the Canadian Sector**

The Canadian Food and Beverage Processing sector is currently facing a number of issues and challenges that are driving changes at the operational level and in the overall structure of the market, affecting the overall competitiveness of the sector.

Drivers for change arise from various sources[50,51], including market factors (consumer trends), supply chain factors, government policies and regulations and global economic context. The consolidation of the sector and distributors, the various consumer trends, the scale of operations and the border issues with Canada's most important trading partner are just a few of several factors affecting Food and Beverage processing in Canada.

**Consolidation**

A recent analysis of plant closures, openings and investments revealed that Canadian Food and Beverage processing firms are consolidating and reorganizing their production facilities to become more globally competitive[52]. Between 2006 and 2014, 143 Canadian food processing plants closed, 128 of which were part of multi-plant companies. These were mostly to "reorganize their manufacturing footprints to be more globally competitive, focusing production facilities, investing in new technologies, automation and new systems, and adopting new processing methods" (Sparling & LeGrow, 2014, p. 8). As such, the plant closures are not indicative of decreased production on Canadian soil. In the majority of cases, plant closures are indicative of actions taken to become more competitive and efficient. However, of those plants that closed definitively, the main reason for closure was financial distress that led the company to no longer be competitive.

The study also revealed that most of the plant openings, plant closures and job losses were in secondary processing rather than primary processing.

An analysis of the investments made over the same period in the sector indicated that 56 of these investments (out of 67) were for existing plants and 39 were investments valued above $1.0 million.

Another interesting finding of this study is that nearly half of the plant activity in the Canadian sector was conducted by non-multinational enterprises (MNE).

Lastly, Canadian-owned MNE firms were more likely than foreign owned MNEs to consolidate and invest in their existing plants.

# Context

**Consumer trends**

Consumer preferences and needs are also affecting the Food and Beverage Processing sector[53]. Consumer trends include:

**Table 6**

| Product Value | Consumers are looking for balance between product quality and price |
|---|---|
| Health Attributes | Consumers are looking for healthy attributes (e.g. low/zero fat, low salt, etc.) |
| Convenience | Consumers are looking for easy and time-efficient meal solutions in line with their schedule |
| Authenticity | Consumers are looking for product attributes such as history, production techniques, origin |
| Sustainability | Consumers are also concerned with the environment and social impacts |

**Retailer/Distributor Concentration**

The grocery retailing sector in Canada is highly concentrated and vertically integrated into the distribution market[54,55], with the top 5 retailers accounting for nearly 80% of total food sales. The structure of the sector is thus intensifying the market competition, constantly looking for means to reduce price, improve product quality and extend the range of products offered. Food and Beverage processing firms looking to compete in the Canadian market are thus pressured to continuously innovate and offer the best price-quality ratio.

**Market Access and Border Related Issues**

Access to different markets plays an important role in the measurement of exports. Despite trade agreements, non-tariff barriers to trade may still exist. While the North American Free Trade Agreement grants access to Canadian Food and Beverage processing firms, the testing of products at the border creates a hurdle to that access (especially meat and other fresh processed products)[56].

The cost and delays associated with border security and the lack of uniformity between the different regulatory agencies of Canada and the United States have been an important barrier to increasing the access of Canadian Food and Beverage processing firms to US market. This hurdle translates into a risk factor from a supply chain perspective, with US distributors less likely to hold contracts with Canadian providers[57].

In this sense, trade agreements do not ensure access to market. Instead, some Canadian firms have been investing abroad, locating their production near the markets they want to serve.

**Scale**

Given Canada's trading relationship with the US, scale is an important factor affecting the ability of Canadian Food and Beverage processing firms to compete.

A recent analysis of the relationship between scale and productivity in Canadian Food Processing firms indicated that Canadian firms operating in this sector are significantly smaller in scale than their counterparts in the United States (US)[58].

Although scale is not the only factor affecting manufacturing productivity, it has helped improve productivity in the US Food and Beverage Processing sector, while Canadian firms are lagging. Technology and innovation are anticipated to continue to be an important driver of scale for Food and Beverage processing firms[59].

However, scale is also thought to allow for greater investment in more labour-saving technologies, which would worsen the gap attributed to differences in scale**.**

**Trade Deficit in Food and Beverage Processing**

The trends and issues faced by the Canadian Food and Beverage Processing sector provide some context to the trade balance recorded over the past few years.

- **Scale is affecting the ability of Canadian processors to compete in large-scale markets**

- **Understanding the trade deficit of processed food requires the analysis of consumer, economic, supply chain and policy/ regulatory environment**

A recent analysis of the Canadian Agri-Food trade balance over the period of 2004 to 2012 indicated that commodity designations, including primary processing, vegetables and fats and oils[d], have been in trade surplus, whereas secondary processing has been facing a rising trade deficit[60]. However, as demonstrated in the report, thorough understanding of the issues at hand for any given sub-sector requires a four-fold analysis of the consumer, economic, supply chain and policy/regulatory environment faced by the firms.

**Contribution of This Study**

The current study will complement existing research on the Canadian Food and Beverage Processing sector by benchmarking the use of automation and robotics by Canadian processors with that of their international counterparts, adding granularity to the challenges faced by Canadian processors and identifying solution pathways for the identified gaps in the adoption of automation and robotics.

# Results and Analysis

# Food and Beverage Processing Segments

**Sub-sectors were grouped into segments of analysis, using similarities in their inputs, processing operations, products and packaging**

Results were gathered for the individual sub-sectors and presented by segment based on a number of similarities. Sub-sector specific interview findings are detailed in **Appendix IV and Appendix V**. This report focuses on providing a qualitative assessment of automation and robotics for each of the following segments:

**Table 7**

| Food and Beverage Processing Segments | | | | |
|---|---|---|---|---|
| Meat, Fish and Seafood | Prepared Meals, Bread & Bakeries, Fruits and Other | Dry Food | Other Packaged Food and Ingredients | Beverages |
| Meat Products | Prepared Meals | Flour Milling | Breakfast Cereals | Soft Drinks and Water |
| Poultry | Fresh | Pasta | Coffee and Tea | Alcoholic Beverages |
| Pork | Frozen | Enhancers | Cookies and Crackers | Beers |
| Beef | Others | Sugar and Sugar Products | Confectionery | Spirits |
| Fish and Seafood | Fruits and Vegetables | Starch & Vegetable Fat and Oil Manufacturing | Chocolate | Wines |
| Canned | Canned | | Non-Chocolate | |
| Frozen | Fresh | | Snack Food | |
| | Frozen | | Dog and Cat Food | |
| | Others | | | |
| | Bread and Bakeries | | | |
| | Fresh | | | |
| | Frozen | | | |
| | Dairy Products | | | |

# Food and Beverage Processing Segments

Segments were determined based on a number of similarities shared amongst sub-sectors. The following table highlights the rationales behind each segment, which can be grouped under inputs, processing, products and packaging characteristics:

**Table 8**

| | Meat, Fish and Seafood | Prepared Meals, Bread, Fruits and Other | Dry Food | Other Packaged Food and Ingredients | Beverages |
|---|---|---|---|---|---|
| **Inputs** | ✓ Variability within and across species<br>✓ Live animals<br>✓ Fresh | ✓ Fresh and dry<br>✓ Mix of bulk and minor ingredients<br>✓ Co-existence of variability and uniformity | ✓ Mostly dry and bulk | ✓ Mostly dry and bulk<br>✓ Mix of bulk and minor ingredients<br>✓ Co-existence of variability and uniformity | ✓ Fresh, dry and liquid |
| **Processing** | ✓ Harsh/difficult environment<br>✓ Food health and safety concerns<br>✓ Primary versus Secondary Processing<br>✓ Variability within sub-sector<br>✓ Some seasonality (Fish and seafood) | ✓ Standardized, larger scale and variable smaller scale<br>✓ Recipe/variability<br>✓ Food health and safety concerns | ✓ Standardized, larger scale and lower scale | ✓ Recipe/variability<br>✓ Large batches<br>✓ Some seasonality around holidays | ✓ Recipe/variability<br>✓ Standardized, larger scale and smaller scale |
| **Products** | ✓ Protein source<br>✓ Variability<br>✓ Short to medium shelf life depending on preservation method (canned products with longer shelf life) | ✓ Co-existence of variability and standardization<br>✓ Short to medium shelf life depending on preservation method (canned products with longer shelf life) | ✓ Longer shelf life<br>✓ Low variability<br>✓ Commodity/low differentiation | ✓ Longer shelf life<br>✓ High variability | ✓ Longer shelf life<br>✓ Liquid<br>✓ High and low value products |
| **Packaging** | ✓ Individual<br>✓ Cases<br>✓ Fresh<br>✓ Frozen<br>✓ Canned | ✓ Individual<br>✓ Cases<br>✓ Fresh<br>✓ Frozen<br>✓ Canned<br>✓ Other preservation methods | ✓ Bulk<br>✓ Industrial<br>✓ Individual<br>✓ Low variability | ✓ Individual or single serve<br>✓ Bulk or larger packaging<br>✓ Variable packs<br>✓ Seasonal packaging | ✓ Individual<br>✓ Larger/bulk<br>✓ Variability associated with special or higher value products |

# Scale and Other Measures

❑ **Firms were asked to:**

✓ **Evaluate their level of automation and robotics for their various processing, packaging and end-of-line applications**

✓ **They were also asked to rank in order of importance previously identified drivers and barriers**

❑ **Other questions pertained to the importance of automation and robotics, the maturity of currently used technology, the nature of this technology and priorities in terms of future capital investment in automation and robotics**

## Food and Beverage Processing Applications

In order to determine the Food and Beverage processing applications for which Canadian firms currently use automation and robotics, broad categories of applications were created for discussion purposes, allowing for a higher degree of comparison within any given Food and Beverage Processing sub-sector, as well as amongst the various sub-sectors. Granularity as to what specific application is or is not automated (or robotized) was obtained through discussions.

The categories are presented below, along with examples of what they comprise.

### Table 9

| Production application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the following ranking options:

- not automated (0% automated[e])
- less automated (less than 40% automated)
- partially automated (between 40% and 70% automated)
- very automated (over 70% automated)

Detailed questions and results are presented in **Appendix IV**

*

## Factors Affecting the Adoption of Automation and Robotics

Potential drivers and barriers to the adoption of automation and robotics by Food and Beverage processing firms were identified based on literature on the subject and discussions with subject matter experts. These include, but are not restricted to:

### Table 10

| Driver | Description |
|---|---|
| Production | Cost savings, improve productivity, improve efficiency of operations, product and input waste management |
| Employees | Improve working conditions, decrease rate of accidents, decrease cost of labor per unit of finished good |
| Consumers | Introduce product innovation, improve product safety and quality control, address consumer preferences |
| Legislation | Quality and safety legislations and regulations |
| Market Share | Potential new international trade agreements, global and national competitors' level of automation and robotics |

| Barrier | Description |
|---|---|
| Cost | Initial cost of robots and automation, cost of training/hiring/maintenance, legacy robots/ automation/system |
| Operations | Size of robots available and space required for automation, product support, and maintenance services availability, culture of the company |
| Market and Financing | Market perception, poor return on investment, funding availability |
| Perceived Risks | Cost vs. short-term payback, unpredicted cost, operational delays, technical limitations, and other issues and frictions with implementation |

# Scale and Other Measures

- ❑ **Variables are presented on a scale to allow for a single visual point of comparison amongst the segments, drivers or barriers**

- ❑ **The numbers represent the weighted average of all answers**

- ❑ **For instance, weighted average of the current level of automation for the Canadian Meat, Fish and Seafood raw food/processing applications was 1.32, with 0 being not automated and 3 being very automated. That of the Dry Food segment was 2.88, indicating that on average, this segment is more automated (p. 41)**

Drivers and barriers were ranked from least to most important by all participants. A weighted average of all answers allowed for the ultimate ranking, a number between 0 and 4.

**Figure 3**

| | Least Important | | | | Most Important | |
|---|---|---|---|---|---|---|
| 0 | | 1 | 2 | 3 | | 4 |
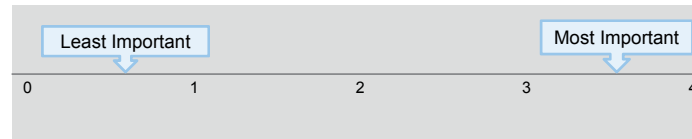
## Gap Analysis

Analysis was conducted to characterize the difference (gaps) between the level and the importance of automation and robotics for each of the following Food and Beverage processing applications.

Throughout this section, measured gaps are presented as a number between 0 and 3. This number represents the difference between the importance attributed to the use of these technologies and the current level of automation and robotics which ranked from Not Automated/Important (0) to Very Automated/Important (3).

**Figure 4**

| | | Level | Gap | Importance | |
|---|---|---|---|---|---|
| 0 | 1 | | 2 | | 3 |
| Not Automated / Important | | | | | Very Automated / Important |
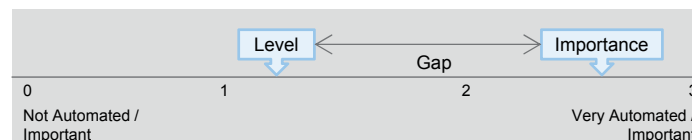
- **Processors were interviewed across Canada and internationally, covering firms from a number of sub-sectors and of various size and ownership structure**

**Canadian Sample Characteristics**

**Sub-Sectors Distribution**

Food and Beverage processing operations were interviewed across a wide number of different sub-sectors. The following graph highlights the distribution of the Canadian sample:

**Figure 5**



Other Packaged Foods and Ingredients 13%
Beverages 9%
Meat, Fish and Seafood 29%
Dry Food 15%
Prepared Meals, Bread & Bakeries, Fruits & Other 34%
N = 106
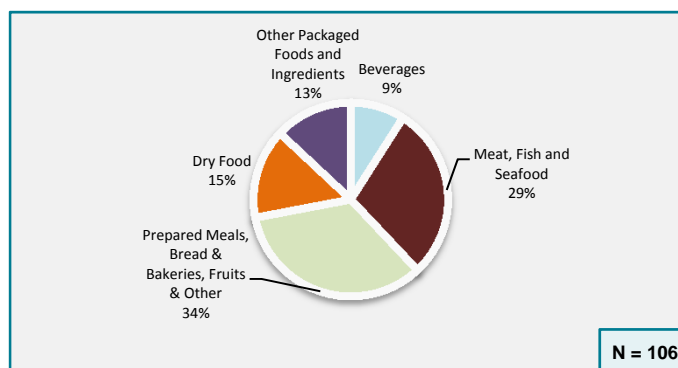
**Size Distribution (Total Sales)**

**Figure 6**



More than $500 million 25%
Under $25 million 11%
$25 - $50 million 14%
$100 - $500 million 25%
$50 - $100 million 25%
N = 56
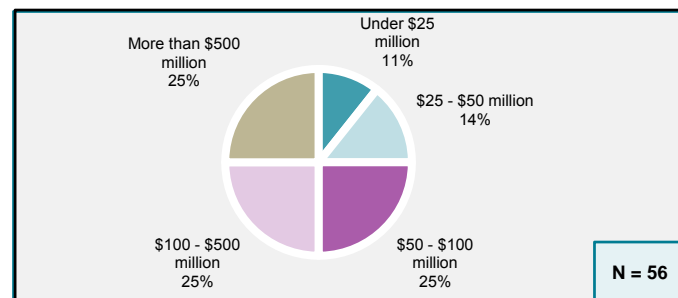
**Ownership Structure**

65% of interviewed firms were Canadian-owned enterprise (35% subsidiaries of foreign companies) and 70% were private companies (30% publicly traded). (**See Appendix IV**)

**Geographical Distribution**

**Figure 7**



Other Provinces 3%
Atlantic Provinces 9%
British Columbia 6%
Quebec 44%
Ontario 38%
N = 68
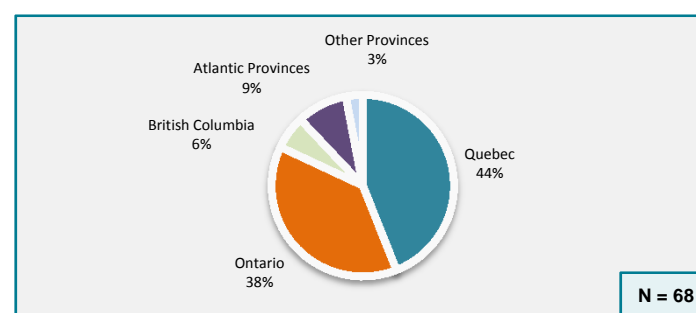
Other provinces comprised firms in Manitoba and Alberta. Note that interviewed firms also had operations in other Prairie provinces, though detailed information was not provided.

**International Sample Characteristics**

**Sub-Sector Distribution**

- Alcoholic Beverages (2)
- Bread and Bakeries (1)
- Energy Drinks (1)
- Fruits and Vegetables (4)
- Fish and Seafood (3)
- Confectionery (3)

❑ **Interviews with Canadian and international associations and machine, equipment and solution providers yielded qualitative information for the assessment of automation and robotics of the segments of analysis and the benchmarking assessment**

**Size Distribution (Total Sales)**

The following graph highlights the distribution of the firm sample by total sales.

**Figure 8**



$50 - $100 million
13%

More than $500 million
53%

$100 - $500 million
34%

N = 15
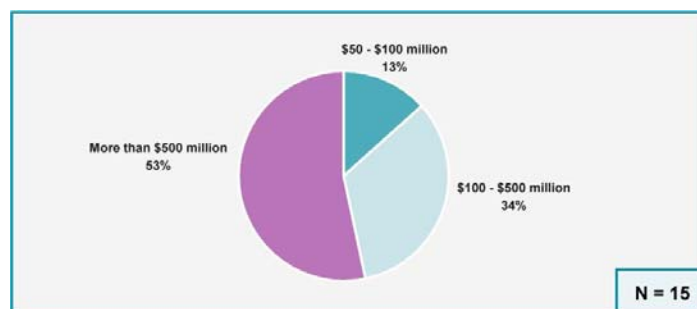
**Other Interviews**

Other interviews were conducted with associations, machine and equipment (M&E)/solution providers. These interviews provided qualitative information in the form of discussions.

Information was gathered on:

▪ the level of automation and robotics of the various sub-sectors in Canada and internationally;

▪ drivers, barriers and challenges faced by firms that affect the adoption of automation and robotics;

▪ various trends related to Food and Beverage Processing sector;

▪ any lags present in the adoption of automation and robotics;

▪ potential areas of innovation, research and development and associated risks; and

▪ various other considerations of relevance.

Six (**6**) interviews were conducted with international associations, M&E/solution providers.

Seven (**7**) interviews were conducted with Canadian associations and M&E/solution providers.

Additionally, Canadian Food and Beverage processing firms shared their knowledge of the international competition.

# 1 | Current Assessment

# Overview of Current Level of Automation and Robotics

- ❑ **The Canadian Food and Beverage Processing sector is only partially automated, with the level of adoption of automation and robotic technologies varying across sub-sectors and firms**

- ❑ **Larger, non-Canadian owned, publicly traded companies tend to be more automated in their raw food/processing applications**

## Overview of the Current Level of Automation and Robotics

The Canadian Food and Beverage Processing sector is only partially automated, with the level of adoption of automation and robotic technologies varying across sub-sectors and firms.

### Figure 1.1
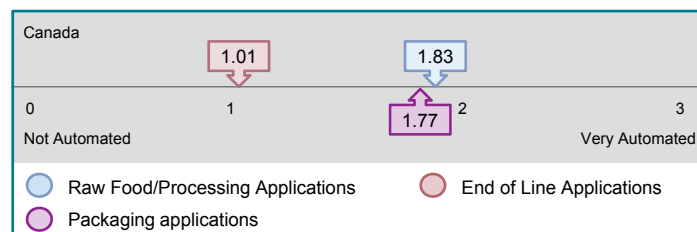


Considering all sub-sectors, the level of automation and robotics was less automated in their end-of-line applications than in their raw food/processing and packaging applications.

### Raw Food/Processing Application

Interviews conducted with Canadian Food and Beverage processing operations indicated some level of automation and robotics across all sub-sectors and segments.

Of those firms that considered their operations as very automated in their raw food/processing applications, the majority were larger scale operations (more than $100 million in sales).

### Figure 1.2
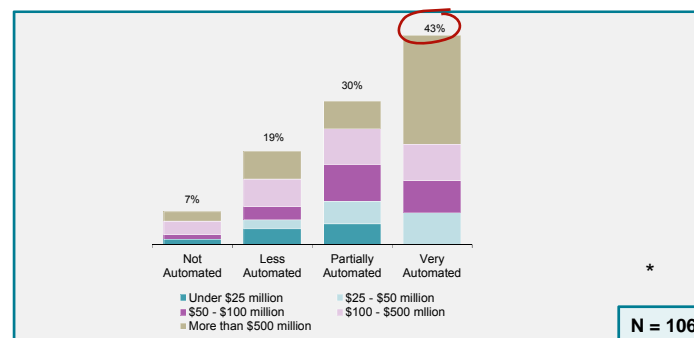


N = 106

* Each segment does not give 100% due to research constraints such as a business not answering the question properly.

Moreover, 57% of interviewed subsidiaries considered their raw food/processing applications as very automated, as opposed to only 37% of Canadian-owned firms.

### Figure 1.3
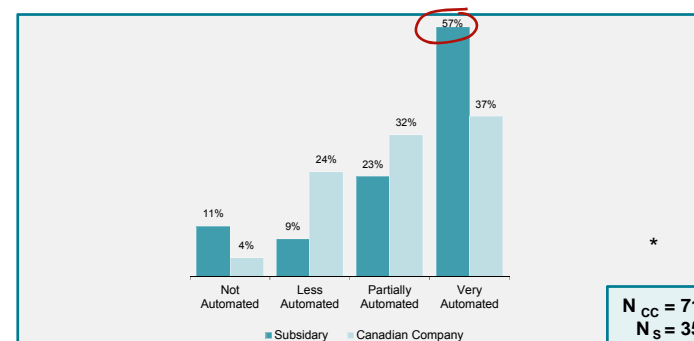


N CC = 71
N S = 35

* Each segment does not give 100% due to research constraints such as a business not answering the question properly.

- **Firms operating in the Meat, Fish and Seafood segment generally used more employees at all levels of the raw food/ processing and packaging applications and less automation and robotics than the other segments**

- **Firm size was less important in the level of automation and robotics of packaging applications**

**Raw Food/Processing Application (cont'd)**

Most of the firms that ranked their operations as very automated in their raw food/processing applications were publicly traded, whereas all of those that considered them as not automated were private companies.

**Figure 1.4**
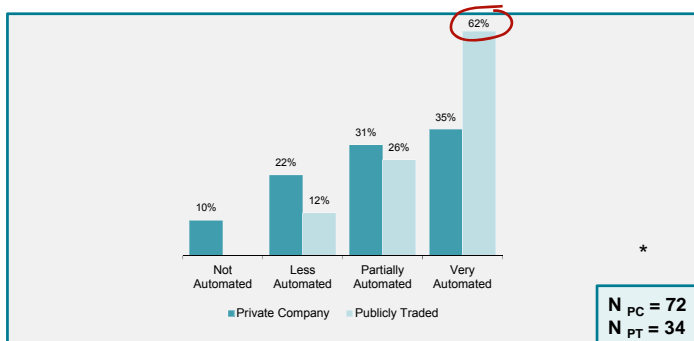


N PC = 72
N PT = 34

\* Each segment does not give 100% due to research constraints such as a business not answering the question properly.

The level of automation and robotics also varied across sub-sectors and segments of the Food and Beverage Processing sector, with sub-sectors/segments characterized by lower variability and higher standardization of processes ranking their raw food/processing applications as partially to very automated.

Firms operating in the Meat, Fish and Seafood segment generally used more employees at all levels of the raw food/processing applications and less automation and robotics than the other segments.

**Figure 1.5**



Meat, Fish and Seafood — 1.32
Beverages — 2.00
2.29
Other Packaged Food and Ingredients — 2.64
Dry Food — 2.88

- ○ Meat, Fish and Seafood
- ○ Prepared Meals and Others
- ○ Dry Food
- ○ Other Packaged Food and Ingredients
- ○ Beverages
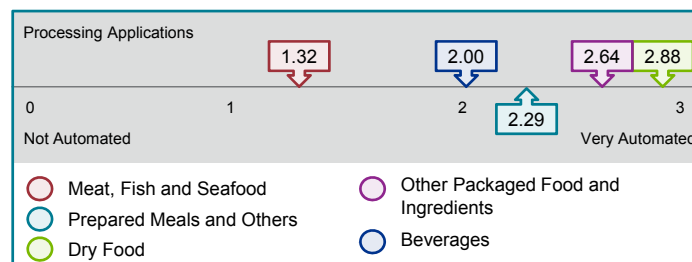
Dry Food and Other Packaged Food and Ingredients segments were characterized by operations that were partially to very automated in their raw food/processing applications.

**Packaging Applications**

Interviews revealed that Canadian Food and Beverage processing operations were only partially automated across all sub-sectors and segments. The direct correlation between the firm size and the level of automation and robotics used in packaging applications was not consistently observed, with smaller firms

**Figure 1.6**



N = 106
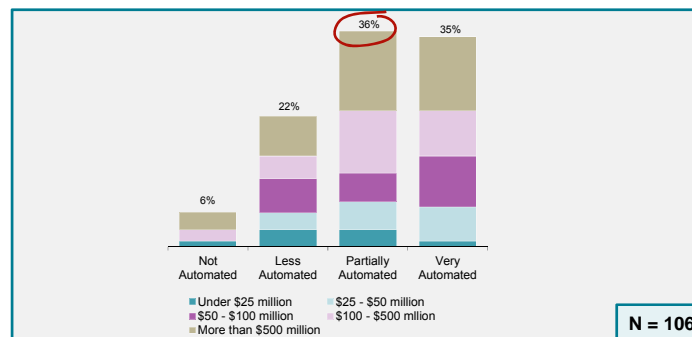
❑ **Company ownership structure was also less differentiating for packaging applications, with a bias towards increased automation amongst non-Canadian and publicly traded companies**

❑ **Firm size and ownership structure was less differentiating in the level of automation and robotics for end-of-line applications**

**Packaging Applications (cont'd)**

sometimes ranking their applications as very automated and some larger scale firms ($100 - $500 million or over $500 million in sales) ranking them as not or less automated.

Cumulatively, a greater proportion of firms that ranked their operations as partially or very automated were subsidiaries of foreign companies.

**Figure 1.7**
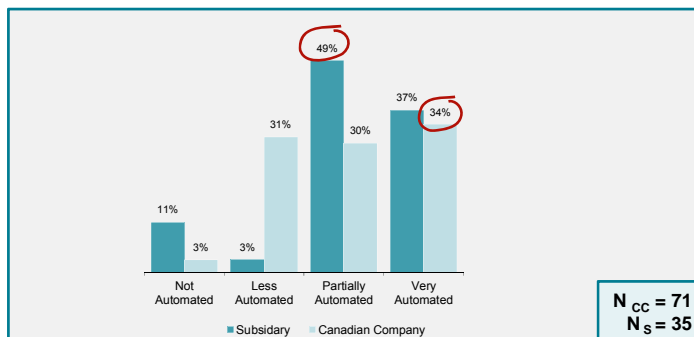


N CC = 71
N S = 35

Most of the firms that ranked their operations as less or not automated in their packaging applications were private companies. However, the majority of publicly traded companies (91%) considered their packaging applications as either partially or very automated.

**Figure 1.8**
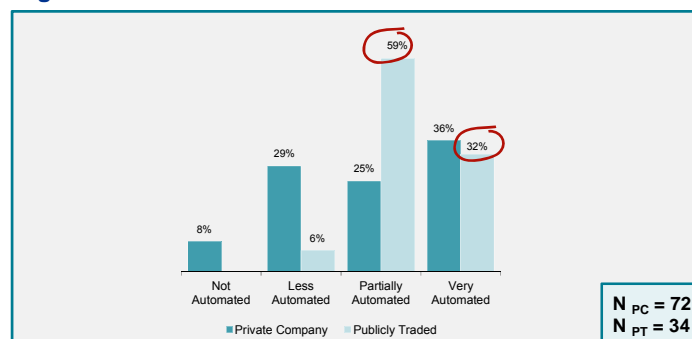


N PC = 72
N PT = 34

The level of automation and robotics varied across sub-sectors and segments of the Food and Beverage Processing sector for packaging applications, but to a lesser extent than for raw food/processing applications.

**Figure 1.9**
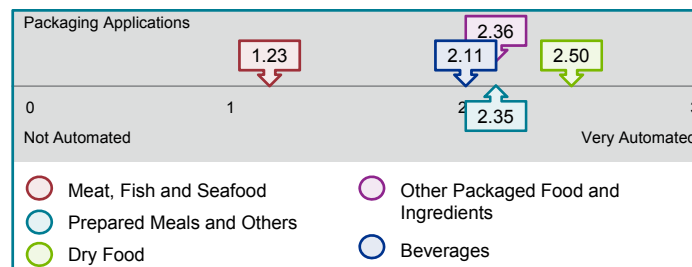


As with raw food/processing applications, firms operating in the Meat, Fish and Seafood segment used less automation and robotics in their packaging applications than all other segments. Overall, firms operating in the Dry Food segment were slightly more automated in their package food applications than other segments, although the exact level of automation and robotics varied across firms.

# Overview of Current Level of Automation and Robotics

❑ **End-of-line applications were generally less automated than their raw food/processing and packaging applications across all sub-sectors and segments**

## End-of-Line Applications

Interviews conducted with Food and Beverage processing firms revealed that end-of-line applications were generally less automated than their raw food/processing and packaging applications across all sub-sectors and segments.

Generally, a greater proportion of larger scale firms (more than $500 million) ranked their end-of-line applications as partially or very automated. However, an important number of large-scale operations ($100 – $500 million or over $500 million) ranked these applications as either not automated or less automated.

**Figure 1.10**
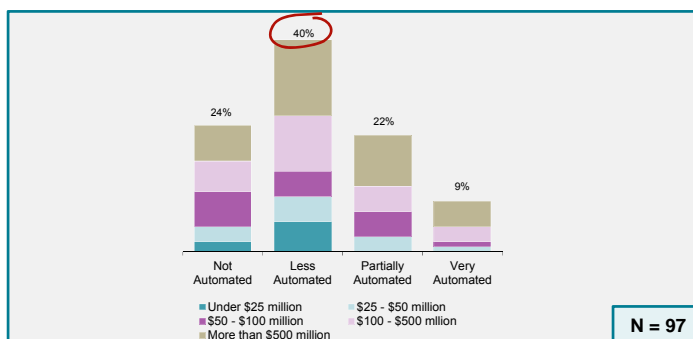


N = 97

Moreover, Food and Beverage processing firms that were subsidiaries/divisions of foreign companies were generally more automated in their end-of-line applications than Canadian-owned companies.

**Figure 1.11**
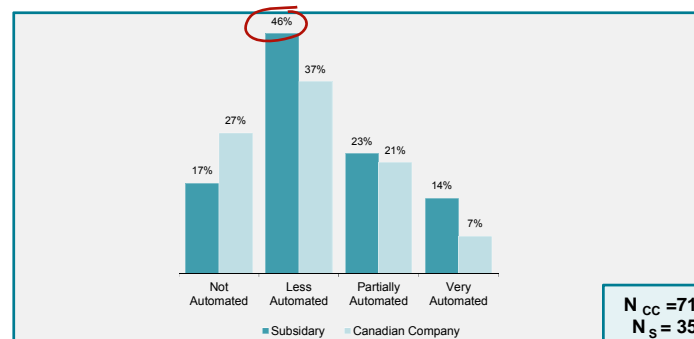


$N_{CC} = 71$
$N_S = 35$

End-of-line applications for privately-owned companies were mostly considered not automated, whereas publicly traded companies mostly ranked these applications as less to partially automated.

**Figure 1.12**



$N_{PC} = 72$
$N_{PT} = 34$
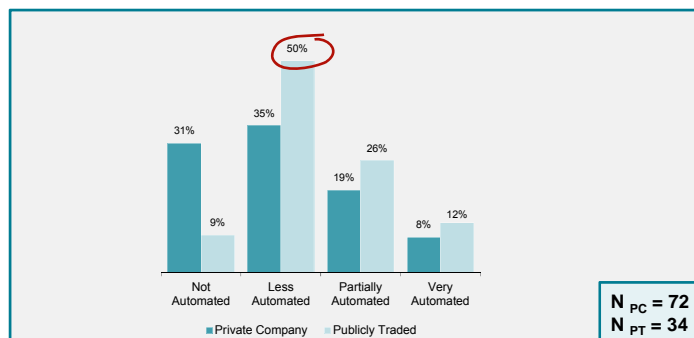
❑ **Meat, Fish and Seafood segment was less automated**

**End-of-Line Applications (cont'd)**

The level of automation and robotics varied across sub-sectors and segments of the Food and Beverage Processing sector for end of line applications. However, averages were concentrated around less automation (1) for most segments of analysis.

**Figure 1.13**
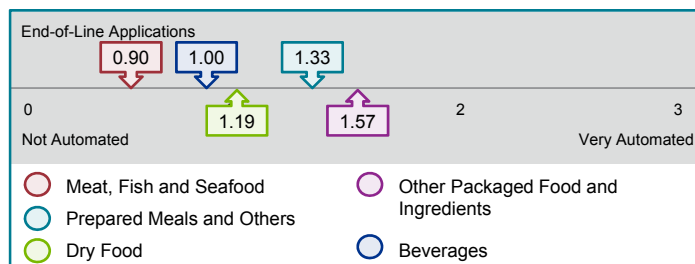


Overall firms operating in the Meat, Fish and Seafood segment were less automated than the other segments, whereas Other Packaged Food and Ingredients operations ranked their end-of-line applications as slightly more automated than the other segments on average.

**The average age of technology across all segments ranged from 5-9 or 10-14 years old**

**Technology was generally more recent in the Meat, Fish and Seafood segment, consistent with its more recent adoption of technology**

**The majority of interviewed firms characterized their operations as using some level of leading-edge technology**

**New, fully automated processing lines tend to co-exist with partially automated, older or manual processing lines**

**Maturity of Current Technology**

Overall, the age of current automation and robotic technologies varied across segments, sub-sectors and firms.

On average, the age of the technology across all segments ranged from 5-9 or 10-14 years old. The technology used in raw food/processing, packaging and end-of-line applications was generally most recent in the Meat, Fish and Seafood, Prepared Meals and Others segments. This is consistent with the more recent adoption of automation and robotics in the Meat, Fish and Seafood segment and some sub-sectors in the Prepared Meals and Others versus the other sub-sectors in general.

The technology used in Beverage processing for the interviewed operations was generally older than in other segments, although some operations used top-of-the-line, leading-edge technology across the plant. **(Appendix IV, Q 8a)**

Generally, Canadian Food and Beverage processing operations used a mix of leading-edge/new technology and older/non-leading-edge technology. While a few of the interviewed firms considered none of their automation and robotic technologies to be leading-edge, others ranked them as mostly leading-edge. The majority of interviewed firms characterized their operations as using some level of leading-edge technology.

Interviews also revealed that new, fully automated processing lines tend to co-exist with partially automated, older or manual processing lines. As such, within any given plant, a mix of new and old technology may be observed. This finding also suggests the gradual adoption of automation and robotics by Canadian Food and Beverage processing firms.

**Figure 1.14**
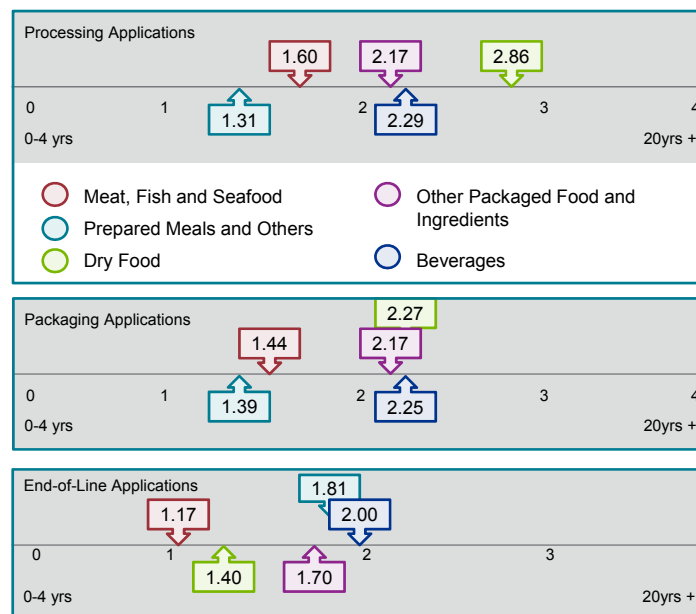


46

# Importance of Automation and Robotics

□ **Interviewed firms recognized the importance of adopting automation and robotics in order to compete in their local market as well as internationally**

## The Importance of Automation and Robotics

Although Canadian Food and Beverage processing operations are currently automated to varying extents in their raw food/processing, packaging and end-of-line applications, interviewed firms recognized the importance of adopting automation and robotics in order to compete in their local market as well as internationally.

### Raw Food/Processing Applications

Generally, raw food/processing applications were ranked as somewhat to very important to automate. However, the greater the variability and seasonality of the processes, the lower the importance that was attributed to the automation of these applications. The availability of technology also contributed to how important firms ranked automation and robotics for the competitiveness of their operations.

As such, the importance of automating the raw food/processing applications for the Meat, Fish and Seafood segment and for the Beverage segment (esp. Alcoholic Beverages) was generally slightly less than for the other segments that display less variability and seasonality. All interviewed firms in the Dry Food segment considered it very important to automate their raw food/processing applications.

**Figure 1.15**



Processing Applications

2.50  2.54  2.64
2.45
2.64
0      1      2      3
Less Important                    Most Important

○ Meat, Fish and Seafood
○ Prepared Meals and Others
○ Dry Food
○ Other Packaged Food and Ingredients
○ Beverages
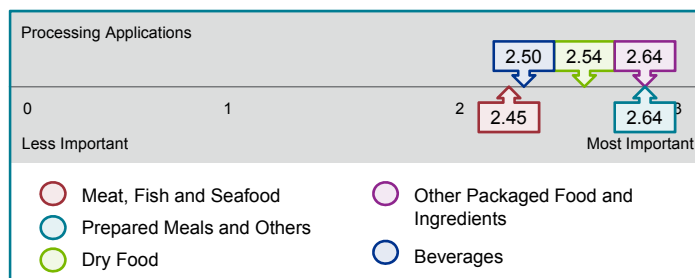
### Packaging Applications

Packaging applications were also considered somewhat to very important to automate on average, with variability and seasonality of products affecting the attributed level of importance.

**Figure 1.16**



Packaging Applications

2.44  2.65  2.79
2.71  2.84
0      1      2
Less Important                    Most Important
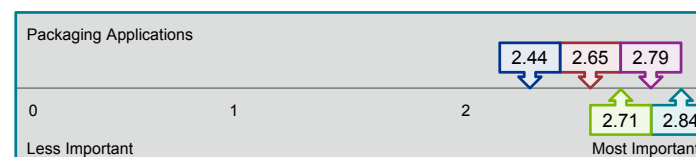
As with raw food/processing applications, firms in the Meat, Fish and Seafood and Beverages (esp. Alcoholic Beverages) segments considered it slightly less important to automate their packaging applications than other segments.

### End-of-Line Applications

Generally, end-of-line applications were considered somewhat less important to automate than other types of applications, given that operations are typically less labour-intensive than raw food/processing and packaging applications.

**Figure 1.17**
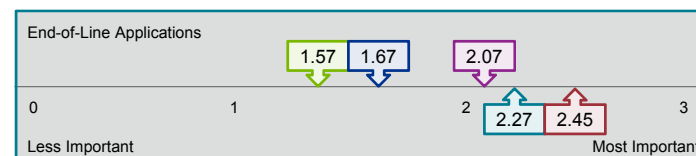


End-of-Line Applications

1.57  1.67    2.07
2.27  2.45
0      1      2      3
Less Important                    Most Important

# Measured Gap and Future Investments

❑ **Although the interviewed Canadian Food and Beverage processing firms recognized the importance of automation and robotics for their ability to compete, there was generally a gap with the current level of adoption**

❑ **Packaging applications were most frequently ranked as top priority in terms of future investment across all segments of analysis**

❑ **Capital investments in automation and robotics tend to involve areas that are more labour-intensive and that could generate important cost savings**

## Current Versus Desired Level of Automation and Robotics

Although the interviewed Canadian Food and Beverage processing firms recognized the importance of automation and robotics for their ability to compete, there was generally a gap with the current level of adoption. The following graphs highlight the measured gap (importance minus current level).

### Figure 1.18
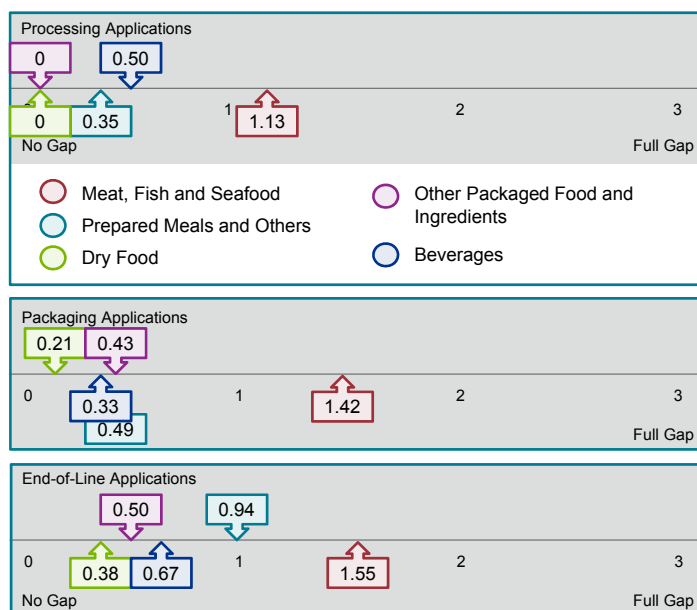


Across all types of applications, the gap was generally the greatest for firms operating in the Meat, Fish and Seafood segment. Comparing the various types of applications, the gap was generally the greatest for end-of-line applications for all segments of the Food and Beverage Processing sector.

## Future Investment in Automation and Robotics

In light of the current level of adoption and the importance attributed to automation and robotics for the interviewed Food and Beverage processing operations in Canada, packaging applications were most frequently ranked as the top priority in terms of future investment across all segments of analysis.

### Figure 1.19
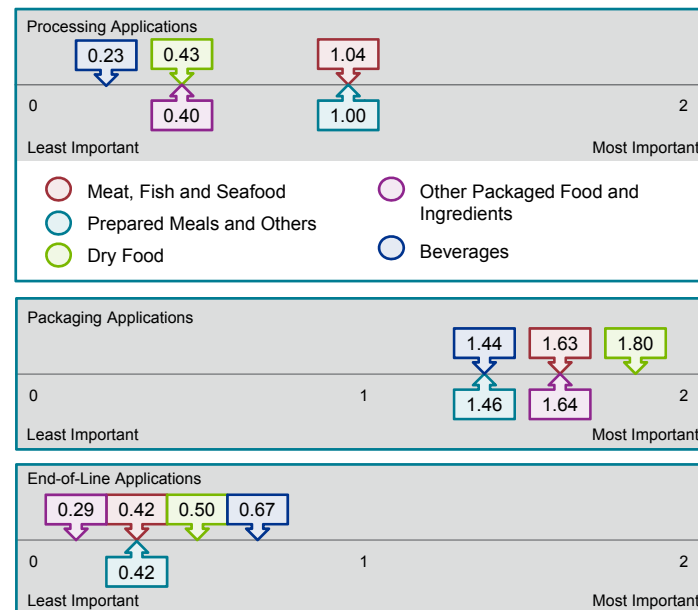


However, the priorities varied across firms and sub-sectors, with greater importance attributed to investments in automation and robotics for the raw food/processing applications in segments that involved fresh products or products with shorter shelf-life.

# Future Investments

Firms operating in the Dry Food segment tend to be more automated in their raw food/processing applications than for the other segments. Greater importance was thus attributed to investments in packaged food and end-of-line applications for this segment.

Generally, capital investments in automation and robotics tend to involve areas that are more labour-intensive and that could generate important operational cost savings (in all forms) and productivity improvements. Whereas end-of-line applications indicated the largest gap for most of the segments of analysis, the benefits associated with automating these applications (such as using automatic storage/retrieval system) were generally not as high as for other types of applications.

A

**Figure 1.20**



❑ **Interviewed Canadian processors generally agreed that Canada is lagging behind most European countries. For the United States, there was less of a consensus, with the exception that generally, American operations tend to be larger in scale and accordingly more automated**

❑ **Greater similarities between Canada and its European and American counterparts were observed for more standardized/ larger scale productions and segments of analysis**
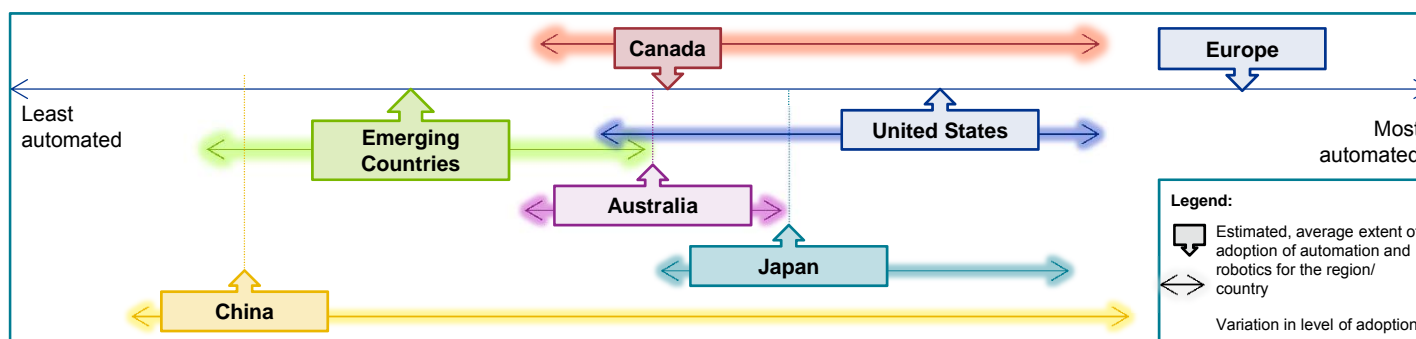
International benchmarking of the current level of adoption of automation and robotics in the Food and Beverage Processing sector in Canada revealed that:

✓ European countries such as Germany, Italy, France, Netherlands and Iceland (thereafter referred to as "European countries") are leaders in their level of automation and robotics.

✓ Some of these European countries are leaders in the development of automation and robotics for the Food and Beverage Processing sector.

✓ The US and Japan represent the other important sources of automation and robotic technologies for the sector.

✓ Although Canadian Food and Beverage processing operations sometimes use greater levels of automation and robotics, the Canadian sector is lagging to various extents behind their American counterparts.

✓ While in some applications Japan may be leading ahead of Canada, it remains similar in others.

✓ Chinese Food and Beverage processing operations tend to be either extremely labour-driven or very automated.

✓ Canadian processors are generally more automated than Chinese firms, with some exceptions.

✓ Canadian operations tend to be more automated than operations in emerging economies, where low-cost labour is readily available.

✓ However, the level of automation in emerging countries may vary according to sub-sectors and scale of operation.

✓ The level of automation and robotics for Canada and Australia tends to be similar in several ways, with potential differences arising across sub-sectors of operation.

The above figure illustrates that there tends to be overlap in the level of automation and robotics in the Food and Beverage Processing sector across the different countries of analysis (as represented by the arrows). Overall European countries are leading the sector globally in their level of automation and robotics adoption.

Interviewed Canadian Food and Beverage processing firms generally agreed that Canada is lagging behind most European countries. For the United States, there was less of a consensus, with the exception that generally American operations tend to be larger in scale and accordingly more automated.

Greater similarities between Canada and its European and American counterparts were observed for more standardized/larger scale productions and segments of analysis. However, the gap also decreased when compared to emerging countries for such type of productions.

## Sub-Sectors Identified as Lagging Behind Europe and US

A number of sub-sectors were identified as lagging behind their European and/or American counterparts. These included:

- Meat;

- Fish and Seafood (mostly Europe);

- Beverages; and

- Flour Milling.

However, there were also instances where Canadian processors ranked their operations as leading-edge and similar to their most automated competitors. These included:

- Fresh Fruits and Vegetables;

- Bread and Bakery;

- Snack Food; and

- Pasta.

## Lagging Applications

Generally, end-of-line applications tend to be less automated than raw food/processing and packaging applications. However, the use of automatic storage/retrieval systems is often observed in Europe, whereas these are only beginning to be introduced in Canada.

For raw food/processing and packaging applications, the gap in automation and robotics tends to be more specific to each sub-sector.

For standardized, larger scale operations, the gap tends to be the greatest between Canada and emerging economies in the packaging applications.

## Extent of the Lags

Although the observed lag varies depending on the firms, the sub-sector and the region of comparison, Canadian Food and Beverage processing operations generally used at least some level of automation and robotics and the lag stemmed from:

- the extent to which existing technologies are used; and

- the maturity of the technology currently used.

Canadian Food and Beverage processing operations are generally at least partially automated (with a few exceptions) and use at least some leading-edge technology. As such, the gap tends to be partial.

# 2 | Segment Results and Analysis

# Applications to Further Automate

Based on the interviews conducted, a number of applications were identified in each segment that could benefit from the development of automation and robotic technologies and/or greater adoption of existing technologies.

## Common Applications of Improvement

Some of these applications were common to most segments.

**Raw Food/Processing Applications**

- Initial material handling and feeding into lines;
- Transport/handling between the various applications;
- Vision technology for quality and content inspection/control;
- Automatic wash down applications/cleaning applications;
- Automatic and vision guided process control;
- Continuous processing (versus batch);
- Automatic reconfigurable mechanism.

**Packaging applications**

- Automatic weighing and primary packaging;
- Automatic case packing;
- Automatic palletizing and pallet wrapping;
- Automatic loading and unloading of packaging machinery;
- Automatic loading of packaging material.

**End-of-Line Applications**

- Automatic or semi-automatic storage/retrieval system;
- Integrated and automatic tracking of products;
- Integrated control of quality from production to distributor/customer.

## Segment-Specific Applications of Improvement

Other applications were specific to segments or sub-sectors. These included:

**Meat, Fish and Seafood**

- Vision technology for guiding cutting applications;
- Automatic weight and quality grading;
- Automatic or robotic deboning;
- Automatic and vision guided slicing technology (shape and weight considerations).

**Prepared Meals, Fruits and Bakery and Other**

- Primary preparation of certain ingredients, such as:
  - First cut and trimming of fruits and vegetable;
  - Preparation of sauces, starch and other meal components;
- Specialty food/meals processing applications such as filling, folding/rolling, pick-and-place.

**Other Packaged Food and Ingredients**

- Automatic pick-and-place for primary packaging (robotics);
- Reconfigurable mechanisms for variable packaging.

## Applications to be Developed Versus Adopted

The majority of the identified common or segment-specific applications already have existing solutions available and Canadian Food and Beverage processing operations would benefit from adopting these technologies to a greater extent.

However, the extent to which such solutions have been developed varies across the different segments and sub-sectors of analysis, contributing to the gap between the ''current'' level and the ''desired'' level of adoption of automation and robotics.

The following table (**p. 54**) highlights the measured gap (current level minus importance of automation and robotics) for each segment (as indicated previously in segment results) as well as how these gaps relate to the applications that could benefit from greater adoption or development of automation and robotic technologies.

### Current State of Automation and Robotics

**Meat, Fish and Seafood Segment**

The Canadian Meat, Fish and Seafood segment is currently lagging in its level of automation and robotics compared to other segments but also compared to its international counterparts. This lag is reflected in the measured gap (refer to table on **p. 54**) and is partly attributed to the lack of solutions directly applicable to the sub-sectors' processing activities. Notably, the sub-sector specific applications that were identified as areas of improvement are facing challenges in the adaptation of already existing solutions. Implementation of solutions developed abroad is not always successful. Interviews provided a number of examples of solutions that were adopted from abroad and adapted to their operations but yielded unsatisfactory results. For the Fish and Seafood sub-sector, several species-specific applications in the raw food/processing and packaging application currently have no readily available solutions.

In terms of the applications to further automate that were common across all sub-sectors (refer to table on **p.54**), the Meat, Fish and Seafood segment required the highest amount of adaptation of existing technologies, as well as the most development of new technologies to address its needs. This statement is generally true for raw food/processing and packaging applications, but less so for end-of-line applications.

Solutions for end-of-line applications tend to be less dependent on sub-sector specificities. However, end-of-line applications were most often ranked as a lower priority of future investments amongst interviewed operations.

Hence, the measured gap likely reflects a combination of priorities for existing investment funds and an actual lag in adoption.

For some applications and for some operations, the current level of adoption of automation and robotics can be justifiable even though it may be lagging behind the desired level of automation or behind its most automated competition. Reasons may include insufficient volume of production and flexibility of orders as market strategy.

**Other Segments**

For the majority of raw food/processing and packaging applications identified as common areas for improvement, the measured gap (Importance minus current level) tends to be much less than for the Meat, Fish and Seafood segment. This is mainly due to the greater availability of existing technology and the lower requirements that may be involved in the adaptation of these technologies when imported from abroad.

However, product-specific robotics applications and flexible automation and robotics solutions are generally under-developed and represent important areas for future development.

Solutions for end-of-line applications already exist for the most part and only require adaptation to meet firm specific requirements.

End-of-line applications do not always need to be automated. For instance, just-in-time operations would not derive as much value from fully automating the storage and retrieval of inventory as operations that constantly hold important inventory (e.g. Dry Food segment).

Moreover, certain raw food/processing applications are generally not automated because there would be little value in doing so. An example would be the handling/addition of minor and micro ingredients.

# Gap and Applications

The following table highlights that the measured gap (importance minus current level) in adoption of automation and robotics tends to be the largest for the Meat, Fish and Seafood segment (red arrows) and the smallest for Dry Food and Other Packaged Food and Ingredients segments (green triangles). However, for the identified common areas for improvement, these larger gaps in automation for Meat, Fish and Seafood also correspond with a greater need for R&D and re-engineering and not only adoption (+++), whereas smaller gaps tend to be associated with greater adoption of already existing solutions (+) rather than R&D and re-engineering.

| Table 2.1 Measured Gap in Adoption per Segment and Current State of the Automation and Robotic Technology (Common Applications of Improvement) | Meat, Fish and Seafood | Prepared Meals, Bread, Fruits and Others | Dry Food | Packaged Food and Other Ingredients | Beverages |
|---|---|---|---|---|---|
| **Raw Food/ Processing Applications** — Measured Gap (Current Level versus Importance) | 🔺 (1.13) | 🟡 (0.35) | 🔺 0.34* | 🔺 (- -) | 🟡 (0.50) |
| Initial material handling and feeding into lines | +++ | + | + | + | + |
| Transport/handling between the various applications | ++ | + | + | ++ | + |
| Vision technology for quality and content inspection/control | +++ | + | + | ++ | + |
| Automatic wash-down applications/cleaning applications | +++ | ++ | + | ++ | ++ |
| Automatic and vision guided process control | +++ | + | ++ | + | + |
| Continuous processing (versus batch) | +++ | +++ | + | + | + |
| Automatic reconfigurable mechanism | + | + | + | +++ | + |
| **Packaging Applications** — Measured Gap (Current Level versus Importance) | 🔺 (1.42) | 🟡 (0.49) | 🔺 (0.21) | 🟡 (0.43) | 🟡 (0.33) |
| Automatic weighing and primary packaging | +++ | ++ | + | ++ | + |
| Automatic case packing | +++ | ++ | + | ++ | ++ |
| Automatic palletizing and pallet wrapping | + | + | + | + | ++ |
| Automatic loading and unloading of packaging machinery | +++ | ++ | + | + | + |
| Automatic loading of packaging material | + | + | + | + | + |
| **End-of-Line Applications** — Measured Gap (Current Level versus Importance) | 🔺 (1.55) | 🔴 (0.94) | 🟡 (0.38) | 🟡 (0.50) | 🟠 (0.67) |
| Automatic or semi-automatic storage/retrieval system | + | + | + | + | + |
| Integrated and automatic tracking of products | + | + | + | + | + |
| Integrated control of quality from production to distributor/customer | ++ | ++ | ++ | ++ | ++ |

**Legend:** +++ would much benefit from greater R&D, re-engineering and adoption    ++ would benefit from greater adoption and/or R&D/re-engineering    + would benefit from greater adoption in general

🔺 Very large gap in adoption    🔴 Larger gap    🟠 Medium gap    🟡 Smaller gap    🔺 Very small gap

Note: This table represents a qualitative general assessments for illustrations purposes and may vary for different firms
* Net positive gap was observed on average for this segment. That is some operations considered their level of automation and robotics at or above the industry requirements.
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# International Benchmarking

- ❑ **While Canada's adoption of automation and robotics is generally lagging behind the US and Europe, it is on par or ahead of other countries**

- ❑ **The lag is generally the greatest for the Meat, Fish and Seafood segment and for sub-sectors with increased flexibility needs in their raw food/processing and packaging applications**

## International Benchmarking by Segment of Analysis and Geographical Region

Interviews with national and international Food and Beverage processing firms, associations and machine, equipment and solution providers provided information for the qualitative benchmarking of the segments of analysis. Assessment key points are summarized in the following table and detailed below for each segment.

**Table 2.2**

| | United States | European Countries | Rest of the World |
|---|---|---|---|
| **Meat, Fish and Seafood** | ✓ Overall lag ● <br> ✓ Similarities with Fish and Seafood processing | ✓ Overall lag 🔺 <br> ✓ Technology mostly developed in European countries <br> ✓ Limited adoption of existing technologies in Canada | ✓ Similarities and differences ● depending on region <br> ✓ Canada leading ahead of labour-intensive models |
| **Prepared Meals, Bread, Fruits and Other** | ✓ Similarities and differences ● <br> ✓ Scale of operations affecting differences | ✓ Similarities and differences ● <br> ✓ Scale of operations affecting differences | ✓ Overall lead on emerging ● economies <br> ✓ Similarities with Australia <br> ✓ Similarities/lag with Asian countries for some specialty products |
| **Dry Food** | ✓ Similarities and differences ● depending on sub-sector and scale | ✓ Similarities and differences ● depending on sub-sector and scale | ✓ Overall lead on emerging ● economies <br> ✓ Similarities depending on applications and region |
| **Other Packaged Food and Ingredients** | ✓ Similarities and differences ● <br> ✓ Scale of operations affecting differences | ✓ Similarities and differences ● <br> ✓ Scale of operations affecting differences | ✓ Overall lead on emerging ● economies <br> ✓ Similarities depending on applications and region |
| **Beverages** | ✓ Similarities and differences ● depending on sub-sector and application <br> ✓ Scale of operations affecting differences | ✓ Overall lag ● <br> ✓ Similarities and differences depending on sub-sector and application <br> ✓ Scale of operations affecting differences | ✓ Similarities and differences ● depending on sub-sector and applications |

**Legend:** 🔺 Very important lag ● Overall lag ● Medium lag, with some similarities ● Small lag or similar ● Similar or leading

### Meat, Fish and Seafood

A general evaluation of the global Meat Processing sector suggests that it is lagging behind other Food and Beverage Processing sub-sectors in their level of adoption of automation and robotics. However, there have been substantial improvements, research and development over the past few years and Europeans and Americans are leading the trend for change. Interviews suggested that Canadian Meat Processing operations are lagging behind their European (e.g. Germany) and American counterparts, particularly in the raw food/processing applications and packaging applications.

Meat processors in Europe and the US have developed and use several technologies that are only partially adopted by their Canadian counterparts.

The Fish and Seafood Processing sub-sector is also considered to be lagging behind the other sub-sectors globally. However, interviews suggested that countries like Japan, Iceland, Norway and Denmark have adopted automation and robotics to remain competitive against the highly labor intensive model adopted by China and other Asian countries.

Although there are some initiatives amongst Canadian centres for technology and processing, the sector is lagging behind its European and Japanese counterparts. However, greater similarities are observed between US and Canadian fish processors in terms of the automation of their various applications.

Best practice also comes in the infrastructures. The model proposed by the Icelandic Seafood sector is an example of such

best practice[61]. It relies on an educated and integrated "cluster" that has the purpose of increasing the value and understanding of ocean-related activities in the country, including fisheries, research and innovation, biotechnology, technology manufacturing and logistics and finance.

Internationally, there is still room for improvement. Some species (e.g. crab and shellfish) and some applications remain labour-intensive in their raw food/processing and packaging applications.

### Prepared Meals, Bread, Fruits and Others

Interviews indicated that Canadian Food processing operations in this segment are similar or lagging behind their European and American counterparts. The level of automation and robotics for raw food/processing, packaging food and end-of-line applications tends to be higher for European countries like France and Norway. The segment shows similarities with the United States, with greater lags observed in the packaging/end-of-line applications (**refer to table on p. 55**).

However, Canadian food processors in this segment are not all lagging behind their international counterparts. For instance, the production of some frozen fruit/vegetable products.

Mexico and South American countries also tend to be very automated in their fruits and vegetables processing. While the cost of labour is lower in these countries and the availability of manual labour is greater than in most European countries, the United States and Canada, the processing applications are still very automated in these regions and the manual labour is mostly for harvesting.

Generally, frozen products (including frozen meals, fruits, vegetables, bread and bakeries) tend to display more automation and robotics than their fresh equivalents.

## Dry Food

Interviews indicated that the level of automation and robotics in this segment is similar, but sometimes lagging behind its European and American counterparts.

## Other Packaged Food and Ingredients

Interviews indicated that Canadian Food Processing operations in this segment are similar or lagging behind their European and American counterparts, but typically more automated than countries like Mexico, China and India. The level of automation and robotics is generally linked to the lower cost and availability of manual labour. As such, the regions of low-cost labour will generally use automation based on a safety (for employee) and cost-benefit (quality) analysis. For a given level of quality and assuming safe ergonomics for employees, firms want to minimize their cost of operations. The type of production is also a differentiating factor, with shorter runs of productions being less automated than large standardized productions.

Once again, the difference between Canadian food processors in this segment and their American and European counterparts lies mostly in the scale of operations as well as packaging and end-of-line applications. Greater flexibility is required in Canada due to the smaller scale of operations and the greater variability in products

that are processed at any given plant. But in general, variability in conjunction with speed of packaging are two factors that are increasingly important for snack food, confectionery and other sub-sectors in this segment.

## Beverages

Interviews indicated that Canadian processing operations in this segment are lagging behind or similar to their European and American counterparts. For other regions, such as South America, there seems to be a mix in the level of automation and robotics used by soft drink processing operations, with more recent installations being at the leading-edge of the industry. In some cases, Canadian Beverage processing firms are clearly ahead of foreign operations. This is usually the case in areas of low labour cost. Given the greater variability in recipes for the alcoholic beverages, this sub-sector tends to be less automated in their material handling and process control (transfers between tanks) than soft drinks and water. However, this lag is more important amongst Canadian processors than their European counterparts.

Case Studies for each of the segments were identified to support the benchmarking finding that several automation and robotics solutions currently exist for Food and Beverage processing operations. Moreover, all of these examples of adoption of automation and robotics in other countries emphasize the inherent need for customization and adjustment of technology and solutions across the Food and Beverage Processing sector.

# International Case Studies

❑ **Case Studies support the benchmarking findings and emphasize the need for customization and adjustment of technology/solutions across the sector**

### Germany: Automatic Slaughtering System - 2006

**Company: Westfleisch eG**

**Solution:** Introduction of four six-axis KUKA robots that are protected against moisture, contamination and cleaning agents by hygienic protective suits are integrated into the production line. Other principal components of the solution comprise a 3D laser measuring system, a PC evaluation software package, and a conveyor software package.

The overhead conveyor moves the carcasses continuously through the slaughtering line. Robots are synchronized with the conveyor (conveyor software) and a 3D laser measuring system provides precise data on the surface of the carcasses, accounting for the variability in size and anatomy of the pigs. The PC software evaluates the exact cutting coordinate and sends the information to the robot.

**Results:** Benefits include reduction in the cost of labour per pig, increased service life of the tools, ensuring sterility through automatic disinfecting of tools (water heated to 82º Celsius), and low space requirements.

BARA, Report number R 279, Robots automate slaughtering system

### Norway: Palletization of Dairy Products - 2003

**Company: TINE Meieriet Øst**

**Solution:** TINE implemented three jointed-arm palletizing robots (KUKA KR 180 PA) that can load a combined total of 1000 to 1200 pallets a week (ten pallets an hour). They can be controlled as two additional robot axes, meaning that all of the products in the filling lines can be handled. These robots have the ability to stack the products by type up to 1.3 meters high on europallets and change the stacking pattern in between each layer in order to increase stability. Slipsheets can also be inserted if needed. These robots can also be equipped with a servoelectric gripper that can extend its fork to varying lengths, thus making it possible to set down trays of varying widths and depths in a defined position. The servoelectric gripper has the ability to operate the hold-down devices with variable pressure.

**Results:** Benefits include significantly increased performance, flexible stacking patterns, gentle handling, and jobs secured.

KUKA Report. Palletizing of dairy products.

### Norway: Optimization of Pork Sides Cutting - 2002

**Company: Glide Hedmark og**

**Solution:** Robots are equipped with a circular cutter and a vision (image recognition) system. They perform a curved loin cut, followed by two horizontal cuts and another specialized cut. "The cutting paths are programmed via the control panel of the robot controller […] and selected or deselected with the aid of the vision system."
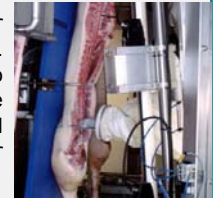
Robots are located on both sides of a two-track overhead conveyor, allowing continuous work by the robots. Additionally, the visually guided and oriented pork sides are stopped at a processing position, and an image recognition system measures four points on the backbone, the position of the hip bone, and two points on the leg. Locating fixtures ensure the pork sides stay in position during measuring and cutting, with only the neck holder allowed to swivel.

**Results:** Benefits include high cost-effectiveness, higher meat quality, excellent flexibility, and compliance with hygiene regulations.

BARA, Report number R 232, Robot optimizes cutting of pork sides.

## UK: Efficient Packing

**Company: Calypso Soft Drinks**

**Solution:** Introduction of three robotic packing cells by Motoman Robotics (UK) that allow for speed and precise positioning accuracy in the box-filling and pallet stacking applications with their six-axis format. One of the robots contains a handling device with vacuum suction cups for the pick-and-place function. It picks two six-packs or 20 cuplets using a dedicated gripper and places them into the box. The second robot places a separator card before the next layer is placed. Change over time for the robot cell is approximately five to ten minutes, which falls within the time needed to change over the filling line. The palletizing robot on the same line uses a vacuum-suction to grip the cartons which are palletized two at a time. Once a pallet load is completed, the pallet is moved away from the load area on a powered roller conveyor. The robot then picks an empty pallet from an integrated pallet stacker using hook-type lifters built into the box handling attachment.

**Results:** Benefits include improvements in efficiency, flexibility, precision and quality.

Motoman Robotics (UK) LTD. Press Release. Efficient Robotic Packing Speeds Soft Drinks Manufacture.

## United States: Automatic Storage Systems

**Company: Weldon Solutions**

**Solution:** The E300 (single-level) and the E310 (multi-level) Automated Pan Storage Systems are automated storage and retrieval systems that allow for pans and lids to move quickly and efficiently from production to storage without the help of an operator. Also the E320 Automated Trough System allows for a seamless integration of the mixing and make-up equipment and controls the fermentation process. These two-line and multi-level systems efficiently store stacked pans and troughs and have interfaces with conventional or robotic pan stacking equipment, as well as a laser guided in all axes.

**Results:** Benefits include reduced labor costs, real-time quality control, reduced interruption, reduced expenses and extended equipment life.

Weldon Solution. Bakery Automation Brochure

## Denmark: "A mill upgraded" – 2008

**Company: Lantmännen Group**

**Solution:** Buhler integrated the existing grain silos and the finished products bins to the new facility, which comprised two soft-wheat mills with grinding capacities of 240 t/24 h and 480 t/24 h as well as a rye mill with a capacity of 180 t/24 h. A new flour storage and handling system were added, including a bulk loadout section with a holding capacity of 5000 metric tons. A new pellet mill was built to process all the byproducts of the new facility, which are sold to feed manufacturing plants. All the plant sections from grain storage and cleaning to grinding and flour storage and handling with bagging and bulk loadout were equipped with cutting-edge machines, sensors, and technologies as to allow for full automation of processes and to ensure consistently high product quality and prevent operating error as much as possible. Buhler WinCos' navigation system allowed for the smart fine-tuning of processes, determining the "right path" for the materials to follow in terms of energy consumption and/or throughput capacity. The system minimizes the inputs from operators and minimizes the risk of human error to achieve optimal capacity utilization and energy management. Aside from operational optimization, the system allows for early maintenance warning, energy utilization status and quality monitoring. The new plant also allows for complete traceability, using automatic recipe management and closed control circuits for ash and gluten, ensuring optimal product consistency and reproducibility. The mill is also equipped with a multimedia information center that automatically provides information on irregularities by SMS or e-mail.

**Results:** Benefits include complete traceability, efficient energy management, quality and safety monitoring and reliability.

Bühler Automation – News. A mill upgraded. 2008

# 3 | Gap Analysis

# Drivers and Barriers

- **Production-related factors were ranked by Canadian processors as most important driver of automation and robotics (on average)**

- **Cost savings and product safety and quality were considered close drivers in terms of automation and robotics**

- **Manual labour cost and availability were considered very important by most interviewees**

- **Cost of automation and robotics was ranked as a key barrier**

Food and Beverage processing firms in Canada recognize the various advantages that automation and robotics can have on their productivity, efficiency, products and in general, on their ability to compete within their local market and internationally.

### Drivers – Canadian Processors

Interviewed Food and Beverage processing operations ranked production-related factors (cost savings, productivity, etc.) as the first or second most important driver of adoption of automation and robotics in 95% of cases. Employee and consumer related factors were also generally ranked as important reasons for automation and robotics (among the top three drivers in 82% and 89% of interviews).

### Table 3.1

| Rank | Drivers | | | | |
|------|---------|-----------|-----------|-------------|--------------|
|      | Production | Employees | Consumers | Legislation | Market Share |
| 1st  | 74% | 8% | 18% | 2% | 2% |
| 2nd  | 21% | 34% | 29% | 5% | 9% |
| 3rd  | 5% | 40% | 37% | 3% | 13% |
| 4th  | 0% | 14% | 12% | 47% | 30% |
| 5th  | 0% | 5% | 3% | 44% | 47% |

### Figure 3.1
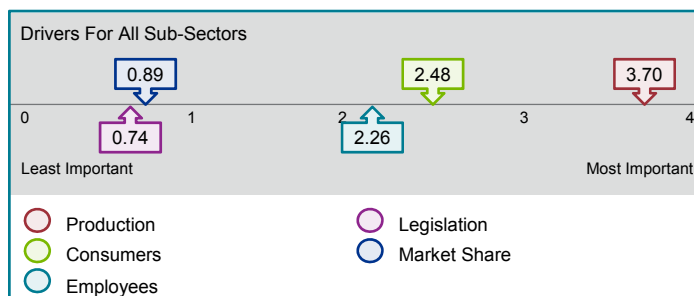


Drivers For All Sub-Sectors

Generally, labour cost saving was an important driver. The decreasing availability of manual labour and the changing and aging demography of available labour were also recognized as a key factor influencing the adoption of automation and robotics. Firms also valued the importance of improving working conditions and ensuring to provide a sound work environment to employees.

Cost savings and product safety and quality (consumers) were considered close drivers in terms of importance, with the common objective being to produce safe products of quality at a competitive price. In segments where product differentiation is important, innovation and consumer preferences were also considered key drivers.

Cost of operations (i.e. land, electricity, etc.) was considered as an increasingly important driver of automation and robotics.

Overall, food health and safety legislation/regulation was rarely considered a key driver of automation and robotics. Most of the interviewed Canadian processors considered their operations as above standards. However, it was recognized that specific instances or changes in legislation/regulation may occasionally lead to change in automation and robotics.

Market-share factors were most frequently thought of as a consequence of the other decisions, rather than a driver of automation and robotics. Although trade agreements can affect the competition's composition, these were not generally considered direct drivers of automation and robotics.

# Drivers and Barriers

- **Financing (sources and availability) was considered an important barrier, though less consistently ranked**

- **The limited availability of technology in some sub-sectors or types of applications and the adjustments/re-engineering of existing technology was often considered an important barrier**

- **The shortage of skilled labour that can operate and maintain the technology was also mentioned as a top barrier to the adoption of automation and robotics by Canadian processors**

**Barriers – Canadian Processors**

Interviewed Food and Beverage processing operations ranked cost (initial cost, cost of training, hiring and maintenance, legacy systems) as the first or second most important barrier to automation and robotics in 74% of cases. While initial costs remain important drivers of the measured gap in automation and robotics, especially for smaller scale operations, costs were often considered within the context of return on investment (ROI), with a longer time horizon (usually 2-5 years depending on firm size) used for anticipated payback.

**Table 3.2**

| Rank | Barriers | | | |
| --- | --- | --- | --- | --- |
| | Cost | Operations | Market and Financing | Perceived Risks |
| 1st | 38% | 5% | 31% | 25% |
| 2nd | 36% | 22% | 23% | 17% |
| 3rd | 22% | 39% | 17% | 22% |
| 4th | 5% | 34% | 27% | 33% |
| 5th | 0% | 0% | 2% | 3% |

**Figure 3.2**



Barriers for all sub-sectors

1.98    2.56    3.06

0    1    2    2.28    3    4

Not Automated / Important                    Very Automated / Important

○ Cost    ○ Market and Financing
○ Operations    ○ Perceived Risks
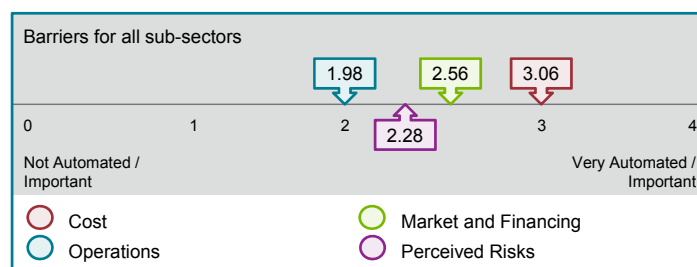
Although financing (sources and availability) was considered an important factor by some of the interviewed firms, this barrier was less consistently ranked than cost by interviewed firms. Smaller firms tend to be more concerned with financing than larger scale

operations. However, amongst larger scale operations, firms that were subsidiaries or divisions of multi-national corporations faced the challenge of internal competition for available funding. In this sense, firms considered outside sources of funding as playing an influential role in obtaining internal financing.

The adoption of new technology comprises a number of risks for Food and Beverage processing firms. Notably, several interviewed firms considered the availability and/or limitations of existing technologies to be an important risk factor in the adoption of automation and robotics, with some segments being more exposed to such risk than others.

Some of the interviewed firms recognized that company culture can be an important barrier to automation and robotics, with some firms currently facing that challenge or recognizing that culture had been an issue in the past. Others considered their organization to have a culture towards automation and robotics.

For the majority, interviewed Canadian Food and Beverage processors did not consider themselves as leaders of automation and robotics, although culture was not a barrier per se.

Although the shortage of skilled labour that can operate and maintain the technology was not one of the proposed choices of barriers, most of the interviewed operations recognized that this was a key challenge to the adoption of automation and robotics. Some firms also considered this factor to be the number one barrier to automation and robotics for their operations.

Lastly, many of the older, legacy plants considered the space and flow/configuration required by automation and robotic technologies to be a barrier. For some of the larger firms, rather than implementing new/leading-edge technologies in their existing infrastructure, older plants are closed as greenfield plants are developed.

- ❑ **On average, drivers of automation and robotics for non-Canadian operations were similarly ranked**

- ❑ **European countries have had to face the issues regarding cost and availability of labour before it became an issue in Canada. This is increasingly becoming important in the US as well**

- ❑ **ROI and cost were ranked top barriers by non-Canadian processors**

- ❑ **Skilled labour was generally considered more readily available in European countries and the US**

### Drivers – International Processors

Key drivers of automation and robotics for interviewed non-Canadian Food and Beverage processing operations were similarly ranked to Canadian processors in their importance.

**Table 3.3**

| Rank | Drivers | | | | |
|------|------------|-----------|-----------|-------------|--------------|
|      | Production | Employees | Consumers | Legislation | Market Share |
| 1st  | 73%        | 13%       | 27%       | 7%          | 7%           |
| 2nd  | 7%         | 73%       | 13%       | 0%          | 0%           |
| 3rd  | 20%        | 13%       | 53%       | 0%          | 7%           |
| 4th  | 0%         | 0%        | 7%        | 40%         | 47%          |
| 5th  | 0%         | 0%        | 0%        | 53%         | 40%          |

Manual labour was an important source of differentiation between Canada and Europe. European countries (e.g. France) have had to face the issues regarding cost and availability of labour before it became an issue in Canada. Moreover, some of these countries also face strict labour legislation that acted as a driver to automation and robotics. The United States is increasingly facing the same issues with regards to manual labour cost and availability faced by Canadian processors.

For emerging countries, manual labour tends to be readily available at a lower price than in Canada, the United States and Europe. This driver was thus attributed less importance than in developed economies. Yet, labour availability issues were mentioned in some of these regions, as was the rising cost of labour.

### Barriers – International Processors

Although costs remained a key barrier for non-Canadian Food and Beverage processing operations, ROI was generally considered a key factor in their decision of adopting automation and robotics (ranked first in 60% of cases).

**Table 3.4**

| Rank | Barriers | | | |
|------|------|------------|----------------------|-----------------|
|      | Cost | Operations | Market and Financing | Perceived Risks |
| 1st  | 33%  | 0%         | 60%                  | 7%              |
| 2nd  | 33%  | 13%        | 13%                  | 20%             |
| 3rd  | 20%  | 67%        | 0%                   | 13%             |
| 4th  | 13%  | 20%        | 27%                  | 40%             |
| 5th  | 0%   | 0%         | 0%                   | 20%             |

Generally, large multi-national companies or European-based operations considered cost in light of ROI, rather than as an individual factor.

Technology-associated risks were more frequently a factor of importance for firms operating in the Meat, Fish and Seafood segment.

Compared to Canada, corporate culture was generally less of a barrier for operations located in the US or Europe. However, legacy systems could pose issues.

The availability of skilled labour was sometimes mentioned as a barrier for some of the firms interviewed in the United States and outside of Europe.

### Differentiating Factors

Interviews with Canadian processors provided some granularity with regards to the factors affecting the various sub-sectors' adoption of automation and robotics. Detailed results of drivers and barriers for all Food and Beverage Processing sectors within the scope of this study are presented in **Appendix IV, Q.9/10**.

**Manual Labour**

Whereas the availability of manual labour is affecting the entire Food and Beverage Processing sector, the harsh work environment provided by the Meat, Fish and Seafood segment

- **A number of factors can explain the differences in the level of adoption of automation and robotics across the various sub-sectors/ segments of analysis. These include:**

  - ✓ **Availability of manual labour**

  - ✓ **Availability of robotics and automation solutions**

  - ✓ **Food safety and quality requirements**

  - ✓ **Profit margins**

  - ✓ **Volume**

  - ✓ **Seasonality**

  - ✓ **Flexibility**

  - ✓ **Market**

**Manual Labour (cont'd)**

exacerbates this issue as these sub-sectors are generally considered less attractive to the changing workforce. Attracting and keeping labour requires an adjustment at the operational level to reduce the use of manual force for heavy lifting and other difficult tasks.

**Availability and Transferability of Automation and Robotics**

A source of differentiation for the Meat, Fish and Seafood segment is the limited availability of proven technology for the sub-sectors. Automation and robotics developers have only recently begun to create technology and adapt existing solutions to meet the requirements of firms in these sub-sectors. The harsh environment (low temperature, thorough and daily wash-downs of equipment) inherent to these sub-sectors, as well as the food and safety standards explain the observed lag in the adaptation of technology compared with other sectors.

Moreover, the transfer of technology from another country can prove itself to be difficult and challenging, especially for primary meat processing and fish and seafood processing operations. There is no guarantee that the technology can be properly implemented and adjustments are often required which, add to the costs of adopting these technologies. Although adjustments are generally needed with automation and robotics, the variability of inputs, the varying food health and safety requirements (by country) and the relatively young market for automation and robotics in this segment add another layer of difficulty to an already existing barrier.

**Food Safety and Quality**

Food safety has different implications across the various Food and Beverage processing sub-sectors. The concerns are generally the greatest for meat, fish, seafood and other fresh produce like fresh fruits and vegetables that are prepared and packaged for direct consumption.

The importance of quality is also much more important for fresh fruits and vegetables than for canned products, because the shelf life is much shorter for these products and because of consumers' expectations (bruised fruits will not be purchased by consumers, and this loss is absorbed by processors, not consumers or distributors). The high quality and safety requirements for fresh produce have been a driver of automation and robotics for this sub-sector. Firms have increasingly adopted technology that helps reduce the time between harvesting and consumption/purchase, increase productivity, reduce direct contact between employees and food products and overall improve the quality of the products.

**Profit Margins and Market**

The size of the margins for any given sub-sector can also be a differentiating point in automation and robotics, driving increased adoption of technologies that allow for small improvements of margins.

However, the maturity of the sub-sector also plays a role in determining whether investments in automation and robotics can be done to improve slim margins.

In commodity type of markets (e.g. some frozen meals, canned products, primary processing), reducing operating costs can become increasingly important and, depending on the profit margins and other factors (e.g. enterprise culture), it may lead to increased use of automation and robotics. Consolidation of markets can also become a key driver of automation and robotics.

**Volume**

Standardization of production allows for greater volume of production and greater use of automation and robotics. Volume has thus been a differentiating factor of automation and robotics across the various Food and Beverage Processing sub-sectors.

# Drivers and Barriers

**Differentiating Factors (cont'd)**

Notably, firms operating in the dry food segment and in the non-alcoholic beverages sub-sector tend to be more automated in their raw food/processing and packaging applications than sub-sectors that involve or require greater variability in these applications.

**Flexibility / Variability**

Variability of inputs (within and across species) is an important differentiating factor for the Meat, Fish and Seafood segment, having contributed to the observed lag in automation and robotics globally. The availability of proven and easily transferable technology that can account for this variability is limited for this segment, thus creating a barrier.

The availability of high output/low downtime flexible automation and robotics for raw food/processing and packaging applications in the Dry Food Segment is also of concern, acting as a potential barrier for plants that manufacture several types of products in a number of packaging formats.

**Seasonality**

Seasonality differentiates the Fish and Seafood sub-sector from other sub-sectors by reducing the short-term/medium-term return on investment (ROI). Given the numerous species processed by any given company, equipment that does not account for this variability of inputs is not as attractive for less specialized plants. This seasonality has contributed to the current state of automation and robotics in the sector.

# Drivers and Barriers – Summary Chart

The following table summarizes the factors affecting the adoption of automation and robotics for the various segments of analysis.

- ❑ **A number of drivers and barriers are common to all segments**

- ❑ **Other drivers and barriers vary across the different segments of analysis**

| Table 3.5 | Meat, Fish and Seafood | Prepared Meals and Others | Dry Food | Other Packaged Food / Ingredients | Beverages |
|---|---|---|---|---|---|
| **Drivers** | | | | | |
| **Production-related factors** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Product safety and quality** | ✓ **Greater concerns** | ✓ **Greater concerns** | ✓ | ✓ | ✓ |
| **Skilled labour availability** | ✓ **Less attractive than other sub-sectors** | ✓ | ✓ | ✓ | ✓ |
| **Consumer / product innovation** | | ✓ | | ✓ | |
| **Market type** | ✓ Commodity-like / low differentiation products | ✓ Commodity-like / low differentiation products | ✓ Commodity-like / low differentiation products | | |
| **Market Consolidation** | | ✓ Dairy / Cheese | | | |
| **Barriers** | | | | | |
| **Cost / ROI** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Manual labour cost** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Manual labour availability** | ✓ **Less attractive than other sub-sectors** | ✓ | ✓ | ✓ | ✓ |
| **Availability of proven technology** | ✓ **Limited / recent** | | | | |
| **Technology transferability** | ✓ **Limited / re-engineering** | ✓ | | ✓ | ✓ |
| **Harsh environment** | ✓ **Affects labour and technology supply** | | | | |
| **Seasonality** | ✓ **Affects labour and technology supply** | | | | |
| **Flexible technology availability** | ✓ Variability of inputs and products; limited technology/re-engineering | ✓ Recipe | | ✓ Recipe, packaging; limited technology/re-engineering | ✓ Recipe, packaging, product value |
| **Volume** | ✓ | ✓ | | ✓ | ✓ Product value affects scale of production |

❑ **Differences in the level of automation and robotics between Canada, the US, Europe and the rest of the world can be explained by differences in:**

✓ **Volume of production and market size/access**

✓ **Manual labour availability and cost, and labour legislation**

✓ **Capacity and infrastructure for automation and robotics in the sector, which includes skilled labour, university programs, machine and equipment developers, integrators and other supporting infrastructure**

✓ **Culture**

### Canada – United States (US)

Amidst some similarities, the Food and Beverage Processing sector in Canada is lagging behind the United States in its level of adoption of automation and robotics. The drivers and barriers to automation are generally similar for Canadian and American Food and Beverage processing firms. However, a number of factors help explain the similarities and differences between the two countries, namely:

**Volume:** The market serviced by American Food and Beverage processing firms is much larger than in Canada. As such, the volume of production tends to be greater for American companies than their Canadian counterparts. Given that scale plays an important role in the viability of investments in automation and robotics, the larger scale of American Food and Beverage processing firms is a factor that distinguishes American firms from Canadian ones. The gap tends to be present even for most automated sub-sectors like confectionery and soft drinks. Subsidiaries of large international companies compete internally for capital investment. The hurdle rate that must be achieved is more easily attainable when operating entities have the volume that justifies the investment.

**Manual Labour:** The cost of manual labour, including wage and other benefits, is lower in the United States than in Canada, which can explain why some applications are sometimes less automated in American Food and Beverage processing operations than in Canada. The availability of manual labour is also more prominent in the US than in Canada. However, interviews indicated that this trend is changing, with labour issues becoming increasingly prevalent in the US.

**Capacity:** Canada and the United States also differ in their capacity to automate and adopt robotics. This capacity relies on the availability of skilled labour who can operate the automation and robotics, of engineers trained to the demands of the sector and of infrastructures that promote, develop and integrate automation and robotics in the Food and Beverage Processing

sector. However, Canada is lagging behind the US in its capacity and supporting infrastructure. The Canadian market is characterized by the absence of food engineering programs, low presence of machinery and equipment providers within the country and low access to service for machine and robots, positioning the Canadian Food and Beverage Processing sector at a disadvantage to its US counterparts.

**Culture:** Differences between Canada and the US also stem from corporate culture and management's level of risk aversion. Interviews pointed towards American companies being more inclined to adopt technology that is riskier/less proven, whereas Canadian enterprises would be inclined to keep the technology currently used given that it is functional, sufficiently efficient and productive. In this sense, the observed lag between Canada and the US, with regards to the adoption of automation and robotics as well as the associated R&D, can be attributed to some extent to their differences in corporate culture.

### Canada – European Countries

A number of European countries are providing automation and robotic technologies for the rest of the world and are leaders in their field of expertise. Such countries include Germany, Italy, Netherlands and Iceland. Canadian Food and Beverage processing firms are lagging behind these and other European countries. The difference is mostly due to:

**Volume:** Population in European countries is more dense than in Canada and each country is in relatively close proximity to one another. The distance that must be traveled to reach the target market is significantly different than in Canada and, as such, Food and Beverage processing operations in European countries tend to produce a much larger volume than their Canadian counterparts.

**Manual Labour:** The cost of manual labour, including wage and other benefits, is lower in Canada than in most European countries.

Although Canadian minimum wage continues to rise, labour cost has contributed to the existing gap in adoption of automation and robotics in the Food and Beverage Processing sector. Restrictive labour legislation (limiting heavy, repetitive tasks) and the type of labour available are also factors that have impacted the adoption of automation and robotics amongst European countries over the past decades.

**Capacity:** Europe's capacity to adopt automation and robotics in the Food and Beverage Processing sector is greater than in Canada. The infrastructure needed to support automation and robotics in the sector has been in place for a while. Most machine and equipment providers (including automation and robotics) are located in Europe and major investments have been made by both the private and public sectors. Communication and collaboration between the private and public sector and between Food and Beverage processing firms, machine builders and academia are also part of the infrastructure that has enabled the current level of automation and robotics in the sector. Labour is trained to develop, integrate and maintain these technologies.

**Culture:** Another differential factor for the Canadian Food and Beverage Processing sector compared to some European countries is the manufacturing culture. Whereas Canada has several viable economic sectors that contribute to the health of the country (including natural resources), these European countries have had to rely on manufacturing (including Food and Beverage) to a much greater extent. In order to ensure the competitiveness of this sector, the public and private participants of these European countries have encouraged a culture towards innovation, automation and robotics, becoming specialized in Food and Beverage processing.

Considering countries that were part of the old USSR, operations that are moving to these countries are typically Greenfield projects, such that a mix of leading-edge and very old operations is observed.

**Canada – Australia, New Zealand and Emerging Countries**

Compared to non-US/European countries, Canada typically uses a greater to similar level of automation and robotics. In China, there are typically two models co-existing: one that is very labour-intensive and one that is very automated. China is characterized by its availability of low-cost labour. However, if sufficiently competitive and with large enough volumes, these operations can move to the other extreme, fully automated plants. As such, China would typically be considered less automated than Canada in its Food and Beverage processing applications. However this statement does not depict the entire picture. As quality and safety of processed food continue to rise, Chinese Food and Beverage processing operations are expected to adopt a greater level of automation and robotics.

Japan is another country that is home of innovation and production of automation and robotics. While in some applications, Japan may be leading ahead of Canada, it remains similar in others.

South Africa, India and South America are also characterized by lower cost and greater availability of labour. However, the level of automation and robotics tends to vary by sub-sector of activity and applications. Sub-sectors characterized by standardized production will typically be at least partially automated in their raw food/processing applications, with a larger proportion of manual labour involved in material handling and packaging applications.

The level of automation and robotics in Food and Beverage Processing Operations in Canada is overall similar to that observed in Australia and New Zealand, with potential variations in some sub-sectors (e.g. wine).

□ **The technology used by Canadian processors does not necessarily differ from that developed and used in the US, Europe or elsewhere, it differs in the extent to which it is adopted in the sector and in the maturity of the equipment used**

Factors affecting cross-country differences include:

**Volume:** The scale of operations varies across and within the aforementioned regions and remains an important factor affecting the adoption of automation and robotics. Although Chinese operations are characterized by a high volume of production, these do not forcibly entail greater automation and robotics.

**Manual Labour:** The cost of manual labour, including wage and other benefits, is more expensive in Canada than in China, India, South America and South Africa. The availability of manual labour is also more prominent in these areas than in more developed economies. The cost and availability of labour in Canada is somewhat similar to Australia and New Zealand.

**Capacity:** With the potential exception of Japan, Canada is likely to be at par or above the other mentioned countries in terms of capacity. Although Canada is not a large producer of automation technology and robotics, it has several of the other elements needed for the creation of a solid infrastructure that would promote automation and robotics in the Food and Beverage Processing sector. The capabilities are present and the climate is favourable to enterprises looking to become or remain competitive in their sub-sector.

**Sub-Sectors/Applications:** The sub-sector of activity affects the differences across countries. For instance, soft drinks and water processing is typically similar in automation and robotics across countries, with a small downward bias for economies where low-cost manual labour is readily available. However, these economies are gradually upgrading their operations, reducing the gap in automation and robotics with Europe and the United States. Overall, bulk processing operations (e.g. rice) are more likely to be fully automated in the raw food applications, whereas the level of automation in packaging applications varies to a greater extent.

**Quality and Safety:** As consumers increasingly demand safe products of quality and as governments increasingly regulate the sector, the gap in automation and robotics amongst Food and Beverage processing firms is likely to decrease.

### Technology Assessment

Most of the automation and robotic technologies used in Canada is manufactured in Europe (raw food/processing and packaging applications; automation and robotics), in the United States (packaging applications and robotics solutions) or in Japan (robotics). This is true for most countries. As such, the technology used does not necessarily differ in nature, but rather in the extent to which it is used and in the maturity of the equipment used.

For instance, solutions for packaging applications have been well-developed in Europe as well as in the United States. However, Canadian Food and Beverage processing firms use a combination of older automation machinery for case packing and palletization applications, as well as robots. The latter provides greater flexibility and improves upon older technologies. Yet, the uptake of robots for packaging applications is only partial in Canada.

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**Best Practice Examples**

### Financing and Incentives in Germany

Germany offers a number of financial assistance instruments that come from private sources or incentive programs available to all firms. The following figure highlights the various instruments available. Cash incentives are provided in the form of non-repayable grants to complement the financing of investment-related expenditures (buildings, equipment or machinery). In Eastern Germany, these are complemented by an investment allowance typically allotted as a tax credit (or tax-free cash payment). A number of labor-related incentives are also in place that can help build a workforce and reduce the operational costs incurred by new operations.

Several incentive programs are in place for R&D project funding, aiming at reducing the operating costs of these projects. Regional, national and European programs exist that are independent from the investment incentives. National R&D project funding in Germany is concentrated in the "High-Tech-Strategy" to promote the development of cutting-edge technologies.

Germany Trade & Invest is an important source of assistance and education on the various incentives offered (www.gtai.com). Their team of industry experts assists Food and Beverage processing companies with project management assistance, location consulting/site evaluation, support services and getting all the information they need.

**Table 3.6**

| Investment Incentives | | | Operational Incentives | |
|---|---|---|---|---|
| Cash Incentives | Interest-Reduced Loans | Public Guarantees | Labor-Related Incentives | R&D Incentives |
| GRW (Investment Grant) | KfW Loans (National Level) | State Guarantees | Recruitment Support | Grants |
| IZ (Investment Allowance) | State Development Bank Loans | Combined State/Federal Guarantees | Training Support | Loans |
| | | | Wage Subsidies | Silent/Direct Partnership |

*Germany Trade & Invest*, The Food & Beverage Industry in Germany, Issue 2012/2013

## Combining Complementary Talents in the Netherlands

The Netherlands' Food and Beverage industry is working in close collaboration with universities and other knowledge organizations. These public-private partnerships are encouraged and valued by the Government and parties involved. For private parties, these partnerships allow them to retain flexibility by working with external experts while keeping access to scientific knowledge. For universities and other knowledge institutes, they are given the opportunity to achieve greater scientific excellence, with direct applications. Top Institute (TI) Food and Nutrition is an example of these public-private partnerships. The institute was founded in 1997 as a result of the initiative of companies and the Dutch government to encourage such partnerships in the sector. Its partners are numerous in the sector. ACTA, Maastritch University/MUMC, NIZO food research, TNO, University of Groningen/UMCG and Wageningen University and Research centre are amongst the institutes' research partners.

The Netherlands public-private partnership and the important amount of R&D activity taking place in the Food and Beverage sector are key to the success of the sector.

Although the Netherlands is a small country, it is the second largest exporter of agri-food products in the world, surpassed only by the United States. The industry contributes €48 billion added value for the Dutch economy. The Netherlands ranked second (as a % of GDP) in Europe for private investments in R&D made by companies located in the country, and two Dutch Universities are featured in the European top 10 regarding their number of agri-food-related publications.

# Gaps and Challenges Faced

❑ **Gaps and challenges faced by the Canadian sector include:**

✓ **Gaps in sub-sector availability of technology, with the Meat, Fish and Seafood segment lagging behind other sub-sectors**

✓ **Gaps in application-specific availability of technology, with more solutions in the packaging/end-of-line applications than in raw food/ processing applications**

✓ **Variability of inputs and products poses a challenge to automation and robotics development and adoption**

Canadian Food and Beverage processing firms in Canada face a number of challenges in the adoption of automation and robotics. Some of these challenges have translated into gaps that must be addressed in order to ensure competitiveness of the concerned sub-sectors. These are summarized below.

**Gaps in Availability of Technology – Sub-Sectors**

Meat Products and Fish and Seafood sub-sectors are characterized by an overall lag in the adoption of automation and robotics for applications that have been available to other Food and Beverage processing sub-sectors. The main reasons for this lag have been the harsh environment and the safety requirements inherent to these sub-sectors. Manufacturers of technology have only recently begun to address these issues.

Based on the interviews conducted with non-Canadian processing firms and associations, Canadian Fish and Seafood processors tend to be similarly to somewhat less automated in their level of automation and robotics to the United States and Australia, with the difference lying mostly in the automation of packaging applications. Compared with European countries such as Iceland, Norway and Denmark, the Canadian sub-sector is lagging in all types of applications. Similar lags are observed for the meat processing sector with the Netherlands and Germany.

As such, while these sub-sectors have only recently begun to adapt and develop automation and robotics solutions in line with the nature of their products and processes, there remains a lag that must be addressed, the size of which varies depending on the country of operation.

**Gaps in Availability of Technology – Applications**

The availability of automation and robotic technologies for the Food and Beverage Processing sector varies across the various types of processing applications. Notably, the packaging applications tend to have a variety of automation or robotic options available. Labeling, secondary packaging and palletization are less specific to the sub-sectors and as such can

be applied to wider range of operations. However, these solutions tend to be standardized, large-scale options that are mostly adopted by larger operations, which can partly explain why these are not consistently adopted amongst Canadian Food and Beverage processing firms. Additionally, primary packaging and most of the raw food/processing applications tend to be sector specific, if not product specific. This is one of the reasons why automation and robotics have lagged in the Food and Beverage Processing sector (especially Food) compared with other industries. While the Food Processing sector is considered an area of current and future growth for the adoption and development of automation and robotics, it is still lagging behind the automotive industry.

**Addressing Variability**

Beef and pork have added another challenge for the Meat Products sub-sector. The slaughtering and primary processing of these animals tend to be more difficult to automate due to their heavy and variable size observed within each species. This variability in the size of animals was mentioned as a barrier to the transfer of existing technology. In some instances, the solution created in another country could not adjust to the variability in the size of animals to be cut in Canada.

Such variability in size also exists within any species of fish. While the sorting according to size is sometimes done mechanically, the preparation of the fish prior to processing remains highly manual, partly due to the variability in the anatomy of each fish.

**Capacity, Infrastructure and Technology Transfer**

The challenge faced by Meat, Fish and Seafood processing firms in the adoption of already existing automation and robotic solutions is a consequence of the gap in capacity and infrastructure common across the sector in Canada. That is, automation equipment, machinery and robotics are rarely developed or even manufactured in Canada.

# Gaps and Challenges Faced

**Capacity, Infrastructure and Technology Transfer (cont'd)**

European countries, such as Germany, Italy and the Netherlands, are amongst the most important providers of automation technology for most of the world, including Canada. The United States is also an important source of automation, and especially robotics, along with Japan. The lack of capacity for Canada to develop automation and robotics for the Food and Beverage Processing sector leads to other issues, such as the limited compatibility of existing technology with Canadian operations and the lack of training expertise within Canada. As such, any transfer of technology requires adaptation and its implementation is typically assisted by foreign experts, brought in by the suppliers in question. These factors add cost and uncertainty to the adoption of automation and robotics by Canadian Food and Beverage processing firms.

A recent study[62] conducted by The Planning Group Inc. concluded to the weakness of the Canadian automation and robotic infrastructure with regards to the limited presence of Food and Beverage component manufacturers within Canada (mostly coming from Europe). The study also suggested that this issue is not specific to the Food and Beverage Processing sector, but rather consists of a general characteristic of the Automation and Robotics sector in Canada. Amongst the factors identified by the study that impact component manufacturing in Canada were the higher cost of components in Canada, currency fluctuation and exposition to US dollar, as well as lower domestic demand.

Although the Automation and Robotics sector in Canada displays several strengths, these are not uniform across the various manufacturing sectors[63]. While interviewed firms generally agreed that system integration, automation controls, PLC and software programming firms are generally well established in Canada and readily accessible by Food and Beverage processing firms (at least in the Toronto – Montreal areas), Canadian operations were

perceived as weaker when specialized skills and knowledge were required. As such, whenever more specialized skills/knowledge were required, initial access to expert integrators for the foreign components were generally negotiated in the purchase contract.

Nonetheless, there are a number of knowledge institutes within Canada that develop or integrate Food and Beverage automation and robotic technologies, some of which could be characterized as innovative and leading-edge. The key weakness with regards to innovation and R&D lies in the limited amount of pure R&D activities, especially those emerging from close collaborations between integrators, universities and other knowledge institutes specialized in the sector. Moreover, mechanical engineering programs focused on the Food and Beverage Processing sector are generally rare across Canada, with some level of sector-specific internship programs.

Lastly, automation and robotic resources for the Food and Beverage Processing sector tend to be located in close proximity of most processing operations, that are near Toronto and Montreal. The limited access of available resources further poses a challenge to processing firms outside of these areas. Since smaller firms rarely have an engineer in place who can immediately repair automation and robotics, the limited availability of readily accessible resources can affect the level of adoption of automation and robotics for firms located further away from these main processing centres.

The Planning Group's assessment of the Automation and Robotics sector in Canada revealed that although the sector displays a number of weaknesses, it also possesses a number of strengths and assets that would benefit from greater information sharing, education of end users, marketing of system integrators and other resources, as well skill development.

# Gaps and Challenges Faced

✓ **Space and flow/configuration of legacy plants acts as a barrier to higher automation and robotics adoption**

✓ **Seasonality affects different sub-sectors, reducing the ROI timeline and affecting labour requirements**

✓ **The smaller scale of Canadian processing operations creates a hurdle to automation and robotics**

✓ **The limited availability of customized solutions limits the adoption of automation and robotics**

### Skilled Labour

The difficulty to find skilled labour to operate and maintain the equipment purchased abroad and integrated by foreign engineers is another challenge faced by the sector. As Canadian Food and Beverage processing firms are looking to increasingly adopt automation and robotics, the shortage of skilled labour creates a barrier for which there are limited immediate solutions. While governmental incentives are in place to assist in training labour for the required skills, the limited supply of skilled labour for the whole sector translates into another challenge in the retention of employees, rising further the cost of automation and robotics.

### Legacy versus Greenfield Plants

The Canadian Food and Beverage Processing sector also faces important challenges related to its older, legacy plants. Existing infrastructures/legacy plants often lack the space and flow/configuration required by automation and robotic technologies. Thus, the adoption of automation and robotics by Canadian Food and Beverage processors generally occurs incrementally, unless new plants are built. In this case, plants are generally designed to implement available technologies. This difference in infrastructure of the various plants can explain observed gaps in automation and robotics within sub-sectors and between Canada and other countries.

### Seasonality

Seasonality is another challenge faced by Fish and Seafood processors. The cost of automation and robotics is more difficult to justify as the technology adopted is rather specific to the species processed. Wild fish/seafood processing is seasonal and so is their processing. Any return on investment will be affected by this seasonality and is thus an important challenge faced by firms looking to automate their operations.

Seasonality also poses an issue for fresh Fruits and Vegetables processors. Since fruits and vegetables production is seasonal in

Canada and that the window of time from harvesting to the grocers market is narrow for fresh produce, there is a temporary peak in production that must be addressed with either increased labour or automation.

While temporary labour can address the temporary needs associated with seasonality, this option is becoming less attractive as the working population continues to change. On the other hand, increasing automation can also mean that for most of the year, processing plants are working under optimal capacity, with only these short periods where they operate at full capacity. This challenge is common to all processors of seasonal food and beverages, including confectionery.

### Scale

The scale of processing applications increases the ability of food processors to justify their investment in automation and robotics. The horizon for which processing firms expect a return on investment is typically 2 to 3 years. Larger operations can typically afford a 5 years pay-back horizon, which helps them recover the initial costs of automation and robotics (technology and all of the surrounding software, hardware, adaptation and implementation costs).

However, for Canadian Food and Beverage processing firms, larger scale operations do not always imply a greater use of automation and robotics than smaller operations. The organizational culture will usually play a role, such that smaller firms in a sub-sector may well be as automated or ahead of their larger competitors. Moreover, large Canadian Food and Beverage processors are generally lagging behind their European and American counterparts.

### Custom Solutions versus Standard Solutions

Overall, there is a need for more customized solutions, as opposed to standardized ones, within Canada to address the need of the market. Given that Canadian Food and Beverage

# Gaps and Challenges Faced

✓ **The high concentration of distributors raises the need for price competitiveness and automation and robotics requirements**

✓ **The maturity of the sector and the company culture can limit the adoption of automation and robotics**
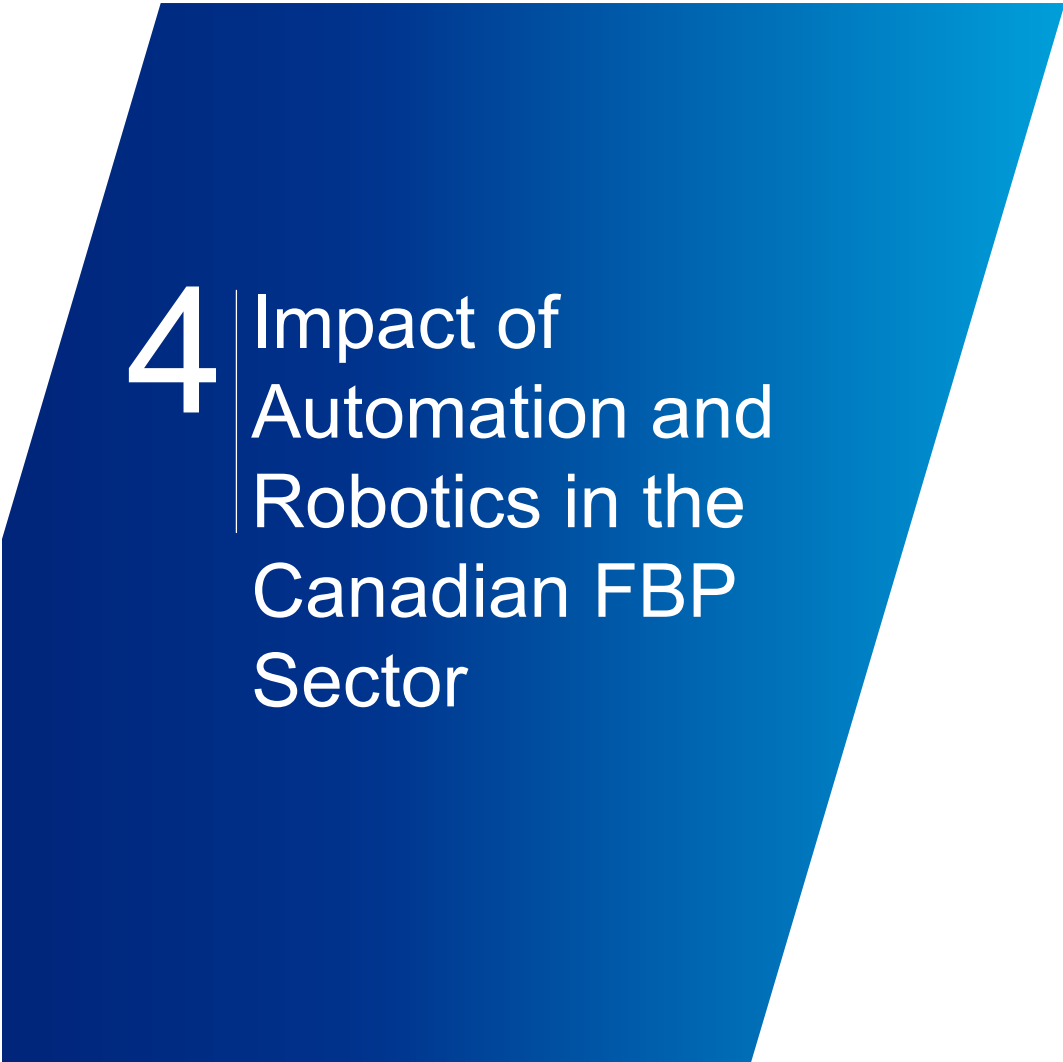
processors are mostly characterized by variable and shorter production runs, there is a need for increased flexibility with minimum change over time.

**Distributor/Wholesalers**

The high concentration of food distributors in Canada also plays a role in the adoption of automation and robotics by Food and Beverage processing firms. Price competitiveness is increasingly important and automation and robotics can sometimes help Food and Beverage processors achieve the lowest price for a given quality of products. Contracts are drafted over increasingly shorter periods, adding an additional source of pressure on prices. The requirements from distributors are also service-based, with data on product specificities and quality available to distributors in real-time. In this sense, the demands from distributors are also acting as a driver of automation and robotics.

**Maturity of the Sector**

Most of the Food and Beverage Processing sub-sectors in Canada operate in a mature market, such that the overall growth is predominantly achieved via acquisition and consolidation. For certain firms, available funds will be directed towards growth options rather than technology. Funding availability for automation and robotics can be limited in certain firms, with the culture of the enterprise affecting the distribution of available funds.

# 4 | Impact of Automation and Robotics in the Canadian FBP Sector

- **The Canadian FBP sector is lagging in automation and robotics**

- **The lag must be addressed in the short term**

- **The availability of internal and external resources, the maturity of the existing technologies, and other feasibility factors impact the decision to adopt automation and robotics**

☐ The Canadian Food and Beverage Processing sector faces a lag in automation and robotics that is affecting the sector's ability to compete nationally and globally. The lag varies across sub-sectors and companies.

☐ The current cost structure for many FBP companies relies heavily on labour, a model that is not sustainable in the long term. Land, electricity, taxes and other costs further weigh on FBP companies' margins.

☐ The lag in automation and robotics must be addressed in the short term (within the next 2 to 3 years) to ensure companies either maintain or improve their competitive position.

☐ Although resources are available, addressing the lag in automation across the sector will require several considerations, varying across sub-sectors, regions and companies:

1. The availability of external expertise (suppliers, integrators);

2. The availability of internal expertise (engineers, operators, technicians, etc.);

3. Plant infrastructure/design and related costs for project implementation;

4. The need for re-engineering of existing technologies and R&D; and

5. Barriers faced (refer to TRA study for details on barriers for each sub-sector).

## Objectives and Scope of Work

### Objectives

Agriculture and Agri-Food Canada (AAFC), in collaboration with Industry Canada (IC), has engaged KPMG to conduct a follow-up study to research undertaken previously, known as the Technology Readiness Assessment of Automation and Robotics for the Food and Beverage Processing Sector in Canada (TRA Study). Through the TRA Study, several Canadian FBP sub-sectors indicated that their level of automation and robotics are lagging behind what would be required to be competitive domestically and globally. AAFC, IC, and departments at other levels of government have expressed interest in these results. However, one remaining question is the implications of this lag in automation for industry's ability to compete.

The objective of this study is to assess the implications of the lag in automation and robotics for certain Canadian FBP sub-sectors, allowing both AAFC and IC to have a better understanding of the extent and urgency associated with these lags, as it pertains to processors' ability to compete locally, nationally and internationally.

### Scope of Work

In order to address the aforementioned objective, KPMG conducted **24 interviews** with FBP companies from sub-sectors that have shown the greatest lags in automation and the most imminent competitive pressure to address them. The selection of FBP companies to be interviewed and the interview guide used to conduct the assessment were approved by the AAFC Project Authority.

The interview guide used to lead discussions with FBP companies addressed the following:

**1**    Is there a lag in automation and robotics?

**2**    Where is the lag and is there a plan to address it?

**3**    What is the urgency of addressing the lag and the expected benefits?

- What is the urgency of addressing/eliminating the lag for the company's ability to compete? And what are the expected benefits derived from the discussed expenditures in automation and robotics?

**4**    How feasible are the planned capital expenditures?

- How feasible are the discussed capital expenditures in automation and robotics in terms of current infrastructure capacity, the availability of existing technologies, the need for re-engineering or R&D, and the availability of external and internal (in-house) expertise to support the automation and robotics projects?

**5**    What are the challenges faced by FBP companies in Canada?

- What are some of the challenges and conditions that impact FBP companies' plan to automate and add robotics to their processing operations?

### Source of Information

The analysis conducted therein draws upon interviews conducted with FBP companies, issued from an original sample of companies interviewed for the purposes of the TRA study.

### Final Report

Key findings presented in the following sections are based on the analysis from **24 interviews** with FBP companies, representing 36% of Canadian FBP companies interviewed during the TRA study. As such, the lag in automation and robotics may be under-represented therein. The statement of work signed on February 4, 2015 specified that a minimum of 15 interviews had to be conducted for the purposes of this study.

# Summary of Findings

- Interviewed firms with an identified lag in automation and robotics have expressed the importance of rapidly addressing/eliminating the lag within the next 2-3 years.

- Firms generally have an established plan that they are already following, and the expected impact on their ability to compete nationally and internationally was considered significant and even critical in some instances.

- Although most of the identified projects in automation and robotics could be done within current plant infrastructures, a number of interviewed companies mentioned the need for plant expansion and remodelling of plant design. While some companies stressed that a priority would be additional capacity/increasing plant size, others mentioned that they had just invested in plant expansion for recently completed projects.

- External expertise has been identified (or at least partly) by most interviewed companies. Although machine/technology manufacturers are sometimes not found within Canada, integrators generally are.

- Interviewed companies indicated that a mix of adaptation of already existing technology, of re-engineering and of R&D would be involved to carry out the proposed projects in automation and robotics.

- Based on the conducted interviews, palletizing applications would mostly involve adaptation/fine-tuning of already existing technologies. Re-engineering would sometimes be needed to adjust technology to the plant's process.

- For some applications in some sub-sectors (e.g. Meat, Fish and Seafood, Prepared Meals) the technology that is currently available (in other countries) does not fulfil the requirements or specifications of the company (e.g. inputs are different in Canada, products are processed differently, not the same final product, etc.). There is thus a need for re-engineering and R&D for those more specific applications, which generally fall in Raw Food/Processing Applications or Primary Packaging Applications.

- Interviews in the Meat sub-sector pointed towards a greater need for re-engineering and R&D given the relatively immature state of the automation and robotics industry as applied to the sector's applications (especially Raw Food/Processing Applications). Material handling in between applications for non-packaged meat products was mentioned as an example of an application that has yet to be developed to withstand washdown conditions in order to be used in the industry.

- Although some companies already have the in-house expertise to support the changes brought about by the automation and robotics projects, others are lacking those resources or would not have sufficient resources to do so. In a number of cases, expertise would need to be acquired, either through the transfer of knowledge from solution providers or via the acquisition of experienced skilled labour.

- There is heterogeneity amongst interviewed firms as it pertains to the feasibility of the identified capital expenditures in automation and robotics, from plant infrastructure to the availability of external and internal expertise and resources. Notably, companies with multiple plants have sometimes done the same changes in automation and robotics in other plants and the expertise can be transferred to the other plants.

- The cost structure of the interviewed companies' operations and the ability of the automation and robotics projects to reduce the pressure on already tight margins appeared to be one of the key expected benefits of the identified capital expenditures.

## Summary of Findings

❑ However, the decision for these investments and the level of automation and robotics planned by companies over the next few years reflects the constraints of size (production capacity) and of expected returns on investment (and the related payback period).

- ❑ **Interviewed companies have a technological lag in automation and robotics at some or all levels of their food and beverage processing operations**

- ❑ **79% reported having a plan to address the lag**

- ❑ **Packaging applications are the most frequent target of planned capital expenditures in automation and robotics**

**1** **Is There a Lag in Automation and Robotics?**

Interviewed companies reported having a technological lag in automation and robotics at some or all levels of their food and beverage processing operations. The information presented in the following sub-sections pertains to the answers provided by these **24** interviewed companies (thereafter referred to as "companies").

**2** **Where is the Lag? and Is There a Plan to Address it?**

79% of companies (19/24) confirmed having a formal plan to address the identified lag in automation and robotics. For those companies without a formal plan, reasons included:

- ▪ The lengthy payback period; and

- ▪ The corporate culture/importance of human capital.

However, it could also be that although no formal plan had been developed, solutions were being investigated and that the company had an interest in investing further in automation and robotics in the next few years.

The elaboration of a formal plan to address the lag in automation and robotics generally depended on a number of variables, including the sub-sector of activity and its life-cycle stage, the feasibility and difficulty associated with any given project as well as other capital projects contemplated by the company.

In the case of sub-sectors where major consolidation is taking place, additional investments in automation and robotics will only be considered and planned after the consolidation has formally taken shape.

Moreover, although plans have been formally developed to address the lag in automation and robotics, companies face a number of challenges (discussed in a later sub-section of this report and more extensively in the TRA study) that impact the extent to which companies can reduce these shortcomings. As

such, formulated projects in automation and robotics are part of a company-wide capital expenditure planning and only partially address the lag experienced by these companies.

Over the next  years, (planned) capital expenditures in automation and robotics for the interviewed companies appeared to be mostly geared towards Packaging Applications, with 92% of companies having plans to that effect. 71% of these companies also mentioned interest in automating Raw Food/Processing Applications.

**Figure 4.1 Capital Expenditures per FBP Application**



Raw food/Processing Applications — 71%
Packaging Applications — 92%
End-of-line Applications — 21%
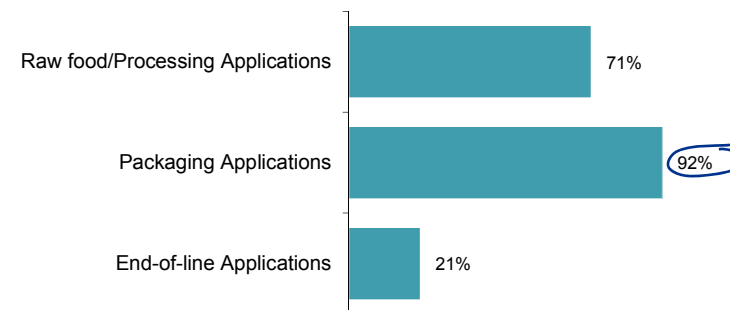
*Source: KPMG LLP, March 30, 2015; N = 24 companies*

Although the exact nature of the applications to be automated varied across interviewed firms and sub-sectors, automatic palletizing and pallet wrapping was the most common type of application to be (further) automated/robotized (58% of interviewed companies). The second most common type of application to be automated by interviewed companies was automatic weighing and primary packaging (54%), followed by automatic case packing (46%) and initial material handling and feeding into lines (38%).

- **Automatic palletizing and pallet wrapping was the most common type of application to be (further) automated/robotized**

- **Vision technology for quality and content inspection/control, cleaning systems and technology to reduce product waste were applications targeted for Raw Food/Processing Applications**

- **For many, planning of capital expenditures was part of a two to five-year plan**

**Table 4.1 Raw Food/Processing Applications to be Automated**

| Raw food/processing | 71% |
|---|---|
| Automatic and vision guided process control | 8% |
| Automatic reconfigurable mechanish | 4% |
| Automatic washdown applications/cleaning applications | 17% |
| Continuous processing (vs. batch) | 0% |
| Initial material handling and feeding into lines | 38% |
| Transport/handling b/w various applications | 13% |
| Vision technology for quality and content inspection/control | 29% |
| Other | 8% |

*Source: KPMG LLP, March 30, 2015; N = 24 companies*

**Table 4.2 Packaging Applications to be Automated**

| Packaging applications | 92% |
|---|---|
| Automatic case packing | 46% |
| Automatic loading and unloading of packaging machinery | 0% |
| Automatic loading of packaging material | 8% |
| Automatic palletizing and pallet wrapping | 58% |
| Automatic weighting and primary packaging | 54% |
| Other | 8% |

*Source: KPMG LLP, March 30, 2015; N = 24 companies*

Raw Food/Processing Applications frequently mentioned by companies as a targeted area for automation and robotics included vision technology (cameras or other) for quality and content inspection/control as well as cleaning systems (clean in place or C.I.P. systems). Automation and robotic technology that could help reduce product waste was also of interest for some of the interviewed companies.

For many of the interviewed companies, planning of capital expenditures was part of a two to five-year plan which they were currently part of. As such, over the past year (since the TRA study was conducted) some of these firms had already invested in automation and robotics and addressed part of their lag. A number of companies attested to the importance of trade/industry shows in educating and providing information regarding new and existing technologies. Hence, plans in automation and robotics are regularly reviewed to consider changing technologies in the sector.

- **50% indicated that the lag had to be addressed within the next 12 to 24 months**

- **The planned capital expenditures were generally expected to at least bring a significant improvement to the company's ability to compete**

- **Main expected impacts of CapEx:**

  - **Reduction of operating costs;**

  - **Increasing productivity, efficiency and accuracy of production;**

  - **Reducing health and safety risks.**

**3** **What is the Urgency of Addressing the Lag and the Expected Benefits?**

In most cases, it was considered urgent or at least very important to address the identified lag in automation and robotics for the companies' ability to compete in their national and/or international market. Notably, 50% of interviewed companies indicated that the lag had to be addressed within the next 12 to 24 months (urgent) and 29% between 3 to 5 years (very important).

**Figure 4.2 Timeline to Address the Lag in Automation and Robotics**
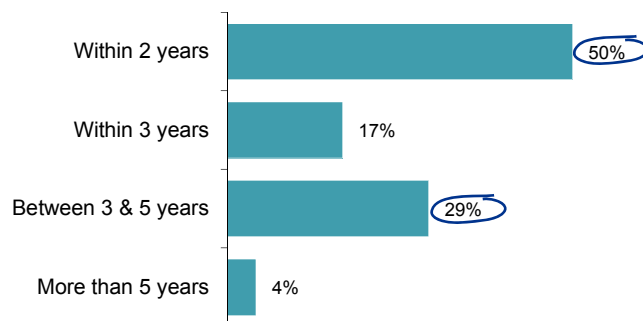


Source: KPMG LLP, March 30, 2015; N = 24 companies

When the urgency was not considered immediate, companies pointed towards the imminent need to establish a sector/sub-sector strategy to approach the lag and ensure this issue does not become critical in the near future. The necessity to address the knowledge gap that currently exists in some sub-sectors, notably the Fish and Seafood sub-sector and the Meat Product sub-sector, was also expressed amongst participants.

The planned capital expenditures were generally expected to at least bring a significant improvement to the company's ability to

compete (42%), with 42% of interviewed companies indicating that these plans in automation and robotics were critical to the company's ability to compete.

The most frequently mentioned anticipated benefit from the identified (planned) capital expenditures in automation and robotics was a reduction in production costs. The importance of reducing operating costs was re-emphasized by the fact that some of the interviewed companies tend to operate on small profit margins and that these projects of automation and robotics could allow them to either maintain or improve their already small margins.

**Figure 4.3 Expected Impact of CapEx in Automation and Robotics**
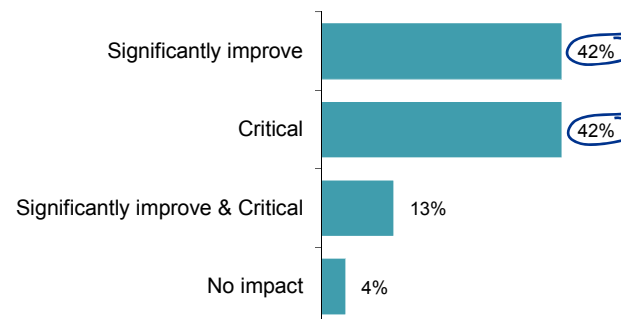


Source: KPMG LLP, March 30, 2015; N = 24 companies

Other expected benefits included:

- Increasing productivity: increasing the output and producing with increased reliably (which would in turn reduce operating costs);

- Reducing unnecessary labour health and safety risks;

- Finding an alternative to labour availability/retention issues;

❑ **Planned CapEx in automation and robotics is critical to FBP companies' ability to compete**

- Increasing efficiency of production;

- Increasing product accuracy and consistency;

- Increasing product quality and safety, as it pertains to being compliant with health and safety regulations as well as client expectations;

- Ensuring client retention; and

- Increasing market share by entering new markets (for automation and robotics that allow for new specifications not previously addressed).

Interviewed companies also discussed the regional differences in overhead costs (land and labour) and how the planned capital expenditures were critical to their ability to compete with their competition located in Canada (in provinces of lower overhead costs), in the United States, as well as in Asia.

- **67% reported that investment projects would be feasible within current infrastructure**

- **Automation and robotics in Packaging Applications would require adaptation or fine-tuning of already existing solutions**

- **Automation and robotics in Raw Food/Processing Applications will require re-engineering and R&D for some sub-sectors**

**4** **How Feasible are the Planned Capital Expenditures?**

The feasibility of the (planned) capital expenditures was evaluated with regard to:

1. The ability to conduct the projects in automation and robotics under current plant infrastructure;

2. The need for re-engineering of existing technologies and R&D (versus adaptation and fine-tuning of already existing technologies); and

3. The availability of external and internal resources to support the projects in automation and robotics.

**Brownfield versus Greenfield**

Interviewed companies indicated that most of the identified projects of automation and robotics could be feasible within current infrastructure (brownfield), with plant extensions sometimes needed as well as remodelling of plant structure (greenfield; major plant redesign, moving walls, changing flow process). 67% (16/24) of the interviewed companies answered that the projects would entirely be feasible under current infrastructure. 29% (7/24) indicated a mix of brownfield and greenfield projects. The potential need for re-design of production lines was also mentioned as a likely requirement for some projects. Only one of the interviewed companies considered that none of their planned expenditures would be possible under current plant infrastructures.

**Required Technology Adaptation, Re-Engineering and R&D**

Generally, the (planned) capital expenditures in automation and robotics would require a mix of adaptation or fine-tuning of already existing technologies, of re-engineering of already existing technologies and of R&D.

Automation and robotics in Raw Food/Processing Applications would mostly involve adaptation or fine-tuning of already existing solutions (43%), re-engineering of already existing solutions

**Figure 4.4 Feasibility of Projects under Current Plant Infrastructures**
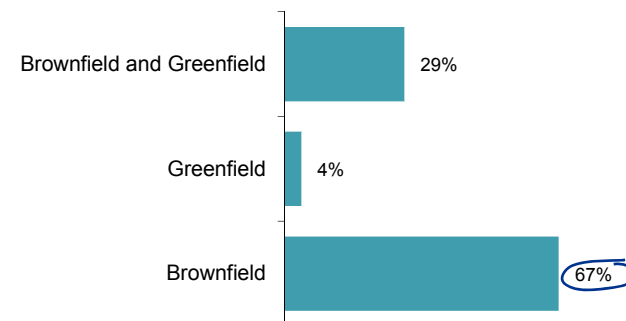


*Source: KPMG LLP, March 30, 2015; N = 24 companies*

(13%) or a mix of both (7%). A number of companies with identified projects in Raw Food/Processing Applications indicated the need for re-engineering, R&D or a mix of both (40%).

The most frequent Raw Food/Processing Application in terms of identified lags in automation and robotics was "initial material handling and feeding into lines." 33% of the planned expenditures would involve a mix of re-engineering of existing technologies and R&D (3/9 project), 22% (2/9 project) would involve R&D, 22% would require a mix of adaptation, re-engineering and R&D, and another 22% would require adaptation only. Sub-sectors that identified (planned) capital expenditures/lags in this application included: Meat, Fish and Seafood, Cookies and Crackers as well as Bread and Bakeries.

Automation and robotics in Packaging Applications would mostly involve adaptation or fine-tuning of already existing solutions (62%) or a mix of adaptation and re-engineering of already existing solutions (17%). A number of companies with identified projects in Packaging Applications indicated the need for re-engineering, R&D or a mix of both (20%).

- ❑ **The packaging application "automatic palletizing and pallet wrapping" would mostly require adaption**

- ❑ **The majority had identified solution providers (external expertise)**

- ❑ **58% mentioned that the expertise was available in Canada**

The most frequent Packaging Application in terms of identified lags in automation and robotics was "automatic palletizing and pallet wrapping." 71% of identified projects in this application would involve adaptation and 14% would involve a mix of adaptation and re-engineering of existing technologies. The second most frequent Packaging Application was "automatic weighing and primary packaging." 54% of identified projects in this application would involve adaptation and 31% would involve a mix of adaptation and re-engineering of existing technologies. Adaptation and re-engineering of Packaging Applications frequently referred to the need for adjustments to meet the product specifications or plant designs.

Projects identified in End-of-Line Applications were mostly adaptation (60%) or a mix of adaptation and re-engineering (20%) of already existing solutions and technologies.

**External Expertise**

The majority of interviewed companies indicated that their company had identified solution providers (external expertise) that operate in their business line and would be able to supply or provide services for the development and/or implementation of the solutions. In fact, only one of the interviewed companies stipulated that they did not identify external expertise. 71% (14/24) of the interviewed companies mentioned they already know where to find external expertise. 58% (14/24) of the interviewed companies also mentioned that the expertise was available in Canada. 25% (6/24) mentioned that only part of the expertise was currently available within the country. Since most equipment comes from foreign countries, international expertise is usually more developed outside of Canada.

A "knowledge gap" was identified in terms of automation and robotics for the Meat Products and Fish and Seafood sub-sectors, especially in the Raw Food/Processing Applications. As such, external expertise was not always identifiable by companies in these sub-sectors that are looking to automate

**Figure 4.5 Identification of External Expertise**
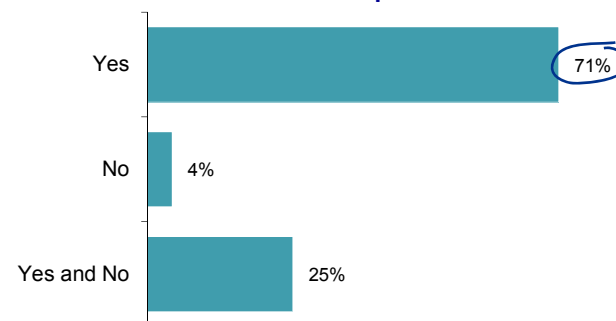


*Source: KPMG LLP, March 30, 2015; N = 24 companies*

**Figure 4.6 Identification of Canadian External Expertise**
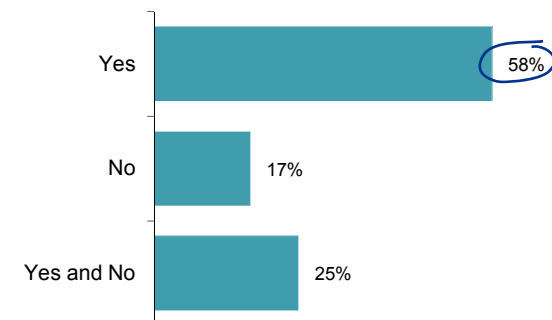


*Source: KPMG LLP, March 30, 2015; N = 24 companies*

these applications. When external expertise was identified, it was rarely within Canada.

- **21% do not have the required in-house expertise to support the technological changes**

- **Generally, companies with available internal expertise needed additional labour, training and expertise to support the technological changes**

Generally, external expertise for automation and robotic technologies in Packaging Applications was found either in Canada or in the United States. Although the technology itself is mostly built outside of Canada (as indicated by interviewed companies), integrators and/or providers of these solutions were generally found in Canada. More advanced packaging solutions were identified to be found in Germany, Italy and other European countries as well as Japan.

**In-House Expertise**

21% (5/24) of interviewed companies considered that they do not have the required in-house expertise to support the technological changes brought about by the adoption of automation and robotics (e.g. skills to operate, maintain, program, etc.). However, half (12/24) of the companies indicated that they had some in-house resources, but would need additional labour, training and expertise to support the identified expenditures in automation and robotics. Yet, 29% (7/24) of interviewed companies considered they had all in-house expertise to support the automation and robotics projects identified:

Identified expertise or resources that would be needed included:

- Engineers with experience in the sub-sector;

- IT technicians; and

- Skilled technicians and electricians to operate and maintain the technology.

Although, in some cases, the expertise was currently present within the company, additional resources would be needed for the additional technology, sometimes specifically for robotics. Although IT specialists were mentioned as a resource, some companies would need to integrate the technologies altogether, and most interviewed companies agreed that programing was mostly conducted externally by third party resources. In some cases, these external firms could monitor and provide software updates remotely.

It was also generally agreed that training is required from the service/technology providers as some of the knowledge is product-specific.

**Figure 4.7 Availability of In-House Expertise**
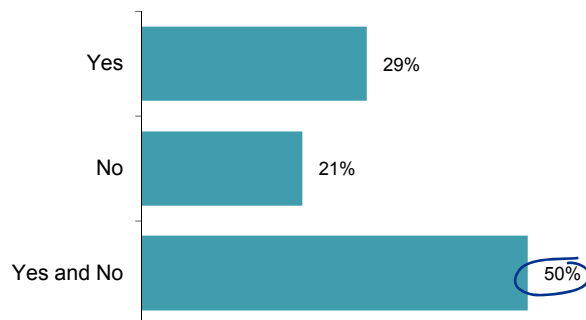


*Source: KPMG LLP, March 30, 2015; N = 24 companies*

- **A number of challenges impact the CapEx plans in automation and robotics, including:**

  - **Scale of projects and expected impact;**

  - **Availability and maturity of automation and robotics industry**

  - **Suppliers ability to support R&D**

  - **Changing labour supply and cost**

**5** **What are the Challenges Faced by FBP Companies?**

Automation and robotics are generally part of a company's contemplated projects as they pertain to their plans in capital expenditure. Although the interviews conducted in the context of this follow-up study did not specifically target challenges faced by FBP companies in Canada (the topic having been covered in the TRA study), participants have provided some explanations for their answers, including some of the challenges that impact the companies' decisions for capital expenditure.

**Scale of Projects and Expected Impact**

The scale of the projects in automation and robotics, the required resources that must be mobilized for the planning, implementation and execution of the project as well as the expected impact on the firm's ability to compete all affect a company's decision to proceed or abandon a proposed initiative. For instance, smaller projects with immediate, quantifiable impacts may be more likely to be adopted as part of a company's capital expenditures planning, than large-scale projects that would require large capital commitment with a longer payback period. Once again, the decisions are taken within the context of available budgets and the whole of proposed initiatives.

**The Availability and Maturity of the Automation and Robotics Industry for some Sub-Sectors**

Seafood processing is an example of a sub-sector for which automation and robotics solutions and integrators represent scarce resources (especially for applications prior to freezing of the products). The urgency for automation and robotics in this sub-sector does not only rely on the adoption of technologies but also on addressing the "knowledge gap".

Similarly, the Meat Products sub-sector faces a "knowledge gap" to varying extents depending on the type of meat that is processed and the level of processing (primary versus secondary processing).

The need for re-engineering and R&D is greater for these sub-sectors. However, external resources in applications for which R&D is most needed in meat, fish and seafood processing are generally scarce, outside of Canada, or unable to adjust the existing technologies to meet the Canadian companies' product specifications.

The Prepared Meals sub-sector is another sector that sometimes faces similar issues (depending on the product type).

**Technology Developers Ability to Support R&D**

Related to the above issue is the ability of technology developers/manufacturers in Canada to take on some of the costs associated with re-engineering and R&D. FBP companies looking to adopt an existing technology may still require re-engineering to meet their various operations/specifications (from a product or plant perspective). Larger supplier firms or other external sources are more likely to be able to take on the charges associated with R&D to adapt their technology instead of passing down all the costs to the client company. This is much more difficult for smaller, local suppliers/technology developers. Given that most technologies are developed/manufactured outside of Canada, the resources that can work in such partnership with FBP companies are also generally found outside of Canada and not always readily available.

**Changing Labour Supply and Cost**

The aging and changing labour supply has a direct impact on a company's decision to automate. As the aging population retires, companies that are highly dependent on manual labour and experience difficulties in attracting new labour (attractiveness of the sub-sector or location) must find alternatives to labour intensive tasks, such as automation and robotics.

Moreover, several companies spoke of the manual intensive approach no longer being a sustainable approach to competitiveness. While companies used to be able to compete with counterparts in the United States on the basis of lower labour cost, the depreciating Canadian dollar continues to add pressures for Canadian companies to compete on other grounds.

# 5 | Solution Pathways

# Solution Pathways

**Solution pathways include:**

❑ **Targeting the applications to automate based on a strategy that accounts for technology availability and areas that would most benefit from automation**

❑ **This requires an understanding of the level of R&D and innovation possible and desirable within Canada**

❑ **Focus on flexibility**

In order to achieve the required level of technological development, but mostly the required level of technological adoption to move the Canadian Food and Beverage Processing sector to a globally competitive position, a number of strategies, partnerships and other solution pathways should be considered.

Whereas government and regulations can act as enablers and facilitators for many of these solution pathways, the desired outcome is only achievable with the participation of all parties involved.

## Solution #1 – Targeting the Applications to Automate

Although not all processes/applications may be targeted at once to improve the overall technology readiness of Food and Beverage processing operations in Canada, sound corporate strategies can include a structure of investment in automation and robotics that identifies those areas that would benefit most from increased automation and robotics. Whereas immediate needs are easily identified, targeting strategies would benefit from clear understanding of the development, innovation and adjustments that may be required.

### Innovation Pathways and Research and Development (R&D)

When considering areas of R&D and innovation pathways that could potentially be explored to develop leading-edge automation and robotics solutions, a number of factors must be taken into consideration, including:

✓ the little availability of Canadian machine and equipment builders specialized in Food and Beverage processing solutions and, as such, the limited extent to which Canada actually performs automation and robotics related R&D in this sector; and

✓ the limited existence of Universities and other Research Institutes that specialize in Food and Beverage processing and the lack of trained engineers coming out of Canadian Universities with practical knowledge of the sector.

As such, areas of future automation and robotics R&D and innovation pathways for Food and Beverage processing applications in Canada can be grouped into two categories:

1. applications for which there are no or limited solutions currently available, and

2. applications for which solutions currently exist in other countries or in other sectors/sub-sectors of activity, but that require adaptation to be functional to the desired task.

Examples of general applications/areas with no or limited solutions that were identified by interviewees included:

▪ increased applications for automatic wash-down of equipment and machinery; and

▪ energy optimization of processes (reducing input and product rejection rate, reducing waste) via real time automatic quality and safety control (versus manual sampling and laboratory analysis) and automated quantity and dosing control.

Example of general applications/areas with solutions requiring adaptation that were identified by interviewees included:

▪ increased flexibility of equipment to address changing demand, variability of inputs and to increase outreach of automation and robotics to smaller firms and different sub-sectors (increase flexibility and reduce down time);

▪ improvement of production throughput (increasing speed and minimizing bottlenecks); and

▪ remote tracking of operations.

Moreover, requirements for R&D and innovation are not consistent across all processing sub-sectors, with some automation and robotic technologies being more easily transferable to Canadian operations in some sub-sectors than others.

# Solution Pathways

The following table highlights the likely level of R&D required for each of the previously identified areas of potential improvement. The qualitative assessment reflects general findings from Canadian and non-Canadian interviews, and reflects the likely level of re-engineering implied for each application in each segment, from a general perspective.

**Table 5.1 R&D, Adaptation and Adjustments for Increased Automation and Robotics in the Food and Beverage Processing Sector in Canada**

| | Meat, Fish and Seafood | Prepared Meals, Bread, Fruits and Other | Dry Food | Other Packaged Food and Ingredients | Beverages |
|---|---|---|---|---|---|
| **Raw Food/Processing Applications** | | | | | |
| Required Level of R&D, adaptation or adjustment | ⬆ | 🔴 | 🔺 | 🔴 | 🟡 |
| Initial material handling and feeding into lines | +++ | ++ | + | + | + |
| Transport/handling between the various applications | ++ | + | + | + | + |
| Vision technology for quality and content inspection/control | +++ | + | + | ++ | + |
| Automatic wash down applications/cleaning applications | ++ | ++ | ++ | ++ | ++ |
| Automatic and vision guided process control | ++ | + | + | ++ | + |
| Continuous processing (versus batch) | + | + | + | ++ | + |
| Automatic reconfigurable mechanism | +++ | +++ | + | ++ | ++ |
| **Packaging Applications** | | | | | |
| Required Level of R&D, adaptation or adjustment | 🔴 | 🟡 | 🔺 | 🔺 | 🟡 |
| Automatic weighing and primary packaging | ++ | + | + | + | + |
| Automatic case packing | +++ | ++ | + | + | + |
| Automatic palletizing and pallet wrapping | + | + | + | + | + |
| Automatic loading and unloading of packaging machinery | + | + | + | + | + |
| Automatic loading of packaging material | + | + | + | + | + |
| **End-of-Line Applications** | | | | | |
| Required Level of R&D, adaptation or adjustment | 🔺 | 🔺 | 🔺 | 🔺 | 🔺 |
| Automatic or semi-automatic storage/retrieval system | + | + | + | + | + |
| Integrated and automatic tracking of products | + | + | + | + | + |
| Integrated control of quality from production to distributor/customer | + | + | + | + | + |

**Legend:**   **+++** R&D likely required    **++** Adaptation and some development likely required    **+** Transfer of existing technology with plant/operation-specific adjustments likely required

⬆ High levels of R&D required to adopt automation and robotics    🔴 Important level of adaptation or R&D required to adopt automation and robotics    🔴 Some level of adaptation required to adopt automation and robotics    🟡 Small level of adaptation required to adopt automation and robotics    🔺 Mostly transferable with plant specific adjustments

Although most automation and robotic technologies require some level of adjustment/adaptation to account for the variability inherent to the Food and Beverage Processing sector and to plant specificities, the previous table (**p. 92**) emphasizes that some segments and applications may require more important R&D investments than others in order to achieve the desired level of automation and robotics.

**Technologies to be Explored**

Technologies that could be explored to develop "leading-edge" automation and robotics solutions in the Food and Beverage Processing sector and address the above R&D and innovation pathways include:

- optical sensors, on-line spectroscopy and machine vision technologies for quality and safety inspection as well as to increase process flexibility and accuracy;

- gripper technologies for the handling of unpackaged materials (ingredients, processed food) that address variability of handled products, food and safety concerns as well as special care treatments required by certain types of food;

- reconfigurable mechanism technology to address the need for quick changeovers between different products for food handling and packaging, and thereby achieving flexible production and reducing costs associated with seasonality;

- SCADA, related systems for automated process control and better hardware-software and software-software integration and communication for efficient operations;

- wireless sensor network (WSN) technology to address the stringent monitoring resulting from the increasing demand for safe and healthy food of quality and increasingly demanded food and beverage traceability.

The above list of technologies is not exhaustive, but reflects the interview findings.

**Potential R&D Risks**

Other than the regular risk of failure associated with R&D, a number of factors ought to be considered when considering the aforementioned R&D/innovation pathways.

**1** The fact that the Food and Beverage Processing sector is not "uniform" requires that technology be adapted or adaptable to accommodate for all types of variability. This requirement for variability across and within sub-sectors poses a challenge to the development of automation and robotics in this sector, such that technology developed is rarely (if ever) directly transferable to another operation or sub-sector.

**2** Although developed technology is generally tested prior to implementation, the results obtained during that testing phase are not necessarily representative of the results that will be obtained during live production in terms of output rate, efficiency and other measures, even after the technology was adapted to the needs of the operations or of the sub-sector.

**3** As Canadian Food and Beverage processors are looking to export their products, research and development in automation and robotics for the sector should be considering the various regulatory body accreditations (Health Canada, FDA and others) in order to not only market the end product outside of Canada, but also the technology that is developed.

**4** The learning curve of each organization regarding a technology can pose a risk to the perceived return on investment and thus impact the incentive of such investment in the first place.

- ❑ **Encouraging public – private partnerships for increased R&D, innovation, re-engineering and adoption of automation and robotics**

- ❑ **Building the capacity and infrastructure needed to achieve the desired level of technology readiness**

**Potential R&D Risks (cont'd)**

**5** The training and availability of the skilled labour required to support greater automation and robotics can pose a risk to firms undertaking R&D/innovation in this sector. Since there is a shortage of available skilled labour who can operate and perform the maintenance on automation equipment and robotics, there is always a risk associated with the ability to properly and efficiently operate the technology invested in.

**Solution #2 – Building Collaboration Between Industry, Academia and Government**

The current infrastructure surrounding automation and robotics in the Food and Beverage Processing sector in Canada is currently composed of a few Universities and other knowledge institutes, integrators, testing centers and very little in terms of equipment builders. Importantly to note, these parties tend to act independently of each other, with isolated events of partnerships.

As mentioned in the Gap Analysis section of this report, one of the key differentiating factors for countries that have successfully adopted automation and robotics as part of their global strategy for the Food and Beverage Processing sector has been access to information and support. Thus, in order to build a sound infrastructure that encourages automation and robotics in the Food and Beverage Processing sector, more of the players that make up the current infrastructure are needed, as well as greater communication, and information and expertise sharing between industry, as well as academia and government.

Therefore, a first step towards achieving this goal for Canada would be to create a centralized centre for information and assistance. Although some resources exist, navigating through the various strategies, options and services would be facilitated with a single service point. For example, although there are currently several partnerships between Canadian Food and Beverage processing firms and knowledge institutes, universities and technology centers, there are several opportunities for

improvement, including the need for a facilitator that could educate with regards to the various institutions/enterprises that exist, the type of work that can be performed and the milestones to achieve it.

Overall, partnerships are essential to drive R&D and innovation. Although the incentives for private companies to participate in partnerships are not always clear (with some companies that prefer to keep their R&D confidential), their participation is needed in order to build a Canadian capacity for automation and robotics in the Food and Beverage Processing sector. Moreover, given that most technology is developed and built outside of Canada, consideration should also be given to partnerships with non-Canadian equipment providers. Further, encouraging equipment builders servicing other industries in Canada to develop and service the Food and Beverage Processing sector could further allow the sector to become more self-sufficient in the future and rely less on other economies. Their involvement would also help to address current shortages in the infrastructure.

In the short run, the creation of a skilled labour work force that can service the Food and Beverage Processing sector in their expansion towards greater automation and robotics is essential. One of the key barriers to automation and robotics across all sub-sectors remains the availability of labour who can operate and perform the maintenance of the technology. Although there exist some assistance programs assisting processing firms in training their employees to that effect, the shortage barrier persists. In order to address this shortage, the following considerations were identified:

- ▪ ensuring awareness of existing labour training initiatives among processors and providing adequate firm-specific support in identifying the right programs;

- ▪ providing sector-specific programs for the training and retention of skilled labour; and

# Solution Pathways

**Building Collaboration Between Industry, Academia and Government (cont'd)**

▪ raising awareness of the importance and attributes of the sector among the labour force.

In the longer run, attraction of talents from universities would require additional effort to develop post-secondary education programs, courses and internships that encourage engineers to look into professions within the Food and Beverage Processing sector.

**Solutions # 1-2 – Clusters as Competitive Advantage**

Porter's theory[64] defines clusters as groups of interconnected firms operating in the same fields and in related industries, specialized suppliers, service providers and related associations, including universities and technology transfer centers. These clusters successfully create a competitive advantage (nationally and internationally) through their competitive and cooperative dynamics.

An overview of the framework behind industry clusters helps explain the determinants of the competitive advantage cluster firms can derive as opposed to firms that are isolated from one another and the weaknesses of existing clusters in Canada.

**Figure 5.1**



**Table 5.2**

| | |
|---|---|
| **Firm strategy and rivalry** | Refers to the regional innovation dynamics that can contribute to regional competitiveness. Assuming firms in a cluster choose to continuously innovate, in order to compete. Other firms in this cluster will also continuously upgrade and invest to differentiate themselves from their rivals. |
| **Demand conditions** | If local customers are sophisticated and demanding, cluster firms will need to continuously innovate and stay on the leading-edge of technology. Such an environment encourages cooperation of cluster firms with their customers / clients. In addition to meeting the demand of local customers, this climate will help cluster firms be more competitive in the global market. |
| **Related and supporting industries** | Refers to the presence of "capable, locally-based suppliers and of competitive related industries" that create a network of essential resources. Firms and suppliers cooperate, exchanging information and knowledge about new processes and products that drive the innovation in the cluster. |
| **Factor conditions** | Refers to factors of productions such as skilled labour force, specialized and educational institutions that all cluster firms can draw upon to increase productivity. Essentially, clusters amplify the pressures to innovate and improve. |

The effectiveness of Canadian clusters are affected by the limited resources (e.g. specialized institutions and skilled labour) and collaborations that drive the higher competitiveness and international edge that can be achieved when all elements of a "healthy" cluster are present. Therefore a national strategy would consist of improving existing clusters by addressing the specific weaknesses and missing infrastructures.

### Solution #3 – Attract Foreign Investment

To enhance private investment in R&D and innovation by international firms, it is important to ensure Canada's competitiveness as a suitable investment location for enterprises that are active internationally. A number of large multi-national firms are choosing European counties such as Germany and the Netherlands (to name a couple) as home of production and innovation due to the attractive tax structures and proximity to R&D and automation and robotics developers amongst other reasons. Although Canada may not have the current capacity to develop automation and robotic technologies to the level observed in these regions, it can be an attractive location for other reasons.

# Appendix I
**Selected Food and Beverage Processing Sub-Sectors**

# Selected Sub-Sectors of Interest

## Selection Criteria

For the purpose of this project, sub-sectors of interest were selected in collaboration with Industry Canada and Agriculture and Agri-Food Canada (AAFC) based on a number of factors, including:

- North American Industry Classification ("NAICS") codes;

- GDP contribution;

- economic considerations;

- strategic considerations;

- raw- and end-products attributes.

Activities classified under NAICS code 311 (Food Manufacturing) and 3121 (Beverage Manufacturing) were used as primary sources of sub-sectors selection. At the very least, sub-sectors ought to account for approximately 80% of the entire Food and Beverage Processing sector, as measured by Gross Domestic Product (GDP).

## Selected Sub-Sectors

| | |
|---|---|
| Meat Products | Cookies and Crackers |
| Fish and Seafood | Snack Food |
| Fruits and Vegetables | Prepared Meals |
| Dairy (excl. fluid milk and ice cream) | Pasta |
| Flour Milling | Coffee and Tea |
| Oilseed Processing | Bread and Bakery Products |
| Breakfast Cereals | Soft Drinks and Water |
| Sugar and Confectionery Products | Alcoholic Beverages |

## Meat Products Processing

### Relevant NAICS:

**3116:** Meat Product manufacturing

**311611:** Animal Slaughtering

Comprises establishments primarily engaged in slaughtering animals and preparing meat products. Example of activities include:

- beef carcasses, half-carcasses, primal and sub-primal cuts;

- boxed meat;

- canned meat;

- frozen meat and meat products.

### Sub-Sector Overview

As the largest Canadian Food Manufacturing sector, the Meat Product Manufacturing sub-sector was included as to ensure the integrity of the methodology and adequate representation of the Canadian Food and Beverage Processing sector.

According to Statistics Canada, Meat Products Processing accounts for approximately $24.3 billion of Canadian revenues and 26% of all Food and Beverage shipments. The sub-sector employs over 66,500 people, with Ontario and Quebec as main employers (accounting for 32.2% and 25.6% of establishments, respectively), followed by Alberta and British Columbia (accounting for 13.9% and 11.1% of establishments, respectively).

For time sensitivity reasons, rendering (NAICS 311614) activities were excluded from this study.

# Selected Sub-Sectors of Interest

**Literature Review**

A number of key success factors were identified for the Meat Processing sub-sector. These included automation to increase efficiency, vertical integration to better manage rising costs and ensure delivery channels, and re-orientation and adjustment of productions to meet consumer preferences and health concerns (IBISWorld, 2013).

Although a number of manufacturing and packaging processes are highly mechanized, the degree of manual labour and automation varies and tends to depend on the exact process. For the Meat Processing sector in Canada, IBISWorld estimates a medium level of capital intensity, that is, $0.23 is spent on capital for each dollar spent on wage. Ongoing reliance on workers to carry out slaughtering and processing is at the origin of the lower level of capital intensity according to this same source, although processing firms have recently invested significantly in plant modernization and equipment.

In addition to increasing their capacity towards larger and more modern plants, industry players are also investing in technology that revolves around food health and safety concerns. Reduction of food-borne illnesses connected to meat consumption, meat quality improvement and cost efficiency in the production of lean meat are common concerns and research focus for the sector. Research uses molecular and microbiology techniques to address tracking of the microbial status of meat.

In order to meet the heavy regulatory standards and efficiently compete with internal competitions such as fish and seafood, which are increasingly demanded by Canadians as an alternative source of proteins, and with global competition, Meat Processing companies must continue to invest in technologies that allow them to improve productivity and maintain high quality products. With import penetration on the rise and new trade agreements signed, Canadian meat processors are pressured to gain or maintain their competitive advantage.

**Fish and Seafood Preparation and Packaging**

Relevant NAICS:

**3117:** Fish and Seafood Preparation and Packaging

Comprises establishments primarily engaged in:

- canning seafood, including soup;
- smoking and drying seafood;
- preparing fresh fish by removing the heads, fins, scales, bones and entrails;
- shucking and packing fresh shellfish;
- processing marine fats and oils; and
- freezing seafood.

**Sub-Sector Overview**

Although the Seafood Products Preparation and Packaging sub-sector accounts for a smaller portion of total Food and Beverage sales ($4.3 billion), it is an important contributor to economies of Atlantic Provinces, including New-Brunswick, Nova-Scotia, and Newfoundland. As Canadians are progressively adopting a healthier way of living, fish and seafood are expected to gain market share as an important source of protein and healthy fat. Worldwide, people are eating more and more seafood, about 8 times more than 60 years ago.

**Literature Review**

Based on the reviewed literature, the Seafood Processing industry relies on a relatively low level of automation and robotics compared to other sub-sectors. Yet, they face the same challenges regarding fresh food handling and hygienic requirements as other industries.

**Fish and Seafood Preparation and Packaging (continued)**

One of the main challenges that is particularly true for seafood is the high variability in shape, size, and structure of the products that pose a significant problem for the development of sensor systems and manipulators for handling such products (Caldwell, 2012). New and future developments in gripper technologies work towards addressing this problem.

As with other live food products (as opposed to dry-food), the issue of developing robots that are consistent with hygiene standards is important, and has been a key barrier in the adoption of greater automation and robotics to processes. That and the harsher (cold) environment in which the products are processed.

As a consequence, cost is likely an important barrier to the adoption of robots. Robots that are adopted to the hygiene requirements of clean room and/or humid (cold) working environments are typically 10-20% more expensive than standard industry robots.

While the Seafood Processing sector is still highly dependent on manual labour, the degree of automation is increasing. The technology is becoming more and more affordable. But the seafood industry faces other challenges that the meat industry doesn't: seasonality and variability of the raw material and, in case of at-sea mechanization, the ability to compensate for motion.

**Dairy Products**

Relevant NAICS:

**3115:** Dairy Products Manufacturing

**311515**: Butter, cheese, and dry and condensed dairy product

Comprises establishments primarily engaged in manufacturing butter, cheese, and dry and condensed dairy products. Establishments primarily engaged in manufacturing substitute products are included. Examples are:

- cheese (except cottage cheese);
- cheese spreads;
- cheese, imitation, substitute or analog, processed;
- dips, cheese-based;
- milk, concentrated, condensed, dried, evaporated or powdered;
- milkshake mixes;
- non-dairy creamers, dry;
- whey, condensed, dried, evaporated and powdered, etc.

**Sub-Sector Overview**

According to AAFC, the Dairy Product Manufacturing sub-sector in Canada generated $13.7 billion in sales (2011), making it the second largest sub-sector (including fluid milk and ice cream). In 2012, the dairy processing produced a total value of $14.7 billion, which represents 15.1% of the value of all products produced by the Canadian Food an Beverages Industry. The dairy processing sector employs 24,500 workers**.** Dairy processing plants are mainly located in regions where dairy farms are located. The majority of the dairy processing plants are located in Quebec and Ontario[65]. Canada imports around $677.3 million in dairy products. The main products imported are cheese, milk protein isolate and casein[66].

## Selected Sub-Sectors of Interest

**Dairy Products (continued)**

Fluid milk and ice cream were excluded from the current analysis. Given the nature of the products, food safety and hygiene are likely to be important drivers to automation and robotics for the sub-sector.

**Fruits and Vegetables Preserving and Processing**

Relevant NAICS:

**3114:** Fruit and Vegetable Preserving and Specialty Food Manufacturing

**31142:** Fruit and Vegetables Canning, Pickling and Drying

Comprises establishments primarily engaged in preserving fruits and vegetables by canning, pickling, brining and dehydrating (including freeze-drying). Canning uses heat sterilization; pickling uses vinegar solutions and brining uses salt solutions.

And to some extent:

**311410**: Frozen Food Manufacturing

Comprises establishments primarily engaged in manufacturing frozen fruits and vegetables; and frozen dinners and side dishes of several ingredients, except seafood.

**Sub-Sector Overview**

According to AAFC, fruit and vegetable preserving and specialty food manufacturing generated $6.9 billion in sales in 2011.

**Literature Review**

Processed fruit and vegetable products are considered common household food items that are purchased everywhere around the world. They plays an important role in the Canadian diet and economy.

Based on reviewed literature, as quality and freshness becomes more and more important, technology will likely provide more opportunities for manufacturers to address the needs and demands of consumers. The health benefits of these products will increasingly appeal to more and more consumers, especially in North America, Europe and Australia, where consumers are becoming increasingly concerned with their health.

Throughout the literature, one can see that of all agricultural operations, those performed post-harvest have employed the most automated equipment for a long time. Post-harvest operations offer an environment suitable to technology research and further automation. Over 10 years ago, the first automated fruit and vegetables grading facility became available. While packing and palletizing robots have long been frequent features of grading facilities, the development of machine vision and sensor systems led to a greater level of automation and data gathering, in line with growing concerns about quality and safety. Traceability systems for food safety and security has been an important milestone in Food and Beverage automation, addressing the problems pertaining to food poisoning by bacteria, illegal unregistered agricultural chemicals, and the lack of product authenticity.

## Selected Sub-Sectors of Interest

### Flour Milling

Relevant NAICS:

**3112:** Grain and Oilseed Milling

**311211**: Flour Milling

Comprises establishments primarily engaged in grinding grains, fruits or vegetables, except rice. Integrated mills, which grind grain and further process the milling products into such products as prepared flour mixes or dough, are included.

### Sub-Sector Overview

According to AAFC, the Canadian grain and oilseed milling sub-sector, which comprises flour milling, oilseed processing and breakfast cereals manufacturing, generated $8.5 billion in sales in 2011.

### Literature Review

Revenues are expected to grow for Canadian flour manufacturers as the flour milling sub-sector continues to invest in product innovation, introducing a greater variety of healthier products, and as the economy continues its slow recovery.

Note that flour milling establishments are typically located close to large city markets for ease of serviceability, making Ontario, Quebec, and British Columbia the key locations for Canadian flour milling facilities.

In terms of automation and technology, the processes used today at mills are very similar to what was developed 80 years ago. The advancements in technology trend towards increased efficiency and operating capacity.

Modern manufacturing plants typically require a moderate-to-high level of capital investment as they adopt sophisticated technology and equipment that increase productivity as well as enable adaptation to consumer preferences and health concerns. Over the past 5 years, R&D allowed some operators to grade (assess the quality of) raw inputs. Innovation in downstream markets like gluten-free breads and cereals has led to differentiation.

The significant level of initial capital investment is the sector's main barrier to entry. Survival of new entrants also depends on the volume of production and vertical integration versus its competition. Securing low cost inputs and transportation impacts the viability of firms in this industry.

The price and availability of wheat is an important driver of profitability. Wheat is used in many industries (food and non-food) as a key input to production. Its overall demand determines product pricing of many manufacturers, which can be absorbed by consumers. However, increase in wheat cost is likely to harm the demand from price-sensitive consumers, and as such is more often absorbed by manufacturers.

According to IBIS World, the world price of wheat is predicted to increase in 2014, which could pose a potential threat to the sub-sector.

### Oilseed Processing

Relevant NAICS:

**3112:** Grain and Oilseed Milling

**311224:** Oilseed Processing

Comprises establishments primarily engaged in crushing oilseeds and tree nuts and extracting oils.

### Breakfast Cereals

Relevant NAICS:

**3112:** Grain and Oilseed Milling

**31123:** Breakfast Cereals

Comprises establishments primarily engaged in manufacturing breakfast cereal foods. Examples include:

- breakfast cereal (e.g., oats, corn, hominies, grits, wheat, rice), manufacturing;

- granola breakfast cereal (except bars and clusters), manufacturing;

- instant cereal beverage, manufacturing; and

- ready-to-serve breakfast and instant hot cereal foods, manufacturing.

**Literature Review**

Product innovation is likely to be a key driver to greater automation and robotics for Breakfast Cereals Processing firms, as consumers' dietary requirements and preferences change (high protein, gluten-free, etc.) and a greater variety of products is offered. Individualized packaging and variety/customization of packaging is yet another trend for some of these products (e.g. instant oatmeal).

### Sugar and Confectionery Products

Relevant NAICS:

**3113:** Sugar and Confectionery Product Manufacturing

**31131:** Sugar Manufacturing

Comprises establishments primarily engaged in manufacturing raw sugar, sugar syrup and refined sugar from sugar cane, raw cane sugar or sugar beets.

**31132-31134:** Chocolate and Non-Chocolate Confectionery Products

Comprises establishments primarily engaged in manufacturing chocolate or non-chocolate confectionery.

**Sub-Sector Overview**

According to AAFC, Sugar and Confectionery Product Manufacturing generated $4.5 billion in sales in 2011.

**Literature Review**

Sugar manufacturing is typically highly capital intensive due to its dependence on advanced commercial grinding and refining machinery. However, literature reviewed indicates that the degree of capital intensity varies with geographical location. For instance the EU is known for using highly efficient technology in their processing plants. Investment in technology is typically aimed at increasing productivity, storage and workers' safety. Specifically, most of the new technology has centered on the crushing cane capacity, as well as increasing efficiency and quality standards through better streamlining of related activities. Technology that improves the sucrose extraction levels from sugar inputs is also an area of R&D. Developed regions have vastly already adopted most of the extensive capital improvements. However, emerging countries like China and Africa are in the process of bringing up to scale their operations with that of other global producers.

# Selected Sub-Sectors of Interest

## Sugar and Confectionery Products (continued)

### Literature Review

Confectionery Products (sugar and chocolate confectioneries) Manufacturing is typically characterized by short runs and small batch production. As such, confectionery packaging is often highly manual intensive, which in turn results in higher waste, injuries, and hygiene issues. High variety of the products, stemming in part from the sector's high seasonality (hotels, gifts, Valentine's day, Easter, Christmas, and so on), necessitates an extremely versatile automated packaging system. Reconfigurable mechanisms are likely to offer the required flexibility in the packaging of confectionery products. Moreover, according to reviewed literature, the sub-sector is highly competitive, with profitability depending on the range of packaging formats offered, the speed of change (of format), lean production processes and promotions in place. Lean production here refers to increased productivity, reduced waste, efficient labour use, and reduced machinery downtime. Increased use of automation and robotics would address the mentioned issues and requirements for future competition.

Both sugar and confectionery products manufacturers face a challenge from the growing concern of consumers towards a healthier diet, especially in developed countries. IBIS world predicts that the demand for sugar food consumption is likely to continue growing in developing countries, shifting the geographical demand for sugar rather than experiencing a global decrease. A key driver to sugar production includes the growing acceptance of ethanol as an alternative source of energy.

Although confectionery producers have responded to healthy-eating trends with sugar-free and low-calorie products, the literature seems to indicate an increase in confectionery products consumption in the next 5 years amongst Canadians. This market is also quite significant in the EU, with the UK as one of the world's major consumer of confectionery products.

## Cookies and Crackers

### Relevant NAICS:

**3118:** Bakeries and tortilla manufacturing

**311821**: Cookie and cracker manufacturing

Comprises establishments primarily engaged in manufacturing cookies, crackers, biscuits and similar products. Examples include:

- crackers, cookies and biscuits (e.g., graham, saltine, soda);
- ice cream cones and wafers, manufacturing.

### Sub-Sector Overview

According to AAFC, the Canadian Bakeries and Tortilla Manufacturing sub-sector, which comprises bread and bakery products manufacturing, cookie, cracker and pasta manufacturing, as well as tortilla manufacturing, generated $8.5 billion in sales in 2011.

## Snack Food

### Relevant NAICS:

**3119:** Other Food manufacturing

**31191**: Snack Food

Comprises establishments primarily engaged in salting, roasting, drying, cooking or canning nuts; processing grains or seeds into snacks; manufacturing peanut butter; or manufacturing potato chips, corn chips, popped popcorn, hard pretzels, pork rinds and similar snacks.

# Selected Sub-Sectors of Interest

## Snack Food (Continued)

### Sub-Sector Overview

According to the AAFC, despite the fact that snack food processing only accounts for a small portion of Food and Beverage processing sales (2.5% of 2009 sales), the sub-sector has been growing steadily for most of the past decade.

Imports of snack food reached $374.6 million in 2009, while exports were $166.5 million. The majority of Canadian plants are located in Ontario and in Quebec. In 2009, the snack food industry was composed of roughly 7,635 workers[67].

### Literature Review

Variety is very important to snack food manufacturers. Although fat content and health aspects do not seem to be important issues for all consumers, a growing number of consumers became more health conscious over the past 5 years, demanding lower sodium and fat content. The sub-sector has reacted to changing demand by offering baked chips, low sodium products, and smaller, individual-size packaging (e.g. 100 calories bags). This ability to react to changing demand is a key success factor for companies operating in this sub-sector. Economies of scale and scope and product differentiation are two other important success factors according to a recent report by IBIS World.

Moreover, literature on the sub-sector points towards the significant investment in advanced technology and automation by larger companies. These players enjoy efficiencies from economies of scale and greater automation and advanced technologies. However, the degree of capital intensity varies with the size of the firm. According to the reviewed literature, small-to-medium companies tend to be less capital intensive, using more labour to increase productivity.

## Prepared Meals

Relevant NAICS:

**3114:** Fruit and Vegetable Preserving and Specialty Food Manufacturing

**311410:** Frozen Food Manufacturing

Comprises establishments primarily engaged in manufacturing frozen fruits and vegetables; and frozen dinners and side dishes of several ingredients, except seafood.

As well as non-frozen prepared meals, which are likely to be comprised in the following NAICS code:

**3119:** Other Food Manufacturing

**31199:** All other food manufacturing

Comprises establishments, not classified to any other Canadian industry, primarily engaged in manufacturing food. Establishments primarily engaged in manufacturing and packaging for individual resale, perishable prepared foods such as salads, fresh pizza, fresh pasta, and peeled or cut vegetables, are included.

### Literature Review

As the economy recovers and people go back to work, the demand for prepared meals at affordable prices is likely to increase.

**Pasta**

Relevant NAICS:

**3118:** Bakeries and Tortilla Manufacturing

**311824:** Flour mixes, dough, and pasta manufacturing from purchased flour

✓Pasta manufacturing (for the purpose of this study)

Comprises establishments primarily engaged in the manufacturing of dry pasta and noodle mixes.

**Sub-Sector Overview**

In 2012, according to the Global Trade Atlas and Statistics Canada, Canadian imports of pasta and couscous were around $401.9 million, from the United States, Italy, China, Thailand and South Korea. Exports were about $171.7 million and were mostly shipped to the United States, Israel, Philippines and United Kingdom[68].

**Coffee and Tea**

Relevant NAICS:

**3119:** Other food manufacturing

**31192:** Coffee and Tea Manufacturing

Comprises establishments primarily engaged in roasting coffee; manufacturing coffee and tea extracts and concentrates, including instant and freeze dried; blending tea; or manufacturing herbal tea. Establishments primarily engaged in manufacturing coffee and tea substitutes are included.

**Sub-Sector Overview**

In 2009, the Coffee and Tea industry exports were about $324.4 million and imports were about $845.3 million. The United States are the primary country where Canadian firms export coffee products.

Coffee and Tea processing plants are mainly located in Ontario with 41 plants, Quebec with 34 plants and British Columbia with 26 plants. The Coffee and Tea industry employed 2,240 people in 2008.

According to Statistics Canada's Business Patterns Database, in 2008 the range size of Canadian coffee and tea firms varied from small (1-2 person) to large (employing up to 500 people)[69].

**Literature Review**

Even though the Canadian climate does not provide adequate conditions for growing coffee, many Canadian firms import the raw materials and then process the coffee to re-sell into domestic and export markets. In 2009, the United States, Italy and Switzerland were the three major suppliers of roasted coffee to Canada, while on the other hand Columbia, Brazil and Guatemala were the major ones supplying raw coffee to Canada.

Investments in plant buildings, equipment and automation production systems were made to address the increasing consumption of coffee and tea.

Two important growing trends for the Coffee and Tea industry are certified fair trade products and certified organic products. Fair trade products ensure a minimum price for the product and work under safe conditions. Organic products are high-quality products that are produced in an environmental friendly manner. A lot of Canadian coffee companies had to extend and modify their production to address the demand for these growing trends[70].

# Selected Sub-Sectors of Interest

**Bread and Bakery Products**

Relevant NAICS:

**3118:** Bakeries and tortilla manufacturing

**31181:** Bread and Bakery Products

Comprises establishments primarily engaged in manufacturing bakery products, except cookies and crackers. Establishments classified in this industry may sell to commercial or retail customers, for consumption off the premises.

**Soft Drinks and Water**

Relevant NAICS:

**3121:** Beverages Manufacturing

**31211:** Soft Drinks and Ice Manufacturing

Comprises establishments primarily engaged in manufacturing soft drinks, ice or bottled water, including that which is naturally carbonated. Water-bottling establishments in this industry purify the water before bottling it.

**Sub-Sector Overview**

In 2009, Canadian Soft Drinks and Ice Manufacturing employed more than 11,000 workers. Imports were about $593.9 million and exports $127.3 million.

In 2009, the Canadian production of bottled water was estimated to be 2.29 billion liters. Most of the bottling plants are situated in Ontario and Quebec.

The fact that consumption of bottled water increased in Canada combined with the fact that Canada has a lot of water resources on its land attracted a lot of multi-national companies.

Canada's exports of bottles water decreased between 2000 to 2010. It passed from $206.5 million to $22.5 million. The United States, Japan and Taiwan are the three major countries where Canada exports bottled water[71].

**Literature Review**

The level of capital intensity for Soft Drink (and bottled water) Manufacturing is typically high. In order to achieve economies of scale, investment in advanced technology is necessary. Most manufacturing and packaging processes are automated and mechanized. Packaging expenses are significant to the sub-sector's profitability. Labour intensity tends to be higher for specific administrative tasks (admin, marketing, finance and plant maintenance). According to reviewed literature, most of the investments in the past years have been toward the construction of new plants and upgrading of existing facilities. While the process of manufacturing drinks has only changed slightly over the past decades, technology advancements aimed at improving quality control were associated with automating and computerizing production processes.

**Alcoholic Beverages**

Relevant NAICS:

**3121:** Beverages Manufacturing

**31212:** Breweries

**31213:** Wineries

**31214:** Distilleries

# Selected Sub-Sectors of Interest

## Alcoholic Beverages (continued)

### Sub-Sector Overview

In terms of value of production, Beer is the most important element of the Alcoholic Beverages industry in Canada. Wine comes second and distillery follows.

In 2009, the exports of beer mainly to the United States, were about $240.2 million. Imports at that time were $641.6 million. This component of the alcoholic beverage industry employed 8,371 workers back in 2009. The brewery plants are mainly located in Ontario, British Columbia and Quebec. Canada's brewery industry is mainly dominated by two major companies.

The distillery component of the Canadian Alcoholic Beverages industry is the largest exporter. In 2005, exports were $389.1 million and mainly to the United States. Imports were around $542.1 million for the same period. It also employed 1,946 workers[72].

In 2006, Canadian importation of wine was around $1.5 billion and coming mainly from France, Australia, Italy, Chile and the United States. Exports were only about $35 million. At that time, 2,766 workers were employed. There is a seasonal element for hiring in this sector with more people hired during the time of the grape harvest[73].

## Literature Review

The making of traditional beer has not changed much over the past centuries. Large breweries typically require substantial capital investment and are highly automated. Some advancements in technology include: more efficient boiling systems, refining of brewing process, use of solar energy (to reduce energy consumption), etc. Technologies used to distribute, store, package and keep track of beer products are constantly changing. However, the level of automation and robotics varies depending on the size of operations. The production of more specialized beers (craft beers) is most likely to be manual with mechanized steps.

For distilleries, most of the production process is automated. The most recent technological improvements in large-scale distilling are incremental and aim to increase the safety and consistency of products (better filtration systems and greater knowledge about aging fruits and grains). Moreover, the process of packaging shipments was improved thanks to faster and less wasteful bottling and palletizing technologies.

As with the production of beers and spirits, the making of wine has not changed much over the past centuries. The sub-sector tends to be highly labour-intensive, especially in the picking and sorting of grapes. Automation and technological developments are most common in larger wineries, whereas smaller, boutique producers tend to rely more on the 'art' of winemaking. Quality monitoring of the final product is likely to remain a manual task, requiring highly specialized and knowledgeable labour.

Amongst the technologies used by larger wine makers one can find: machine harvesting of grapes in integrated vineyard-wineries, barreling in stainless steel containers, use of temperature controlled storage, automation of clarification, fining, and filtration.

# Appendix II

## Global Food and Beverage Processing Sector

# Scope - Countries

**The Global Food and Beverage Processing Sector**

The Food and Beverage Processing sector plays a prominent role in the global economy, representing the largest manufacturing sector amongst several industrialized countries, including Canada, Europe, the United States (US), and Australia. The sector is also growing in importance for developing economies.

Over the past decade, the Food and Beverage Processing sector underwent significant changes and growth. Some global players consolidated. In the meantime, the middle class in emerging countries has grown to become a viable food and beverage market. Automation and robotics were adapted to the sector, addressing product diversity needs and increasingly stringent legislation and regulations for food safety and quality[74].

As the Food and Beverage Processing sector continues its growth towards a global economy, firms are likely to face increased competition, which will require them to adapt their processes to new customer trends and food health and safety requirements, while offering a greater variety of products at lower cost.

**Countries of Interest**

A number of countries were considered for the benchmarking exercise based on a number of rationales, including:

- automation and robotics has been adopted as part of their business model;

- commercial interaction with Canada;

- importance of the Food and Beverage Processing sector;

- global geographical representations.

These countries/regions included:

| |
|---|
| United States |
| Mexico |
| European Countries:<br>▪ Germany<br>▪ Netherlands<br>▪ France<br>▪ Norway<br>▪ Sweden<br>▪ Italy |
| Japan |
| China |
| Australia |
| South Africa |
| South America |

Outlined below is a short literature review on the Food and Beverage Processing sector in Canada and the countries mentioned above.

**Geographical Region Overview**

With shipments worth $92.9 billion, the Food and Beverage Processing sector is Canada's largest manufacturing sector. The sector accounts for 15.9% of the country's total manufacturing shipments and for 1.7% - including tobacco – of the national gross domestic product (GDP). It is the largest manufacturing employer and provides employment for 249,104 Canadians (2012). This sector is crucial to the economic activity of all provinces, though degrees of importance vary according to sub-sectors of activity as well as the provinces themselves.

Agriculture and Agri-Food Canada (AAFC) estimates that Ontario and Quebec together account for approximately 57.5% of the processed food and beverage sales, whereas Western provinces account for 30.5% and Atlantic Provinces for about 11.9%. Large enterprises account for 3.1% of all food processing establishments in Canada and 50.5% of the value of all shipments. Small and medium-sized enterprises (SMEs) make up 96.9% of food processing establishments and 49.5% of the value of all shipments.

According to a recent report issued by the Alliance of Ontario Food Processors (AOFP), the Food and Beverage Processing sector is a salient contributor to the province's economy. The sector was responsible for generating $39.4 billion in annual revenues in 2011 and $11 billion to the province's GDP. The industry directly provides over 125,000 jobs to the province throughout its 3,000 plus businesses across the various sub-sectors.

The Food and Beverage Processing sector is also Quebec's most important job provider in the manufacturing industry, with approximately 65,000 direct jobs in over 2,000 businesses and over 101,000 indirect jobs.

**Capital Expenditure**

According to AAFC, the Food and Beverage Processing sector invests about $2 billion annually in capital expenditures, with about 80% of the total invested in machinery and equipment.

**Trade Balance**

Exports for the Food and Beverage Processing sector amounted to $24.1 billion in 2012, which represents a year-over-year increase of 12%. Nearly 87% of those exports were directed towards the United States (67%), Japan (7%), China (9%), Russia (3%), South Korea (2%) and Mexico (2%).

The trends and issues faced by the Canadian Food and Beverage Processing sector provides some context to the trade balance recorded over the past few years.

A recent analysis[75] of the Canadian Agri-Food trade balance over the period of 2004 to 2012 indicated that commodity designations, including primary processing, vegetables and fats and oils[f], have been in a trade surplus, whereas secondary processing has been facing a rising trade deficit. However, as demonstrated in the reports, thorough understanding of the issues at hand for any given sub-sector requires a four-fold analysis of the consumer, economic, supply chain and policy/regulatory environment faced by the firms.

Some sub-sectors experienced a trade surplus over the same period. Few examples would include Grain and Oilseed manufacturing, Meat Product manufacturing and Seafood Product preparation and packaging.

Canada's domestic market absorbs much of its food manufacturing output, which is not considered in the trade balance calculation. Moreover, imports for certain products increase because Canada does not have the capacity to produce the demand. For example, although it showed a trade deficit of $2.9 million in 2012, wine is an important and successful Canadian subsector[76,77].

**Consolidation**

A recent analysis of plant closures, openings and investments revealed that Canadian Food and Beverage processing firms are consolidating and reorganizing their production facilities to become more globally competitive[78]. Between 2006 and 2014, 143 Canadian food processing plants closed, 128 of which were part of multi-plant companies. These were mostly to "reorganize their manufacturing footprints to be more globally competitive, focusing production facilities, investing in new technologies, automation and new systems and adopting new processing methods" (CAPI, 2014, p. 8).

**Scale and Productivity**

Given Canada's trading relationship with the US, scale is an important factor affecting the ability of Canadian Food and Beverage processing firms to compete.

A recent analysis of the relationship between scale and productivity in Canadian Food Processing firms indicated that Canadian firms operating in this sector are significantly smaller in scale than their counterparts in the United States (US). The study revealed that the existence of major scale differences exist in all food processing sub-sectors, with Canadian processing facilities using half the labor and generating less than half the sales revenue of US facilities on average.

As measured by the value added per employee, the study indicated that larger establishments (at the 75th percentile) are more productive, i.e. have a value added per employee twice that of median facilities.

Moreover, Canadian Food Processing firms were found to be lagging behind the US in their machinery and equipment investment. Notably, Canadian facilities only invest 62 cents per employee for every dollar equivalently spent by US firms.

Although scale is not the only factor affecting manufacturing productivity, it has helped improve productivity in the US Food and Beverage Processing sector, while Canadian firms are lagging. Technology and innovation are anticipated to continue to be an important driver of scale for Food and Beverage processing firms. However, scale is also thought to allow for greater investment in more labour-saving technologies, which would worsen the gap attributed to scale.

In order to achieve appropriate scale, Canadian companies need to gain access to markets outside of Canada.

**Economic Overview Food and Beverage Processing Sector**

- GDP contribution: ~ 1%

- Employment: 1.5 million (2011)

- Trading Partners: Canada, Mexico, Japan, China, Korea[79]

- Imports: 69% of Canada's exports[80]

- Exports: 61% of Canada's imports[81]

- Trade balance with Canada: $1.1 billion deficit (2013)[82]

**Relationship with Canada**

The US is the largest trading partner for Canada in the Food and Beverage Processing sector. Canada represents the United States' largest importing and exporting destination, followed by Mexico. The established trade relationship and the geographical aspect are two main advantages.

**Relevant Information**

The Food and Beverage Processing sector is one of the most important manufacturing sectors for the US. In terms of employment, the meat processing industry is the largest contributing sub-sector employing 32% of the total food and beverage workforce (2011)[83], followed by bakeries (17%) and fruits and vegetables (11%).

In 2011, the meat processing sector was also the largest component of the US Food and Beverage industry in terms of shipments value. Accounting for 24% of 2011 total shipments value[84], followed by dairy products (13%), beverages (12%), grains and oilseeds (12%), fruits and vegetables (8%).

In 2007, 66% of the Food and Beverage processing plants were small plants (0-19 employees). They accounted for only 4% of the total shipments while large firms (100 or more employees) accounted for 77% of the total shipments despite the fact that they only represented 12% of the total number of plants.

The sector has significantly invested in technology, increased automation and made production improvements, allowing Food and Beverage processing firms to increase their output while relying on less employees[85].

**Economic Overview Food and Beverage Processing Sector**

- GDP contribution: 4.1%

- Employment: N/A

- Trading Partners: United States, Canada

- Imports: N/A

- Exports: N/A

- Trade balance with Canada: $99.6 million surplus[86]

**Relationship with Canada**

Mexico is Canada's sixth-largest export market and fifth-largest source of imports[87]. Both Canada and Mexico have direct access to the US market under NAFTA; therefore, they directly compete in terms of food exports to the US.

**Relevant Information**

There are over 1,000 medium-large food processors in Mexico. The processed food industry in Mexico has experienced steady growth since 2011, growing at a rate of almost 2 percent per year. In 2012, processed food production represented a value of US$123,954 million in Mexico[88,89].

In 2011, the bakery and tortilla industry represented 30.7% of the total production of the processed food sector, whereas other categories such as meat processing and dairy production represented 21.5% and 10.8% respectively. In 2012, Mexican-imported processed food products were valued at US$9.3 billion, with the United States being Mexico's main exporter in this industry.

**Economic Overview Food and Beverage Processing Sector**

- GDP contribution: N/A

- Employment: 4.25 million (2011)[90]

- Trading Partners: US, Russia, EU members, China

- Imports: 2.9% of Canada's exports (2013)[91]

- Exports: 13.9% of Canada's imports (2013)[92]

- Trade balance with Canada: $1..6 billion surplus (2013)[93]

**Relationship with Canada**

Europe has been amongst Canada's top five export markets for several years and the country's second largest import market in terms of value. While Canada sought greater access for beef products in Europe, the EU sought greater market access for dairy products in Canada. The Comprehensive Economic Trade Agreement (CETA) still has to be ratified.

**Relevant Information**

Food and Beverage processing is the European Union's largest manufacturing sector in terms of turnover, value added and employment. The sector contributes 1.9% to EU gross value added (12.9% of the manufacturing share of value added).

The Food and Beverage manufacturing sector directly employs 4.25 million people, making it the largest EU manufacturing sector for direct employment (15%). Moreover, the level of employment in the Food and Beverage sector remains relatively stable.

The meat sector, bakery and farinaceous products, dairy products, drinks, and "various food products" represent the top 5 EU sub-sectors in terms of employment, value added, and turnover (sales).

Nationally, the Food and Beverage Processing sector is key to the economy of Member States. Germany, France, and Italy are the top 3 food and beverage producers, with respective 2011 sales of €163 billion, €157 billion, and €127 billion (FoodDrink Europe, 2012).

The EU is a net exporter of food and beverage products. The United States and Russia are the top importers of EU food and beverage products, with Canada ranking in the 8th place, with nearly €2.3 billion in export value in 2011. The EU is increasingly exporting to China and Hong Kong (2010/11 growth rate of nearly 50%). Drinks (alcoholic and non-alcoholic) accounted for 31% of food and beverage exports in 2011, making it the largest exporting sector, followed by meat (11%) and dairy (10%) products. The largest sub-sectors for which the EU imports include fish and seafood products, oil and fats, fruits and vegetables products and meat products.

**Overview Food and Beverage Processing Sector - Germany**

Food and Beverage manufacturing is the fourth largest manufacturing sector in Germany, generating production value of €163.3 billion (2011 data). The latter represents an 8% increase year-over-year. The German Food and Beverage manufacturing sector is mainly comprised of small and medium sized enterprises (SMEs), with approximately 6,000 firms employing nearly half a million people.

The largest sub-sectors, in terms of production value, are meat and sausage products (23%), dairy products (16%), baked goods (9%), and confectionery products (8%).

2011 exports of processed food and agricultural commodities totaled €60 billion in sales, 30% of which were exported in vast majority to other EU members (80%). Germany is a net importer of food and beverage products, and as such an important market to foreign countries.

**Overview Food and Beverage Processing Sector - Netherlands**

The Dutch agri-food sector is a key sector of the Dutch economy, contributing nearly 10% (€48 billion) to the country's total value added and providing work and income, directly and indirectly, for more than 660,000 people.

In terms of GDP contribution, the Netherlands is the sixth-largest EU economy, generating approximately €600 billion in 2012. The country ranks amongst the top ten exporters of goods in the world (sixth position, 2012), and is the second-largest exporter of agri-food products worldwide, preceded by the United States. The sector accounts for 21% of the country's total export value. The total value of Dutch agricultural exports reached €72.8 billion in 2011.

More than 80% of the agri-food exports are destined for other European countries, with Germany being its largest trading partner for agricultural products (26% of agri-food exports).

**Overview Food and Beverage Processing Sector - France**

In terms of GDP contribution, France is considered the second-largest EU economy, contributing €2.0 trillion in 2012.

The French food and beverage sector is a key contributor to the economy of the country, with €157.2 billion in sales turnover in 2011. The country is ranked the second largest EU member (after Germany) in terms of food and drink sales (FoodDrink Europe, 2012). With about 500,000 people working in the sector, the food and beverage sector is the largest industrial employer in France. In 2011, the sector was comprised of 10,000 firms with 90% of them considered micro-companies (employing less than 10 people) and only 1% considered large companies (employing more than 250 employees).

The country also ranks as the fifth largest exporter of goods worldwide and exporter of agricultural products (Holland Compared, 2014). In 2010, French agri-food exports increased by 12% and represented €57 billion, with the majority (70%) being food products (Food Studies France, 2013). Major importers of France's agri-food products include Germany, Belgium, the UK, Italy, Spain and the Netherlands. The largest two exporting sub-sectors were wine and spirits and dairy products, accounting for 13% and 9% of total agri-food exports in 2010, respectively.

France also imports a large amount of agri-food products, 70% of which are from other EU members, including the aforementioned countries of French export. Meat products, fish, and fruits are the three largest import sub-sectors, accounting for 9.6%, 8.5%, and 7.8% of total agri-food imports, respectively (Food Studies France, 2013).

# European Countries – Additional Information

**Overview Food and Beverage Processing sector - Norway**

Norway's GDP was about $512.6 billion in 2013.[94]

The Food and Beverages industry revolves around fish.[95]

**Fresh and Processed meat:** In 2013, the most important exports were frozen fish, fresh or chilled fish and fish fillets and other fish meat.[96]

**Dairy products:** Cow milk counts for a large portion of the market, considering a €461.65 million production yearly.[97]

**Flour and Bakery:** Wheat and soybean oil are part of the grain sector, which is growing more and more in 2011.

**Overview Food and Beverage Processing sector - Sweden**

Sweden's GDP was about €393.03 billion in 2011. Of that amount, €29 billion represented the total food and drink market in Sweden.

The processing industry is supported by other sub-sectors such as starch and grain, dairy and meat. With a reduction of product market barriers, Sweden's imports have been increasing. Furthermore, Swedes have a health-conscious lifestyle.[98]

**Fresh and Processed Meat:** In 2011, sales were in a constant growth, increasing by €178 million per year.[99]

**Beverages:** In 2011, the Beverages sub-sector accounted for 23% of the Food and Drinks market. The Swedish Beverage market is composed of mainly energy or sport drinks (80%), which is a largely growing sub-sector in Europe.[100]

**Overview Food and Beverage Processing sector - Italy**

The Food and Beverage industry was valued at €173.4 billion in 2011[101]. The processing sector depends a lot on the import of raw materials. The majority of countries that export to Italy are EU members, with France, Germany, Spain, the Netherlands and Austria being the most important suppliers.

The main products that are exported are wine, pasta, olive oil, canned tomatoes, cheese biscuits and baked goods.

**Chilled Food Processing:** In 2012, sales of chilled food products reached €11.4 billion. Chilled soup was the best performing category in 2012 in terms of growth. Chilled processed meat remained the biggest category of this sector with €8,954 million in sales.[102]

**Frozen Food Processing:** In 2012, sales of frozen food products reached €2.9 million. Frozen fish had the best growth in 2012, while in term of sales the fruits and vegetables category was the biggest with €841.3 million.[103]

**Dried Food Processing:** In 2012, sales of dried food products were €2.5 billion. Dried pasta was by far the biggest category of this sector with €1,985.3 million in sales.[104]

**Economic Overview Food and Beverage Processing Sector**

- GDP contribution: N/A

- Employment: 225 110 (2012-2013)[105]

- Trading Partners: China, India, Asia[106]

- Imports: less than 1% of Canada's exports (2013)[107]

- Exports: 1.6% of Canada's imports (2013)[108]

- Trade balance with Canada: $128 million surplus (2013)[109]

**Relationship with Canada**

Throughout time, Australia has not been a significant trading partner to Canada. The similarities of both agricultural and food processing activities create less trade opportunities. Canada and Australia are both tied as the third largest exporter of wheat worldwide.

**Relevant Information**

The Australian Food and Beverage Processing sector contributed 23.5% to total manufacturing value added in 2012-2013. Total manufacturing value added has been decreasing over the past decade, from 9.2% in 2002-03 to 6.8% in 2012-13. The Food and Beverage Processing sector employed 23.6% of total manufacturing employment.

In 2012-13, Food and Beverage exports represented 21.8% of total manufacturing, while imports only represent 5.7%. Asia represents an important and growing market for Australia. In 2011-12, food exports to Asia accounted for more than 50% of Australia's total food exports. Meat products and grains represent the two largest sub-sectors of Australian agri-food production (2011-12 data), as well as the largest export sub-sectors.

Research and development (R&D) expenditures for the sector represented 12.3% of total manufacturing R&D in 2011-12, an increase from 8.9% in 2005-06.

## Economic Overview Food and Beverage Processing Sector

- Employment: N/A

- GDP contribution: N/A

- Trading Partners: US, Malaysia, Indonesia, EU, Canada[110]

- Imports: 9% of Canada's exports [111]

- Exports: 3.3% of Canada's imports [112]

- Trade balance with Canada: $943 million deficit[113]

### Relationship with Canada

China is Canada's second and third largest market for exports and imports respectively in terms of Food and Beverage processing products[114]. Canada has a larger beef production than China and also exports much more of its animal production.

### Relevant Information

China represents an important and growing Food and Beverage market. According to a recent report from the EU SME Centre (The F&B market in China, 2011), total food and beverage sales in China nearly doubled between 2004 and 2008, reaching CNY 800 billion (or €84.2 billion). Processed packaged products account for approximately 10% of the total Chinese food expenditure, compared with 57% in the United States and 48% in Japan[115]. With the growing middle class of China, high quality and convenient food is expected to represent an important growth opportunity for Food and Beverage processing companies. Chinese urban household average per capita annual income has grown significantly over the past few decades. These higher income earners tend to spend a higher proportion of this increased income on packaged food.

China's imports of food and beverage products has displayed a slow but strong growth over the past years. In 2011, China ranked as the top exporter and importer of food and drink products, occupying the fourth position in both categories. The estimated value of Chinese imports for 2011 was $36.9 US billion (FoodDrink Europe), representing 6.3% of global food and beverage imports (an increase from 3.3% in 2002). Chinese exports for 2011 grew to a 7.5% share of global food and beverage exports, an increase from 5.8% in 2002. The value of the country's exports for 2011 was estimated at $44.2 US billion.

According to TradeData International (2011), the United States is the largest food exporter to China, followed by Malaysia, Indonesia, the EU, and Canada. Top EU members exporting to China are France (€1,046 million), the Netherlands (€586 million), Denmark (€268 million), Germany (€241 million), and Spain (€225 million).

**Economic Overview Food and Beverage Processing Sector**

- Employment: N/A

- GDP contribution: N/A

- Trading Partners: US, China, Australia, Canada

- Imports: 6.4% of Canada's exports (2012)[116]

- Exports: Less than 1% of Canada's imports (2013)[117]

- Trade balance with Canada: $812 million deficit (2013)[118]

**Relationship with Canada**

Through time, Japan has always been one of Canada's top three export markets for processed food. The low domestic opportunity and production of products that meet Japanese consumers' strict demand for safe and high quality food products creates an opportunity for Canadian firms.

**Relevant Information**

The Japanese Food Processing industry was worth $282.1 billion in 2012. The most important processing industry is the soft drink, juice and water industry accounting for 16.2% of the total value. It is followed by alcoholic beverages (14.6%), wheat flour (10.2%) and confectionery (10.1%).

The major food exporters to Japan are the US with 25.59% of the exports followed by China (12.86%), Australia (7.75%) and then by Canada (10.1%).

Recently, due to constant pressure to lower costs, some Japanese firms have moved the production of certain ingredients, originally produced domestically, to other countries. It is now common for Japanese food processing firms to import ingredients from other countries and continue to license, process and practice the final products in Japan.

The Japanese market is a difficult market to enter within Asia. There are many factors such as strict legislation in regards to specific ingredients and additives that have to be considered.

In Japan, there are many growing trends concerning food. One trend is traditional health foods such as soy milk that has perceived healthy properties. Another trend is ready-to-go meals. These two trends increase the demand for healthy snacks in Japan[119]. Food safety is also something that Japanese consumers value a lot.

# South America

**Economic Overview Food and Beverage Processing Sector Brazil**

- Employment: 1.4 million (2009)

- GDP contribution: N/A

- Trading Partners: Argentina, Uruguay, Paraguay, Chile, US

- Imports: less than 1% of Canada's exports[120]

- Exports: 2.3% Canada's imports[121]

- Trade balance with Canada: $317 million surplus (2013)[122]

**Relationship with Canada**

Canada is the third largest source of imports in terms of food manufacturing imports for Brazil. Brazil is the second largest producer of beef in the world and also a major exporter, therefore it is a serious competitor to Canadian beef exports[123].

**Relevant Information**

In 2009, The Brazilian Food Processors' Association (ABIA) estimated the net revenue of the Brazilian Food Processing sector at US$173 billion. It is the second largest manufacturing sector of the country. According to the Ministry of Labor and Employment (MTE), the industry employed 1.4 million people in 2009.

The meat and by-product sector (23.7%) is the largest sub-sector of the Brazilian Food Processing industry. In 2009, sales were about US$34.4 billion. Coffee, Tea and cereals (13.3%) are ranked second with sales of US$19.5 billion in 2009. The sugar sector is also an important component of the Food Processing sector with 12.3% of the industry total sales.

The majority of Brazilian imports come from Mercosul countries – Argentina, Uruguay and Paraguay mainly – and also from Chile. Import value from Argentina was US$1,418 million in 2009, accounting for 38.3% of total import value. Import value from Uruguay (12.7%) was US$469 million. Import value from the US (7.3%) was US$469 million.

The Mercosul companies have a tax free agreement between them. Therefore, it is more difficult for other countries that are not part of such agreement to compete and enter the market[124].

**Argentina**

The Food and Beverage Processing sector is a major sector that contributes to Argentina's economy. The Argentinean Food and Beverage sector includes local, national and also multinational companies.

Argentina's total exports in 2010 were $22.6 billion and the Food and Beverage sector accounted for 33% of them.

In 2010, food product imports were valued at $1.4 billion. Imports mainly come from Mercosul countries (33%). Also, a lot of imports come from Europe (17%), NAFTA (16%) and China (12%).

There is a certain level of technology in food processing plants in Argentina, both for commodities and more sophisticated products. Quality control and safety systems are present even in smaller local plant[125].

**Geographical Region Overview**

The South African agricultural sector accounted for 3.4% of the country's total GDP in 2010 and employed approximately 10% of the workforce in South Africa, even though only 13% of South African fields are usable for crop production. The main reason for this is the availability of water and the uneven distribution of rainfall.

In 2006, the South African Food and Beverage manufacturing industry accounted for 16.4% of South African manufacturing production.

Despite the little decrease in export value over the last few years, South Africa has a positive trade balance in terms of agricultural products. The leading export categories are raw sugar, fresh grapes, citrus, nectarines, wine and deciduous fruits (apples, pears, apricot, etc.).

In 2010, exports of South African food products were mostly to the Netherlands (11%) where grapes, oranges and grape wines were the main products shipped. Other export markets included the United Kingdom (9%) where grape wines, grapes and apples were the most shipped products, and Zimbabwe (8%) where sunflower seeds and oils, wheat and sugar were the most shipped.

In 2010, the main countries from which South Africa imported food were Argentina (12%) with soybean, sunflower seeds and oil, and chicken meat being the main imported products. Then comes Thailand (9%) with rice, cereal & starches being the main imported products. Brazil (7%) was also an important partner where chicken meat, tobacco and sugar were the most imported products.

The South African Food industry is primarily composed of its own agricultural activities. Despite the country's economic environment, the agricultural sector is sophisticated and comparable to that of developed economies.

Many South African companies are making partnerships with companies abroad in order to gain access to the latest technologies and also to get expertise on diverse aspects of the industry. The following partnerships are just a few examples: Simba with Frito-Lay (U.S.A.) in the snack food industry, Robertsons with Bestfoods (U.S.A.) in savoury foods and soups, and NCD Clover with Danone (France) in dairy products.

The great development of the Agricultural and Food industry in South Africa is affecting the domestic consumption of food. A greater variety of products are offered to South African customers, which increases the demand for new products. It is estimated that sales in different products such as prepared meals and dairy products are going to increase in the next few years.

# Appendix III
## Trends in Automation and Robotics

## Global Trends in Automation and Robotics

The use of automation and robotics has essentially transformed manufacturing in almost every industrial application. The resulting increase in efficiency and product consistency has resulted in a vast array of affordable and reliable products, addressing stringent market demands (Caldwell, 2012). Over the next few years, the trend towards increased levels of automation and robotics is expected to continue, as demand grows to meet needs from more sectors and additional geographical regions. New York-based technology research firm ABI research anticipates that the global market for industrial robotics will increase from US$5.2 billion in 2010 to US$8.8 billion in 2015.

### Relocating Closer to Demand and Increasing Automation

"Next-shoring," to quote an article recently published by McKinsey and Company (2014), is growing in popularity amongst manufacturers from developed countries. As opposed to "offshoring," which became significant in the 1990s as many manufacturers strategically located their plants in low labor-cost developing countries, the strategy emphasizes locating manufacturing plants in close proximity to demand and innovation. As manufacturers move their operations closer to demand, a trend towards increased automation and robotics is inevitable, especially for developed countries where the cost of labour is simply not comparable to that of China and other developing economies.

The article points towards the growing importance of local demand factors, which is not only present in North America and Europe, but also in China. Emerging markets are contributing more and more to the global demand, not only producing for the developed countries, but for regional markets. The advantage of labour-cost arbitrage is thus limited, with increasing local demand and rising wages in emerging countries like China. Hence, this trend towards automation is not restricted to developed countries.

In fact, data from the International Federation of Robotics (IFR) indicates that China counts amongst the countries that purchased the greatest number of robots (2012) – a trend that is increasing.

As next-shoring is taking place, one can expect advanced technology to grow significantly in importance, along with access to highly skilled labor and innovation centers.

### Cost of Robots versus Cost of Labour

On the one hand, the real price of robots has significantly decreased over the past decade and this trend is expected to continue as new labor-cost saving technologies are developed. On the other hand, cost of labour has been steadily increasing, both in minimal wages and in other paid advantages. Combining these trends in robots prices and labour cost, firms are expected to increasingly adopt automation technology and robotics.

Since 2008, investments in industrial robots have increased by nearly 50%. More factory tasks can be performed by these advanced robots, and robotics is being adapted to new applications, including the Food and Beverage Industry.

According to an article published by Beroe, robot sales for the automotive sector account for more than 30% of all robot sales and the sector represents the largest end-user segment (50% of demand). Yet, sectors like Electrical and Electronics, Chemicals and Pharmaceuticals, and Food and Beverage are increasingly investing in the purchase of robots.

### Advantages of Industrial Robots and Robotic Systems

The manufacturing industry is a very competitive market and thus the pressures to shift towards increased automation and robotics are growing. The following are just a few of the numerous incentives to automate and use robotics.

- ✓ **Increasing production output rates:** Robots (and other types of automation) never get tired and can consistently work for long period of time with minimum down time (breaks). The result is an increased production output rate;

- ✓ **Improving quality and consistency:** High precision and consistency are achievable through automation and robotics, such that once adapted to the production needs, the result is continuous production of high quality finished products;

- ✓ **Increasing flexibility in product manufacturing:** Robots can provide increased flexibility for any given line of production, such that once programed, more than one product can be manufactured on a specific line;

- ✓ **Improving quality of working conditions:** Since robots and automation can perform tedious, dangerous and dirty tasks that used to be performed by humans, their use can improve the working conditions of hired labour, decreasing the amount of repetitive tasks and minimizing the risk of injuries and the level of accidents.

- ✓ **Reducing material waste and increasing yield:** The consistency of robots leads to a higher level of quality products (matching specifications) and a reduction in waste due to rejects.

- ✓ **Saving space:** Since most recent robots are increasingly malleable, they are easier to compact and to install as needed within existing plants.

- ✓ **Reducing costs:** Consistency also means that it is easier for firms to forecast and address the changing demand. Also, new generations of industrial robots are equipped with control systems that reduce energy consumption.

- ✓ **Creating jobs:** A recent study by the IFR and Metra Martech (2012) indicates that robots create jobs directly and indirectly.

However, there are still challenges that must be addressed with regards to robotics and these include increasing the ability to adapt to changing demand (increased variability) while remaining easy to use (minimal engineering requirements), improving vision systems and sensors and increasing the ease of integration of robots to achieve a single point of operation.

## Automation and Robotics in Food and Beverage

The global market for automation and robotics in the Food and Beverage Processing sector is forecasted to continue growing over the years to come. While some countries have been adopting and developing technology for that sector for a number of years already, some sub-sectors, such as Meat Products and Fish and Seafood Processing, have only recently been added to the pool of candidates for automation and robotics.

Food health and safety concerns were one of the main reasons for the observed lag. However, there was also an important lack of applications for many of the Food and Beverage manufacturing processes.

Discrepancies in automation and robotics for the Food and Beverage processing sub-sectors are also observed geographically and amongst firms of any given sub-sector.

According to the IFR, Europe is the region that uses the most robots in the Food and Beverage Processing sector. However, the trend is growing and not only within Europe. In terms of 2012 purchases, the following countries, listed respectively, have purchased the greatest number of robots for Food and Beverage processing applications: United States, Italy, Germany, Japan and China.

A number of drivers are likely to further increase the use of automation and robotics by Food and Beverage processing companies in the future. These include:

✓ increasing cost of labour and availability of manual labour (changing skill set of available workers);

✓ increasing diversity of food and beverage products (which increases demand for flexible automation);

✓ increasing safety and hygiene requirements;

✓ increasing demand for high quality and convenient food;

✓ growing working population ("middle class") in developing countries.

According to the IFR, growth areas for the use of robots by food processors are expected to include:

✓ **Frozen and chilled food:** Frozen and chilled food accounts for over €16 billion of 2011 sales in Europe, or about 40% of the world market, and is expected to continue growing at 3 to 3.5% a year around the world.

✓ **Ready meals:** Ready meals account for nearly 43% of frozen and chilled food sales. The European market only is expected to grow at 2.5 to 3.0% a year. Drivers for this sub-sector include safety, hygiene, cost, and local needs.

✓ **Confectionery products:** Global consumption of confectionery products is 2.1 kg annually on average per person. However, China is thought to be a potential important growth market, with current annual consumptions well below the world average.

✓ **Slaughtered meat:** Slaughterhouses require heavy dangerous work as well as considerable skills. This sub-sector represents an important opportunity for robots as they can address work hazards and the related risk of accidents.

**Canada**

Access to innovation and technology seems to be growing in importance for Canadian Food and Beverage processing firms. A recent report produced by the AOFP (2013) indicates that over the last few years a, "cultural shift has taken place," where Food and Beverage processing firms are actively seeking access to new technologies and opportunities to innovate. Although this report reflects Ontario processors, the trends are likely to apply to the rest of Canadian processors.

As health, sustainability, and consumer trends continue to affect the competitive landscape, rapid access to leading-edge technologies, information and innovation will grow in demand.

Another likely important driver of automation and robotics for the Canadian Food and Beverage Processing sector is labour cost. Although minimum wage varies across provinces, Canada's minimum wage is significantly above its US neighbors, without accounting for all the other benefits. As labor cost continues to rise, Canadian processors are likely to try to find ways of minimizing this impact.

According to IFR statistics, the first and second largest markets for robotics amongst Canadian manufacturers are the automotive industry (57% of 2012 sales), followed by the Food and Beverage processing sub-sector (9% of 2012 sales). Although the IFR has only recently began reporting separate robot sales for Canada (previously reported under North America only, which included Canada, the US, and Mexico), the trend for Food and Beverage processing has been increasing since 2011, especially for use in pick-and-place, packaging, and palletizing.

**United States**

According to IFR statistics, robot sales in the United States (US) have been substantially increasing since 2010, reaching a peak of 22,414 shipped units in 2012. The main industries driving the

### United States (cont'd)

sales of robots are the automotive industry, followed by the metal, plastic and chemical industries. The need to modernize domestic plants and the trend towards automation have boosted the investments in automation and robotics for the United States. In 2012, the US ranked third in terms of imports of robots, just behind Japan and China. Most of these robots were imported from Europe and Japan.

### Mexico

According to IFR statistics, robot sales in Mexico reached a new peak level of 2,016 units in 2012. The trend has been increasing since 2010, and the number of operational robot stock in Mexico increased by 20% to almost 11,000 units in 2012. The automotive industry is the main driver of robot sales. The country is considered a production hub for exports to the US and, increasingly, to South America.

Robot sales for the Food and Beverage industry in Mexico (including Tobacco) was 49 units in 2012.

Although wages remain attractive for the manufacturing industry, increased automation and robotics is anticipated in the coming years. Product quality and standards for exports to the US will further push this trend, and Mexico is thus considered a growth market for robot installation.

### France

According to IFR statistics, robot sales in France were about 2,956 units in 2012. France is Europe's third largest market for robots. Since 2000, the investments in automation and robotics for the automotive industry have decreased. Companies are either investing in growing markets or looking to shift production to more cost-efficient locations. France's robot sales have continuously been increasing since 2008, but it never came close to its peak of 3,800 units reached in 2000.

The Food and Beverage industry increased its robots sales over the past few years, reaching sales of 315 units in 2012. The level of operational robots in the Food and Beverage industry were about 2,650 units in 2012, which accounted for 8% of the total quantity of operational robots in the country. In future years, investments are expected to be mostly for the modernization of existing plants, for increasing automation and meeting environmental and safety standards. The French firms are mostly looking to invest in automation for modernizing and energy efficiency purposes rather than for increasing productivity. An increase is anticipated for investments in the Food and Beverage industry.

### Germany

According to IFR statistics, Germany is Europe's largest robot market in terms of sales and operational stock of industrial robots.

It also ranks third in the world in terms of industrial robots in operation, after the United States and Japan. Worldwide, Germany ranks fifth in sales of robots, whereas about 11% of global robot sales are for Germany.

The automotive industry is the main driver of robot sales in Germany. Robot sales in the Food and Beverage industry increased to 600 units in 2012, below the peak level of 2010 (900 units). Robot sales in the Food and Beverage industry are expected to increase.

### Italy

Italy is Europe's second largest robot market after Germany. The automotive industry has dominated the market over the years. In 2012, robot sales reached 4,402 units. Sales in the Food and Beverage industry have constantly increased over the last few years, reaching 614 units in 2012, which was below its peak level of 658 units in 2011. The number of robots in operation in the

**Italy (cont'd)**

Food and Beverage industry was about 3300 in 2012 and accounted for 6% of the total quantity of robots in operation in the country. It is expected that investments in robots are not going to increase in the near future except for the Food and Beverage industry, which shows the most positive signs economically.

**Netherlands**

Sales of industrial robots for the Netherlands have been decreasing over the years. Almost all industries reduced their investment in robots in 2012, with total sales decreasing from 1,015 units (2011) to 810 units (2012). Robot sales decreased from 800 units to 508 units over the 2007-2010 period.

The Food and Beverage industry is an important sector of the Netherlands' economy. Robot sales for that industry fell from its 2011 peak level of 161 units to 124 units in 2012, which constitutes 15 percent of total robot sales for the country.

The Netherlands is one of the major exporters of food in the world. However, the current weak economic situation has affected the investment climate of the manufacturing industry in general. As such, robot sales are expected to further decrease in 2013.

**Norway**

According to IFR statistics, the total sale of robots for Norway in 2012 was 91 units. The stock of operational robots was estimated at about 1,019 units. Robot sales for the Food and Beverage (including Tobacco) industry was 16 units, with a total operational stock of industrial robots of 128 units for that industry.

**Sweden**

Robot sales for Sweden were 1,016 units in 2012, 58 of which were for the Food and Beverage industry (including Tobacco). The total operational stock of industrial robots reached 9,800 units in 2012. For the Food and Beverage industry, this number was 533 units. According to the IFR, the increase in robot sales for Sweden was considerable for both the Basic Metal and Food and Beverage industries.

**Japan**

Japan is the world's biggest robot market. In 2012, robot sales continued to increase reaching 28,700 units. In 2009, around 30% of robot sales worldwide were from Japan. The market for industrial robots is dominated by the automotive industry and also by the electrical/electronics industry. Japan has a high export rate in all different industries.

Even though Japan is the largest robot market, robot sales in the Food and Beverage industry remain low. In 2012, the Japanese Food and Beverage industry reached its peak level of robot sales, with 600 units shipped. There are approximately 3,400 robot units operating in the Food and Beverage industry in Japan compared to 6,000 units in Germany.

In 2012, 70% of the robots produced were shipped to other countries. The Japanese domestic market is considered to be more or less saturated in terms of robots.

**China**

In 2012, robot sales from China reached 23,000 units. China is the fastest growing robot market in the world. Between 2005 and 2012 robot sales increased by roughly 25% per year. China ranked second in terms of annual supply behind Japan. Most of the robots used in China are shipped to Japan, Europe and North America. 65% of robots imported into North America are from China.

The Food and Beverage industry had sales of around 500 units in 2012 and investments in this industry are increasing. Although China is an important robot market globally, it still has huge potential for automation in its manufacturing industry.

**China (cont'd)**

Compared with many automated countries like Japan, Korea and Germany, with robot density in the manufacturing industry that varies between 270 and 400 robots per 10,000 employees, China's robot density is very low with approximately 20 robots. China's robot production is expected to increase in the next few years and foreign robot suppliers will also increase the assembly of robots in China.

**Australia**

The IFR statistic report provided little information on Australia's robot sales and investment. Most of the robot sales increase were attributable to the automotive industry. Total robots sales in 2012 reached 1,200 units.

**South Africa**
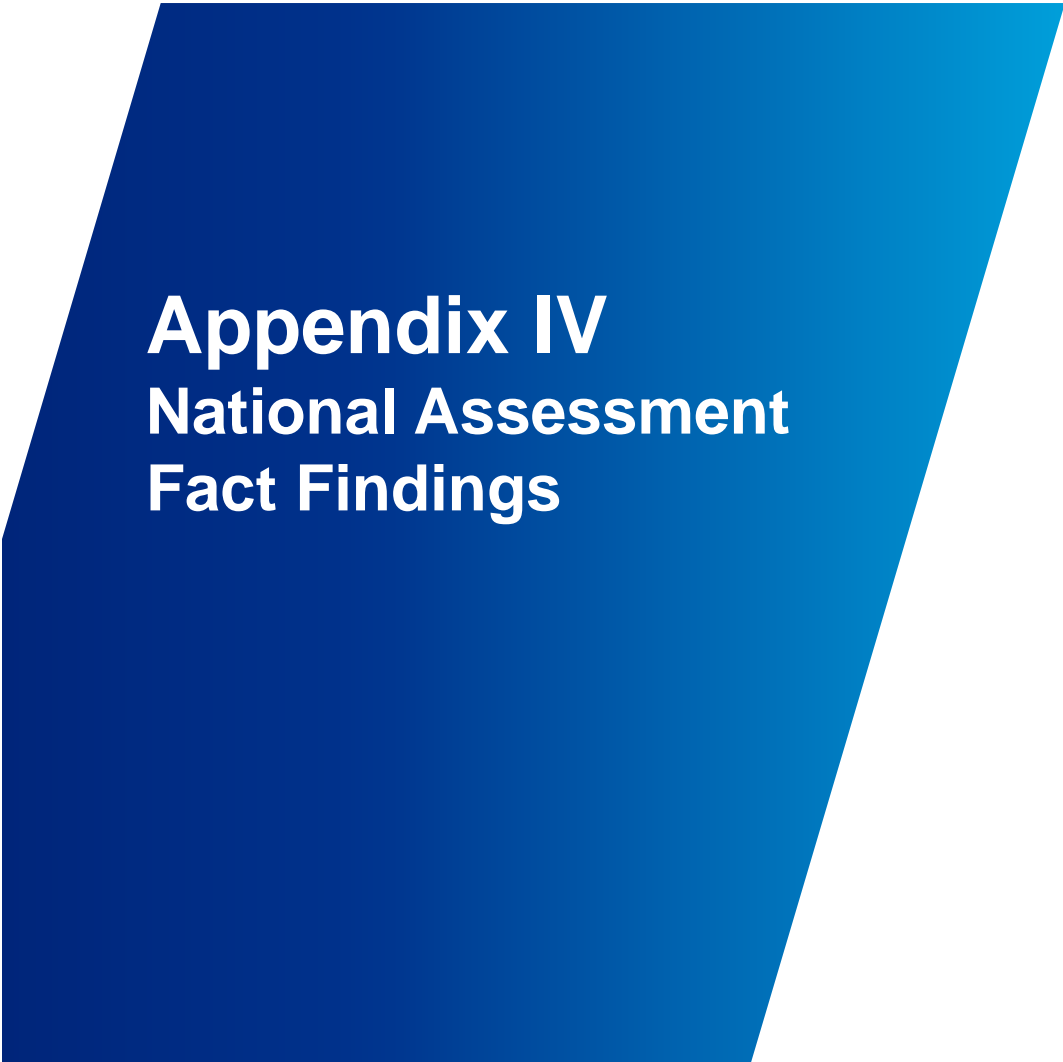
In 2012, robot sales in South Africa increased to 337 units, which was below its peak level of 431 units in 2008. The automotive industry accounts for 55% of the South African market. The IFR statistic report provided little information on South Africa's robot sales and investment.

**Brazil**

According to IFR statistics, 2012 robot sales for Brazil continued to increase (14% year over year) reaching a new peak level of 1,645 units. The automotive industry was the main driver of robot installation, with 12 robots sold for the Food and Beverage industry (including Tobacco) in 2012.

**Argentina**

According to IFR statistics, robot sales in 2012 were 180 units, 29 of which were for the Food and Beverage industry (including Tobacco).

# Appendix IV
## National Assessment
## Fact Findings

# Question 1/2 – Company Information

**Description of the Question**

Participants were asked to indicate whether the Company was Canadian or a subsidiary of a foreign company, and whether it was privately owned or publicly traded.

**Figure 1**

**Figure 2**



Publicily traded
30%

Private Company
70%
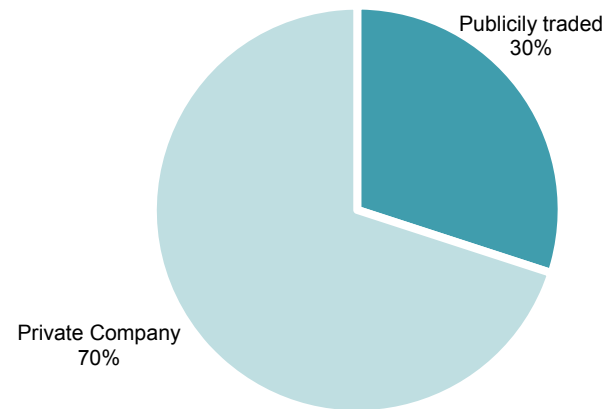
Company Ownership Type

N $_{PC}$ = 72
N $_{PT}$ = 34

Subsidiary
35%
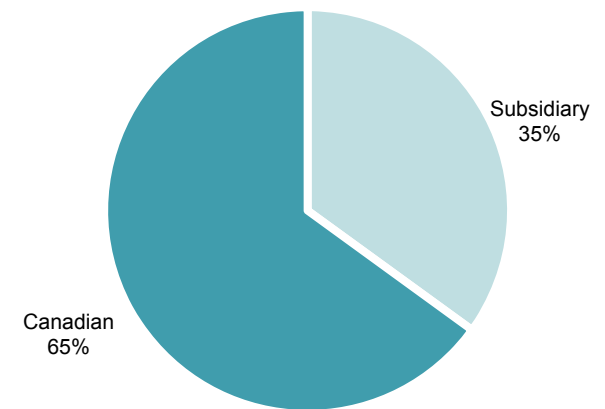
Canadian
65%

Parent Company's Country

N $_{CC}$ = 71
N $_{S}$ = 35

# Company Information

**Description**

Distribution of the sample by geographical region. The sample, divided as follows, comprises a total of 68 Canadian Food and Beverage processing plants since some firms gave information about multiple plants located in different geographical regions:

**Figure 3**
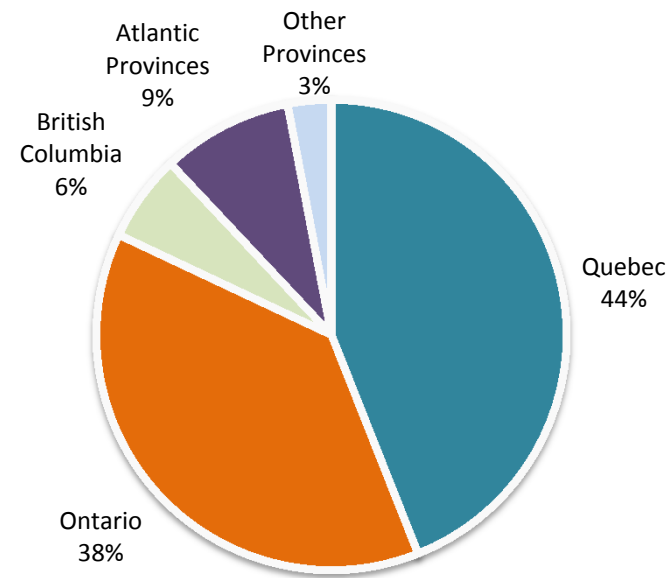
# Question 3 – Size of Interviewed Firms

**Description of the Question**

Participants were asked to indicate the company's estimated revenue stemming from Canadian Food and Beverage processing operations. A total of 56 Canadian Food and Beverage processing firms were interviewed, distributed by size as follows.

**Figure 4**
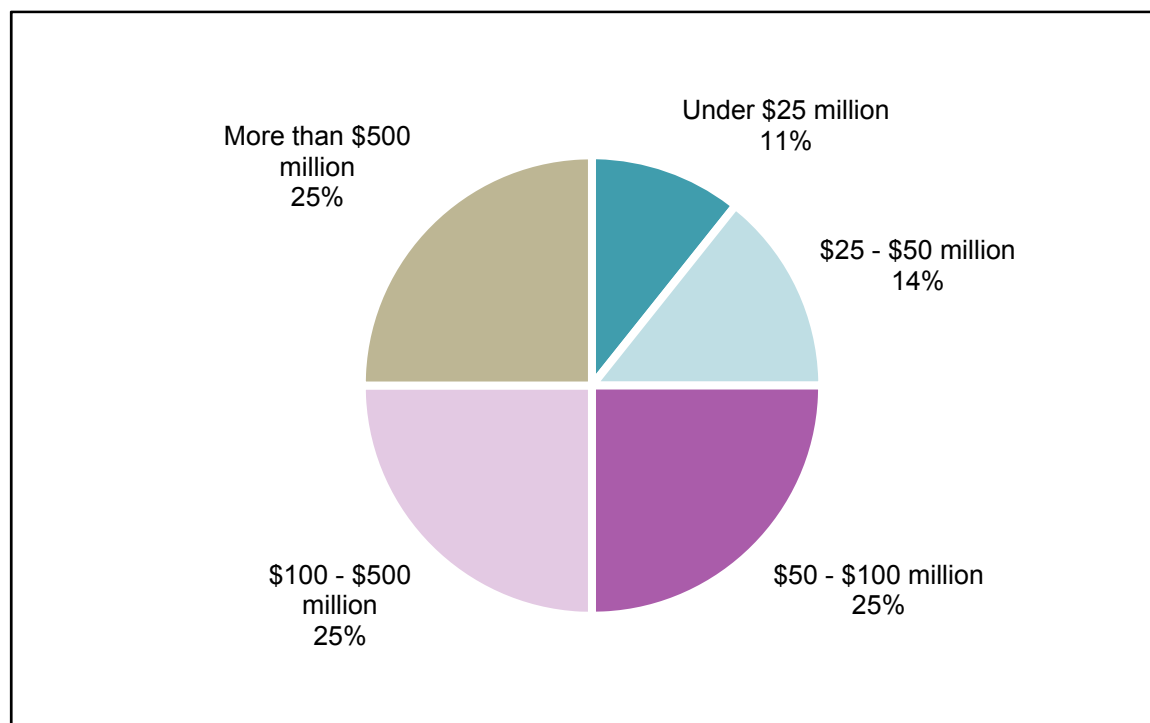
# Question 4 – Sub-Sectors of Operation

**Description of the Question**

Participants were asked to identify the Food and Beverage Processing sub-sectors of operation. The sample comprises a total of 106 business operations, divided as follows.

**Figure 5**

# Question 5b – Current Level of Automation and Robotics

## Description of the Question

Participants were asked to characterize the level of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the scale below.

| Scale | Description |
|---|---|
| 1 (0) | Not automated (0% automated) |
| 2 (1) | Less automated (less than 40% automated) |
| 3 (2) | Partially automated (between 40% and 70% automations) |
| 4 (3) | Very automated (over 70% automated) |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the group of sub-sectors to which they were assigned. The answers were rescaled from 0 to 3 for presentation purposes, with 0 corresponding to not automated and 3 corresponding to very automated.

## Overview of Results

Overall, the current level of automation varied across sub-sectors and within sub-sectors.

The Dry Food segment is leading in all three groups of applications in terms of level of automation and robotics, followed closely by the Other Packaged Food and Ingredients segment. The Meat, Fish and Seafood segment shows the lowest level of automation in all three applications.

### Figure 6
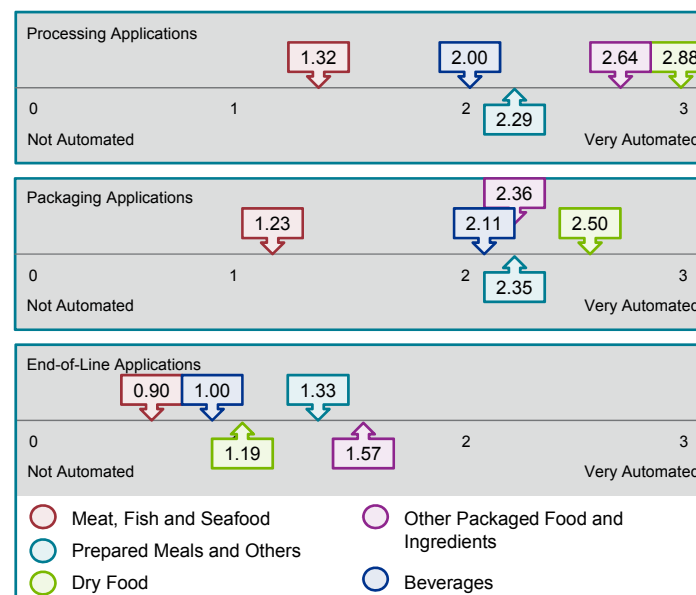
**Figure 7**

**Representation of the current level of automation and robotics by firm size.**

**Number of Business Operations: 106**



| | Under $25 million | | $25 - $50 million |
| --- | --- | --- | --- |
| | $50 - $100 million | | $100 - $500 mllion |
| | More than $500 million | | |
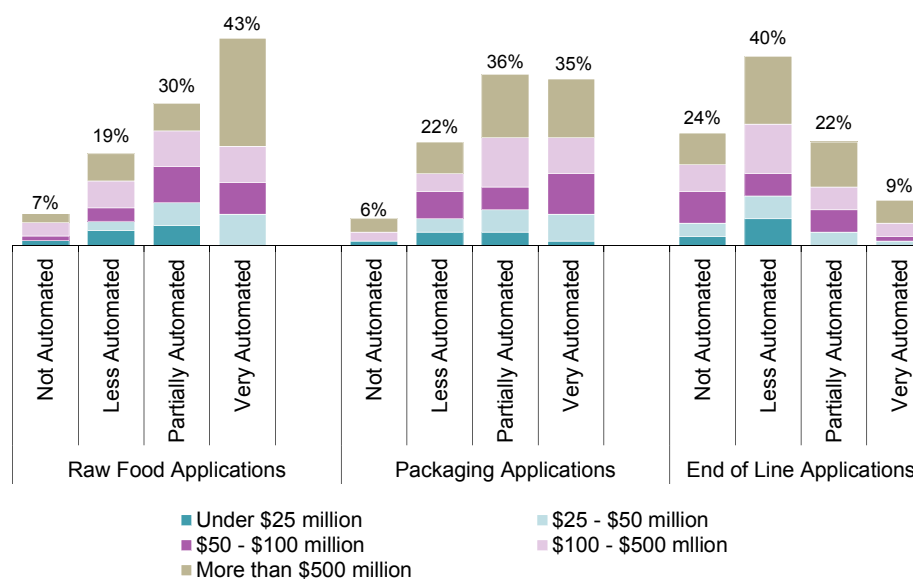
**Figure 8**

**Representation of the current level of automation and robotics by Canadian owned firms or subsidiaries of foreign firms.**

A few companies may be accounted for in the sample more than once, representing their different business operations/facilities. Variation in the number of operations or "N" stems from how companies answered questions during the interview.

**Number of Canadian Companies: 71**          **Number of Subsidiaries: 35**



Raw Food Applications | Packaging Applications | End of Line Applications

■ Subsidary   ■ Canadian Company

# Current Level of Automation and Robotics
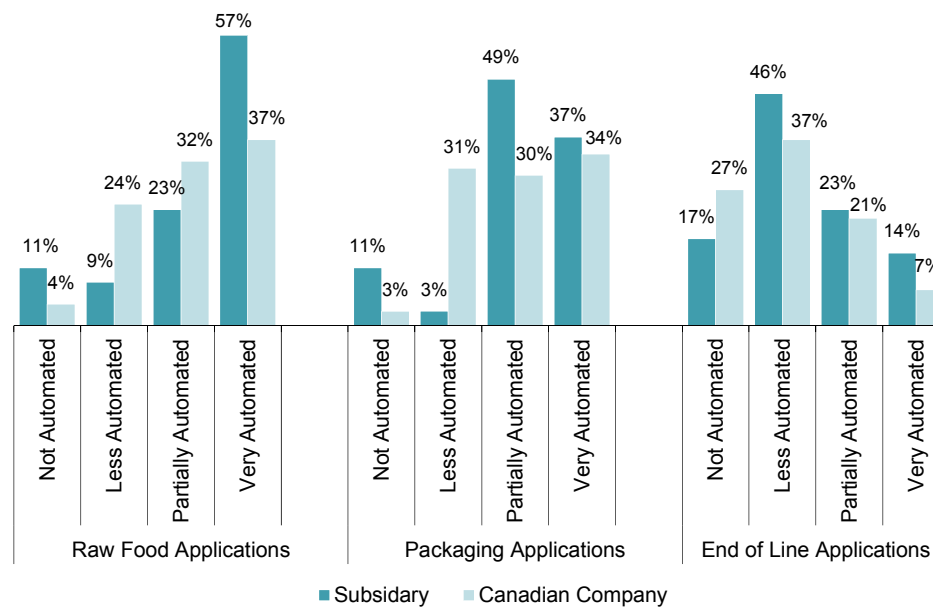
**Figure 9**

**Representation of the current level of automation and robotics by private or publicly traded companies.**

A few companies may be accounted for in the sample more than once, representing their different business operations/facilities. Variation in the number of operations or "N" stems from how companies answered questions during the interview.

**Number of Private Companies: 72**          **Number of Publicly Traded: 34**

# Question 6 – Importance of Automation and Robotics

## Description of the Question

Participants were asked to characterize the importance of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the below scale.

| Scale | Description |
|---|---|
| 1 (0) | Not important |
| 2 (1) | Less important |
| 3 (2) | Somewhat important |
| 4 (3) | Very important |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The answers were rescaled from 0 to 3 for presentation purposes, with 0 corresponding to not important and 3 corresponding to very important.

## Overview of Results

Overall, the importance given to the automation of each Food and Beverage processing application group varied across sub-sectors and within sub-sectors and segments.

Most segments considered the adoption of automation and robotics as somewhat to very important for their operations and ability to compete, with the automation of end-of-line applications considered as less important than other types of applications in general.

### Figure 10

# Gaps Between the Level and Importance of Automation and Robotics

## Description

Analysis was conducted to characterize the difference (gaps) between the level and the importance of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

Given that the assessment of the current level of automation (Question 5b) and the importance of automation (Question 6) were answered based on the same scale, answers were compared for the various business operations of interviewed firms and gaps were calculated as the difference between the importance and the level.

### Figure 11



Calculations were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The calculations were scaled from 0 to 3 for presentation purposes, with 0 corresponding to no gap between the level and the importance of automation and robotics.

## Overview of Results

Overall, the gaps between the level and the importance of automation and robotics varied across sub-sectors and within sub-sectors.

The Meat, Fish and Seafood sub-sector is leading in all three applications in terms of gaps. All the other sub-sectors show similar gaps. There is not a sub-sector that stands out concretely, but the Dry Food sub-sector tends to show less difference between the level and the importance of automation and robotics.

### Figure 12

# Gaps Between the Level and Importance of Automation and Robotics

**Figure 13**

Not automated/Important               1.13           Very automated/Important

0         1     1.32         2     2.45     3

| Meat, Fish & Seafood | Raw Food Applications |
|---|---|
| Current Level ○ | 1.32 |
| Importance ○ | 2.45 |
| Gaps ○ | 1.13 |

                   1.42

0         1   1.23         2     2.65     3

| Meat, Fish & Seafood | Packaging Applications |
|---|---|
| Current Level ○ | 1.23 |
| Importance ○ | 2.65 |
| Gaps ○ | 1.42 |

                   1.55

0       0.90   1         2     2.45     3

| Meat, Fish & Seafood | End-of-Line Production |
|---|---|
| Current Level ○ | 0.90 |
| Importance ○ | 2.45 |
| Gaps ○ | 1.55 |

# Gaps Between the Level and Importance of Automation and Robotics

**Figure 14**

Not automated/Important — Very automated/Important



| Prepared Meals, Bakeries, Fruits & Others | Raw Food Applications |
|---|---|
| Current Level | 2.29 |
| Importance | 2.64 |
| Gaps | 0.35 |

| Prepared Meals, Bakeries, Fruits & Others | Packaging Applications |
|---|---|
| Current Level | 2.35 |
| Importance | 2.84 |
| Gaps | 0.49 |

| Prepared Meals, Bakeries, Fruits & Others | End-of-Line Production |
|---|---|
| Current Level | 1.33 |
| Importance | 2.27 |
| Gaps | 0.94 |

# Gaps Between the Level and Importance of Automation and Robotics

Dry Food

**Figure 15**

Not automated/Important

Very automated/Important

0.34

| 0 | 1 | 2 | | 3 |
|---|---|---|---|---|

2.54    2.88

| Dry Food | Raw Food Applications |
|---|---|
| **Current Level** ○ | 2.88 |
| **Importance** ○ | 2.54 |
| **Gaps** ○ | -0.34 |

0.21

| 0 | 1 | 2 | | 3 |
|---|---|---|---|---|

2.50    2.71

| Dry Food | Packaging Applications |
|---|---|
| **Current Level** ○ | 2.50 |
| **Importance** ○ | 2.71 |
| **Gaps** ○ | 0.21 |

0.38

| 0 | | 1 | 2 | 3 |
|---|---|---|---|---|

1.19    1.57
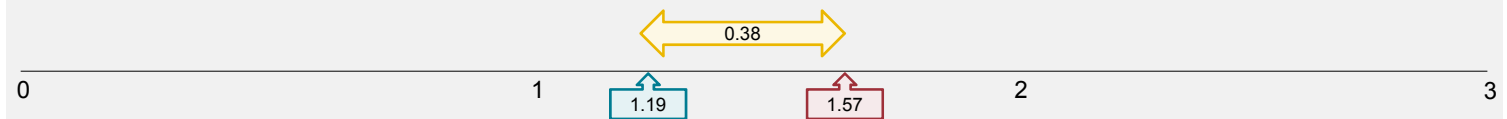
| Dry Food | End-of-Line Production |
|---|---|
| **Current Level** ○ | 1.19 |
| **Importance** ○ | 1.57 |
| **Gaps** ○ | 0.38 |

# Gaps Between the Level and Importance of Automation and Robotics

**Figure 16**

| Not automated/Important | | Very automated/Important |
|---|---|---|

2.64

0      1      2      3

2.64

| Other Packaged Food and Ingredients | Raw Food Applications |
|---|---|
| Current Level | 2.64 |
| Importance | 2.64 |
| Gaps | - |

0.43

0      1      2    2.36     2.79    3

| Other Packaged Food and Ingredients | Packaging Applications |
|---|---|
| Current Level | 2.36 |
| Importance | 2.79 |
| Gaps | 0.43 |

0.50

0      1    1.57    2   2.07     3

| Other Packaged Food and Ingredients | End-of-Line Production |
|---|---|
| Current Level | 1.57 |
| Importance | 2.07 |
| Gaps | 0.50 |

# Gaps Between the Level and Importance of Automation and Robotics

**Figure 17**

Not automated/Important                                                                Very automated/Important



| Beverages | Raw Food Applications |
|---|---|
| Current Level ⭕ | 2.00 |
| Importance ⭕ | 2.50 |
| Gaps ⭕ | 0.50 |



| Beverages | Packaging Applications |
|---|---|
| Current Level ⭕ | 2.11 |
| Importance ⭕ | 2.44 |
| Gaps ⭕ | 0.33 |



| Beverages | End-of-Line Production |
|---|---|
| Current Level ⭕ | 1.00 |
| Importance ⭕ | 1.67 |
| Gaps ⭕ | 0.67 |

# Question 7 - Importance of Key Technologies

**Description of Question**

Participants were asked to identify and discuss key technologies and areas of development in the field of automation and robotics for their current processing operations. The following technologies were mentioned to initiate the discussion.

| Technologies and Areas of Development |
| --- |
| Optical sensors and online spectroscopy for automated quality and safety inspection |
| Supervisory control and data acquisition (SCADA) and related systems for automated process control |
| Gripper technologies for pick-and-place |
| Wireless sensor networks (WSNs) |
| Automation and robotics for bulk sorting |
| Automatic control of food chilling and freezing |
| Automatic control for batch thermal processing |
| Reconfigurable mechanism technology |

The above list was non-exhaustive.

# Question 8a – Maturity of the Current Robotics and Automation per Applications

## Description of the Question

Participants were asked to provide an estimate for the age of robots and automation technology used for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the below scale.

| Scale | Description |
|---|---|
| 5 (0) | 0-4 years |
| 4 (1) | 5-9 years |
| 3 (2) | 10-14 years |
| 2 (3) | 15-20 years |
| 1 (4) | 20 years + |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to 0-4 years of age and 4 corresponding to 20 years + of age.

## Overview of Results

Overall, the age of current automation and robotic technologies varied across segments, sub-sectors and firms.

On average, the age of the technology across all segments ranged between 5-9 or 10-14 years old. The technology used in raw food processing, packaging and end-of-line applications tends to be the most recent in the Meat, Fish and Seafood segment, which is consistent with the more recent adoption of automation and robotics in these sub-sectors versus the other sub-sectors. The technology used in Dry Food and Beverages processing for the interviewed operations was generally older than in other segments, although some operations used top-of-the-line, leading-edge technology across the plant.

### Figure 18



Processing Applications
1.60   2.17   2.86
0   1   2   3   4
1.31   2.29
0-4 yrs                                    20yrs +

○ Meat, Fish and Seafood          ○ Other Packaged Food and Ingredients
○ Prepared Meals and Others
○ Dry Food                        ○ Beverages

Packaging Applications
2.27
1.44   2.17
0   1   2   3   4
1.39   2.25
0-4 yrs                                    20yrs +

End-of-Line Applications
1.81
1.17        2.00
0   1   2   3   4
1.40   1.70
0-4 yrs                                    20yrs +

# Question 8b – Is the Technology used Leading-Edge/Top-of-the-Line?

**Description of the Question**

Participants were asked to provide a general assessment of the technologies used in all of their processing applications. The assessment was performed for the various business operations of interviewed firms, selecting one of the following statements as most representative of the current state of their automation and robotic technologies.

| Possible Answers |
| --- |
| Most of the automation technology and robotics are leading-edge/top-of-the-line |
| Some of the automation technology and robotics are leading-edge/top-of-the-line |
| The automation technology and robotics are not leading-edge/top-of-the-line |

Leading-edge/top-of-the-line was used to describe technology that is most recent in advancements. Some solutions may be 5-10 years old. However, if no further advancement occurred since the technology was purchased, it might still be top-of-the-line.
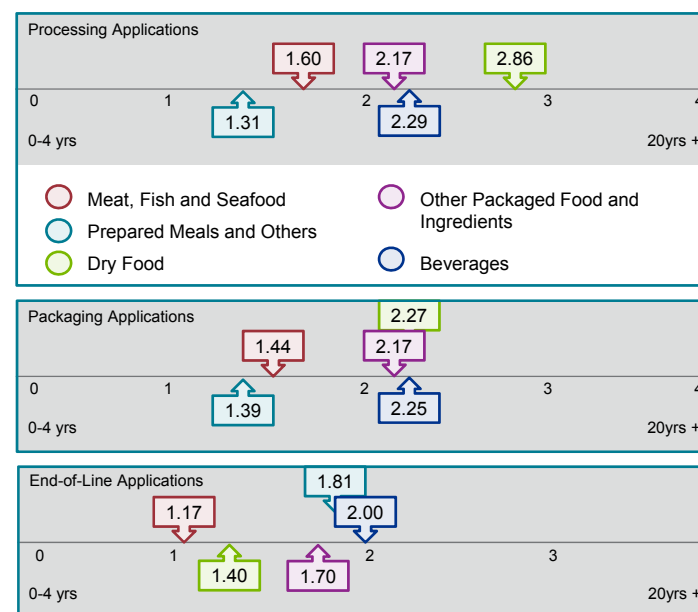
Answers were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The answers were rescaled from 0 to 2 for presentation purposes, with 0 corresponding to not leading-edge and 2 to most are leading-edge.

Note that this assessment only took into consideration the technology currently used by the interviewed firms.

**Overview of Results**

Overall, the maturity of the technology used in each Food and Beverage processing applications varied across segments, sub-sectors and within sub-sectors.

While some of the interviews qualified their automation technology and robots as not leading-edge/top-of-the-line, others considered most of them as leading-edge/top-of-the-line. Generally, the technology used by Canadian Food and Beverage processing operations is only partially leading-edge/top-of-the-line.

**Figure 19**
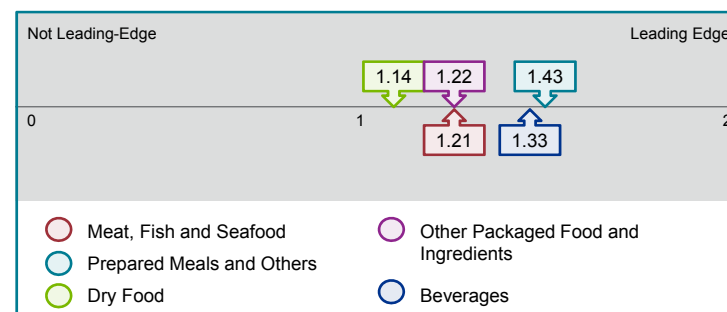
# Questions 9 & 10 – Drivers and Barriers to the Adoption of Automation and Robotics

## Description of Question 9

Participants were asked to rank in order of importance the following drivers to the adoption of automation and robotics.

| Drivers | Description |
|---|---|
| Production | Cost savings, improve productivity, improve efficiency of operations, product and input waste management |
| Employees | Improve working conditions, decrease rate of accidents, decrease cost of labor per unit of finished good |
| Consumers | Introduce product innovation, improve product safety and quality control, address consumer preferences |
| Legislation | Quality and safety legislations and regulations |
| Market share | Potential new international trade agreements, global and national competitors' level of automation and robotics |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to the least important driver and 4 corresponding to the most important driver for the adoption of automation and robotics.

## Overview of Results

Overall, the importance of these drivers to the adoption of automation and robotics varied across sub-sectors and within sub-sectors.

Production-related factors were ranked as the most important driver to automation and robotics, followed closely by employee-related factors and consumers. Essentially, the adoption of automation and robotics can help firms produce cost-efficient and safe products of quality. In most cases, quality and safety legislations and regulations were considered as necessities that must be met and in most cases, not a driver of automation and robotics. The importance of market share factors to the adoption of automation and robotics was generally not considered as important, although the answers varied across firms and sub-sectors.

### Figure 20



Drivers For All Sub-Sectors

0.89   2.48   3.70
0.74   2.26

0   1   2   3   4
Least Important        Most Important

○ Production       ○ Legislation
○ Consumers        ○ Market Share
○ Employees

# Questions 9 & 10 – Drivers and Barriers to the Adoption of Automation and Robotics

## Description of Question 10

Participants were asked to rank in order of importance the following barriers to the adoption of automation and robotics.

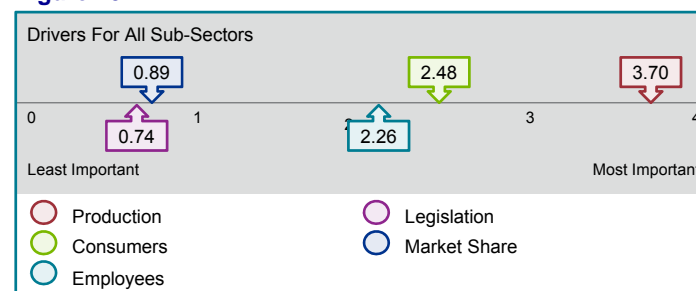| Barriers | Description |
|---|---|
| Cost | Initial cost of robots and automation, cost of training/ hiring/maintenance, legacy robots/ automation / system |
| Operations | Size of robots available and space required for automation, product support, and maintenance services availability, culture of the company |
| Market and Financing | Market perception, poor return on investment, funding availability |
| Perceived risks | Cost vs. short-term payback, unpredicted cost, operational delays, technical limitations, and other issues and frictions with implementation |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the group of sub-sectors to which they were assigned. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to the least important barrier and 4 corresponding to the most important barrier for the adoption of automation and robotics.

## Overview of Results

Overall, the importance of these drivers to the adoption of automation and robotics varied across sub-sectors and within sub-sectors. Cost barriers were ranked the most important in the majority of interviewed operations, followed by return on investment and funding availability (Market and Financing).

### Figure 21



Barriers for all sub-sectors
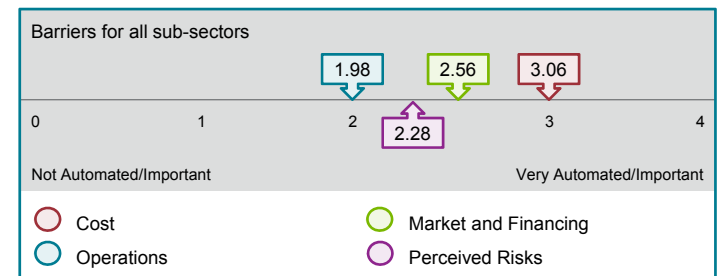
Other barriers were raised by interviewed companies, including seasonality, existing legislations and regulations and the availability of skilled labour to operate and maintain the automation and robotic technologies.

# Drivers and Barriers to the Adoption of Automation and Robotics

## Drivers of Automation and Robotics

Cost savings (including cost of labor), improvement of productivity and efficiency of operations, product and material waste management (Production) were mentioned as the most or second most important drivers in all (100%) interviews conducted in the Meat, Fish and Seafood segment.

| Rank | Drivers | | | | |
|------|---------|-----------|-----------|-------------|--------------|
|      | Production | Employees | Consumers | Legislation | Market Share |
| 1st  | 65% | 6%  | 25% | 0%  | 6%  |
| 2nd  | 35% | 25% | 13% | 6%  | 19% |
| 3rd  | 0%  | 50% | 38% | 0%  | 6%  |
| 4th  | 0%  | 13% | 19% | 56% | 19% |
| 5th  | 0%  | 6%  | 6%  | 38% | 50% |

Consumer related factors (i.e. improving quality and safety of products, product innovation and consumer preferences) were mentioned as the most important driver of automation and robotics in 25% of interviews. Cost and quality were considered close drivers in terms of importance, the objective being to produce safe products of quality at a competitive price. Product innovation tends to be more significant for secondary processing, such as blended and formed meat products, or for operations that offer a more customized product (e.g. special cuts).

## Barriers to Automation and Robotics

In 69% of the interviews, cost (initial cost, cost of training, hiring and maintenance and legacy systems) was considered the most or second most important barrier to the adoption of automation and robotics. Perceived risks were also considered important.

| Rank | Barriers | | | |
|------|------|------------|------------------|----------------|
|      | Cost | Operations | Market Financing | Perceived Risks |
| 1st  | 31% | 0%  | 19% | 44% |
| 2nd  | 38% | 19% | 25% | 19% |
| 3rd  | 25% | 56% | 19% | 0%  |
| 4th  | 6%  | 25% | 31% | 31% |
| 5th  | 0%  | 0%  | 6%  | 6%  |

## Other Considerations

For the Fish and Seafood sub-sector, seasonality in the context of justifying the investment in automation and robotics (return on investment) was considered an important barrier. Variability of species and within species is another important factor having contributed to the lag in automation and robotics for the Fish and Seafood sub-sector.

The availability of proven technology directly applicable to the Meat, Fish and Seafood processing applications is also an important barrier for these sectors. The harsh environment (low temperature, thorough and daily equipment washdown) inherent to these sub-sectors, as well as the food and safety standards explain the observed lag in the adaptation of technology compared with other sectors.

The transfer of technology from another country can prove itself to be difficult and challenging. For primary processing companies, these represent an additional cost to be considered. There is no guaranty that the technology can be properly implemented. Adjustments are often required.

The decreasing availability of manual labor is another driver for these sub-sectors. The work environment provided by the Meat, Fish and Seafood processing operations are not as appealing to the changing working population. Attracting and keeping labour requires an adjustment for heavy lifting and other difficult tasks.

Another consideration is the market in which firms operate. For instance, primary meat processors operate in a commodity type of market and as such cost savings and management are particularly important in order to be able to compete at a national and international level.

Appendix IV – National Assessment
**Drivers and Barriers to the Adoption
of Automation and Robotics**

Prepared Meals, Bakeries,
Fruits and Others

### Drivers of Automation and Robotics

Cost savings (including cost of labor) and other production factors were mentioned as the most or second most important driver in 91% of the interviews conducted in this segment.

| Rank | Production | Employees | Consumers | Legislation | Market Share |
|---|---|---|---|---|---|
| | | | Drivers | | |
| 1st | 59% | 14% | 32% | 5% | 0% |
| 2nd | 32% | 32% | 27% | 0% | 5% |
| 3rd | 9% | 32% | 36% | 10% | 10% |
| 4th | 0% | 14% | 0% | 40% | 48% |
| 5th | 0% | 9% | 5% | 45% | 38% |

Overall, product quality and safety as well as cost savings (including cost of labour) were often considered in a dynamic perspective, whereby the use of automation and robotics could help processors achieve lower cost of production while maintaining the same (or better) product quality, consistency and safety. When product differentiation is important, innovation and consumer preferences were also considered as key drivers.

### Barriers to Automation and Robotics

Cost was considered the first or second most important barrier to automation and robotics in 67% of the interviews conducted in this segment. While the initial cost remains an important barrier, especially for smaller enterprises, costs are often considered in a return on investment context, with a longer time horizon (usually 2-5 years, depending on firm size) used for anticipated payback.

| Rank | Cost | Operations | Market and Financing | Perceived Risks |
|---|---|---|---|---|
| | | | Barriers | |
| 1st | 43% | 5% | 24% | 29% |
| 2nd | 24% | 38% | 24% | 10% |
| 3rd | 33% | 29% | 14% | 24% |
| 4th | 0% | 29% | 38% | 33% |
| 5th | 0% | 0% | 0% | 5% |

Technical availability and limitations remain important barriers. For some applications, the technology does not exist yet or has just been introduced. Implementation itself involves some adjustments and sometimes systems are incompatible, preventing the adoption of these technologies. In other words, there is an actual risk that the technology being adopted fails to work or perform according to the productivity and efficiency anticipated.

### Other considerations

**Fruits and Vegetables:** Product safety and quality takes an important role in most fruits and vegetables processing operations, especially for fresh produce. The availability of seasonal labour is a key challenge for these producers of fresh fruits and vegetables, with foreign labour temporarily hired for peak seasons. Cost management is key in order to compete internationally. Most of the competition appears to come from the United States and Mexico.

**Dairy:** In Quebec, a consolidation of cheese manufacturers is anticipated as well as an increase in the adoption of automation and robotics for the new, larger, consolidated plants.

**Prepared Meals:** Certain frozen meals operate in a commodity-like market, where cost takes on an important place. The cost of labour and of operation (land, electricity, etc.) were mentioned as key factors motivating their adoption of automation and robotics.

**Bread and Bakeries:** Production, employees and consumer-related drivers were considered as equally important in the decision of adopting automation and robotics for a number of interviewed firms in this sub-sector. Cost of labour, but also the availability of skilled labour willing to perform heavy or manual repetitive tasks was mentioned as being an important driver.

The availability of skilled labour that can perform the maintenance of the automation technology and robotics was also mentioned as an important barrier outside of cost.

# Drivers and Barriers to the Adoption of Automation and Robotics

### Drivers of Automation and Robotics

Production-related factors were considered the most important driver (100% of interviews) of automation and robotics across this segment. Cost competitiveness is paramount as products have low differentiation in the views of customers. In 100% of cases, product quality and safety were considered the second or third most important drivers. Quality and safety legislations and regulations were mostly considered as a must and rarely a driver of automation and robotics.

| Rank | Drivers | | | | |
| --- | --- | --- | --- | --- | --- |
| | Production | Employees | Consumers | Legislation | Market Share |
| 1st | 100% | 0% | 0% | 0% | 0% |
| 2nd | 0% | 50% | 25% | 0% | 25% |
| 3rd | 0% | 25% | 50% | 0% | 25% |
| 4th | 0% | 25% | 25% | 43% | 13% |
| 5th | 0% | 0% | 0% | 57% | 38% |

Market share is possible through cost competitiveness in this segment and, albeit its importance, market share was mostly thought of as an end result.

### Barriers to Automation and Robotics

Cost-related factors were considered the first and second most important barriers to automation and robotics among 88% of interviewed companies in this segment. Flour milling firms indicated that return on investment (ROI) was most important in their adoption of automation and robotics, which itself takes into consideration cost barriers.

| Rank | Barriers | | | |
| --- | --- | --- | --- | --- |
| | Cost | Operations | Market and Financing | Perceived Risks |
| 1st | 50% | 13% | 38% | 0% |
| 2nd | 38% | 13% | 38% | 13% |
| 3rd | 0% | 38% | 13% | 50% |
| 4th | 13% | 38% | 13% | 38% |
| 5th | 0% | 0% | 0% | 0% |

### Other Considerations

Volume was mentioned as an important factor being considered in the decision to adopt automation and robotics. Typically, a certain production threshold must be in place before these technologies are implemented. Essentially, higher volumes help justify the investments.

The decreasing availability of manual labour was also mentioned as a driver of automation and robotics for this segment, but not by all interviewed firms and subsectors. Cost of productivity was considered as the most important driver of automation and robotics adoption for sugar/sugar products processing operations, with labour as a close second.

# Drivers and Barriers to the Adoption of Automation and Robotics

### Drivers of Automation and Robotics

Production-related factors were considered the most important drivers (92% of interviews) of automation and robotics across all sub-sectors for this segment. Cost competitiveness is paramount to these operations as their products have low differentiation in the views of customers. The cost of labour was mentioned as a distinct important driver, although the use of automation to decrease repetitive tasks and the risk of accident were also considered important.

| Rank | Drivers | | | | |
| --- | --- | --- | --- | --- | --- |
| | Production | Employees | Consumers | Legislation | Market Share |
| 1st | 92% | 0% | 8% | 0% | 0% |
| 2nd | 0% | 42% | 50% | 8% | 0% |
| 3rd | 8% | 50% | 25% | 0% | 11% |
| 4th | 0% | 8% | 17% | 58% | 11% |
| 5th | 0% | 0% | 0% | 33% | 78% |

Consumer-related factors were considered the first or second most important drivers to automation and robotics in nearly 60% of cases. Although quality and safety of products are also key for this segment, product innovation and consumer preferences occupy a more important place than in other segments. Choice of flavour, of content (reduced fat, sodium, etc.), of packaging size and variety are demanded by consumers. However, firms operating in these sub-sectors must not only offer variety, but also the lowest prices.

### Barriers to Automation and Robotics

A significant positive return on investment (ROI) over the next couple of years was usually the key barrier to automation for firms interviewed in this segment, with 67% of respondents ranking ROI and/or financing as the most important barrier to their adoption of automation and robotics. Cost (initial or related) was ranked as the first or second most important barrier for 75% of operations in this segment.

| Rank | Barriers | | | |
| --- | --- | --- | --- | --- |
| | Cost | Operations | Market and Financing | Perceived Risks |
| 1st | 8% | 0% | 67% | 25% |
| 2nd | 67% | 8% | 17% | 8% |
| 3rd | 17% | 50% | 8% | 25% |
| 4th | 8% | 42% | 8% | 42% |
| 5th | 0% | 0% | 0% | 0% |

### Other Considerations

Volume is important in order to justify the large investments required by the adoption of automation and robotics. Even for companies that are divisions (or subsidiaries) of large international corporations, their investment propositions must compete against all the operating divisions. In those instances, scale of operations was mentioned as an important barrier in their ability to compete internally.

Although not consistently ranked in importance across interviews, technical limitations were mentioned as an important barrier for some of the participants. Notably, there is a need for automatically reconfigurable technology that can accommodate for the demand in variable packaging with minimum human intervention (changing parts) and down time. As greater levels of automation and robotics are adopted, flexibility and productivity are both desired. However, increased flexibility can sometimes lead to decreased output per hour. On the other hand, increased automation and productivity sometimes imply less flexibility. In this sense, the risk perceived in automation can act as a barrier to automation and robotics.

# Drivers and Barriers to the Adoption of Automation and Robotics

## Drivers of Automation and Robotics

Production-related factors were considered the first or second most important drivers (100% of interviews) of automation and robotics across all sub-sectors for this segment. The importance of cost saving extended to labour costs.

| Rank | Drivers | | | | |
|------|---------|-----------|-----------|-------------|--------------|
|      | Production | Employees | Consumers | Legislation | Market Share |
| 1st  | 86% | 14% | 0% | 0% | 0% |
| 2nd  | 14% | 29% | 43% | 14% | 0% |
| 3rd  | 0% | 43% | 43% | 0% | 14% |
| 4th  | 0% | 14% | 14% | 29% | 43% |
| 5th  | 0% | 0% | 0% | 57% | 43% |

Consumer-related factors were considered the second or third most important driver for 86% of interviewed operations, with safety and quality of products residing in a close second place to cost-effectiveness in terms of importance.

## Barriers to Automation and Robotics

The costs related to the adoption of automation and robotics (initial, maintenance and others) were considered the most or second most important barrier to such adoption for 85% of interviewed operations.

| Rank | Barriers | | | |
|------|------|------------|----------------------|-----------------|
|      | Cost | Operations | Market and Financing | Perceived Risks |
| 1st  | 71% | 14% | 14% | 0% |
| 2nd  | 14% | 14% | 14% | 57% |
| 3rd  | 14% | 14% | 43% | 29% |
| 4th  | 0% | 57% | 29% | 14% |
| 5th  | 0% | 0% | 0% | 0% |

The perceived risks associated with the adoption of automation and robotics was ranked as the second or third most important barrier in 76% of cases.

The short term return on investment (ROI) versus all of the initial associated costs and some of the technical limitations associated with the implementation of these technologies were considered important risk barriers. Overall, ROI and financing remained important factors explaining the current level of automation and robotics across the sub-sectors of this segment.

## Other Considerations

Although this category comprises a wide range of products with different values associated to them, the cost of automation and robotics remains a challenge to the majority of interviewed firms.

As more product categories are produced at a single plant, variability in the packaging machinery becomes more important. However, given that alcohol, soft-drinks and water typically come in different primary or secondary packaging options, reconfigurable mechanisms that can easily be set with minimal labour interventions are of growing importance to this segment.

Lower value products must be cost competitive in order to keep or gain market share. Even for smaller enterprises, with sufficient volume in place, automation and robotics can help companies become more cost competitive.

The little availability of in-house expertise to operate and perform the maintenance of automation and robotics was mentioned as an important barrier.

# Question 11 – Anticipated Level of Capital Investment In Automation and Robotics

## Description of the Question

Participants were asked to rank in order of priority the following applications in terms of future capital investment in automation and robotics.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

Answers were compiled for each of the pre-identified sub-sectors as well as according to the segments to which they were assigned. The answers were rescaled from 0 to 2 for presentation purposes, with 0 corresponding to the last priority applications group and 2 to the first priority applications group for capital investment in automation and robotics in the near future.

Note that some interviews ranked two or all of the applications as equal priorities in terms of future capital investment in automation and robotics.

## Overview of Results

Overall, the priority for capital investment varied across sub-sectors and within sub-sectors. Packaging applications were most often ranked as the top priority in terms of future investment in automation and robotics across all segments of analysis.

The Meat, Fish and Seafood segment, followed closely by the Prepared Meals segment, ranked raw food/processing applications the highest in terms of priority compared with the other segments.

## Figure 22

# Anticipated Level of Capital Investment In Automation and Robotics
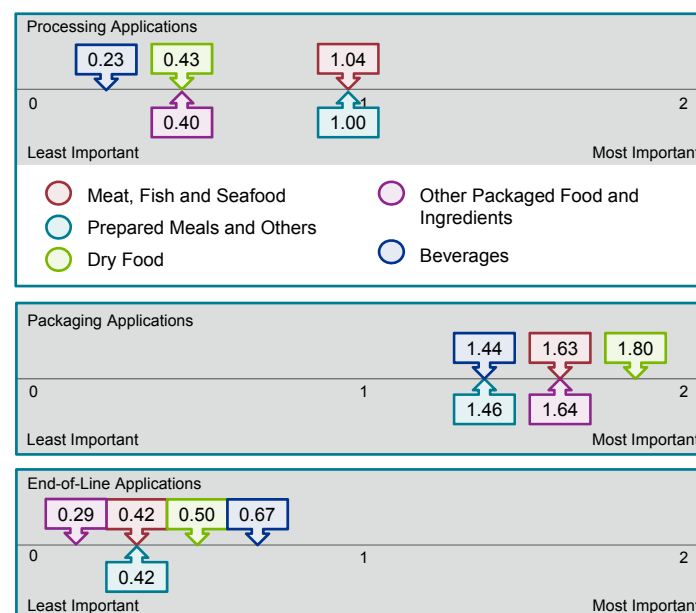
**Figure 23**

**Representation of the anticipated level of capital investment in automation and robotics by firm size**

**Number of Business Operations: 102**

# Anticipated Level of Capital Investment In Automation and Robotics
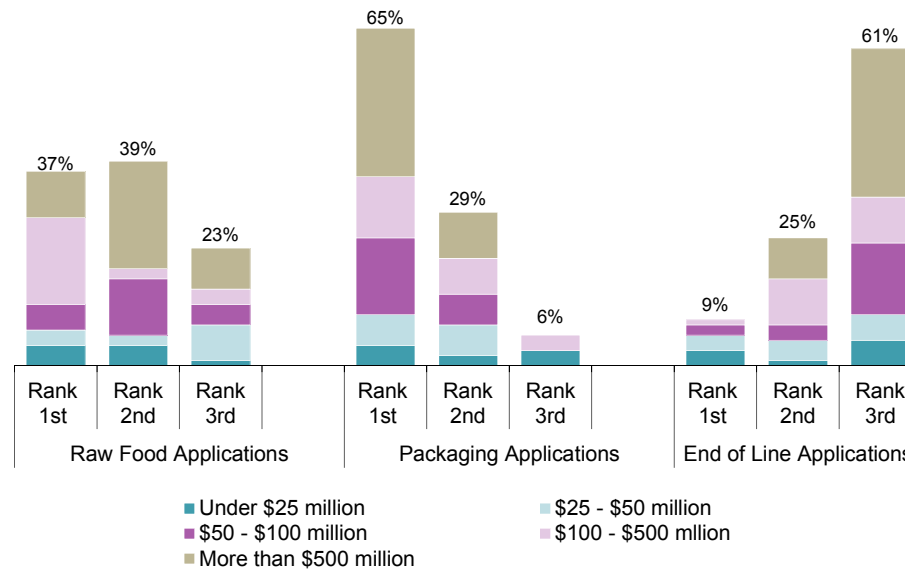
**Figure 24**

**Anticipated level of capital investment by Canadian owned firms or subsidiaries of foreign firms.**

The sample contains few companies more than once, representing different business operations. Variation in N stems from how companies answered questions during the interview.

**Number of Canadian Companies: 41**

**Number of Subsidiaries: 22**



| | Raw Food Applications | | | Packaging Applications | | | End of Line Applications | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank 1st | Rank 2nd | Rank 3rd | Rank 1st | Rank 2nd | Rank 3rd | Rank 1st | Rank 2nd | Rank 3rd |
| Subsidary | 32% | 50% | 18% | 73% | 27% | | | 18% | 73% |
| Canadian Company | 37% | 29% | 32% | 59% | 34% | 7% | 12% | 32% | 51% |

■ Subsidary  ■ Canadian Company

# Anticipated Level of Capital Investment In Automation and Robotics
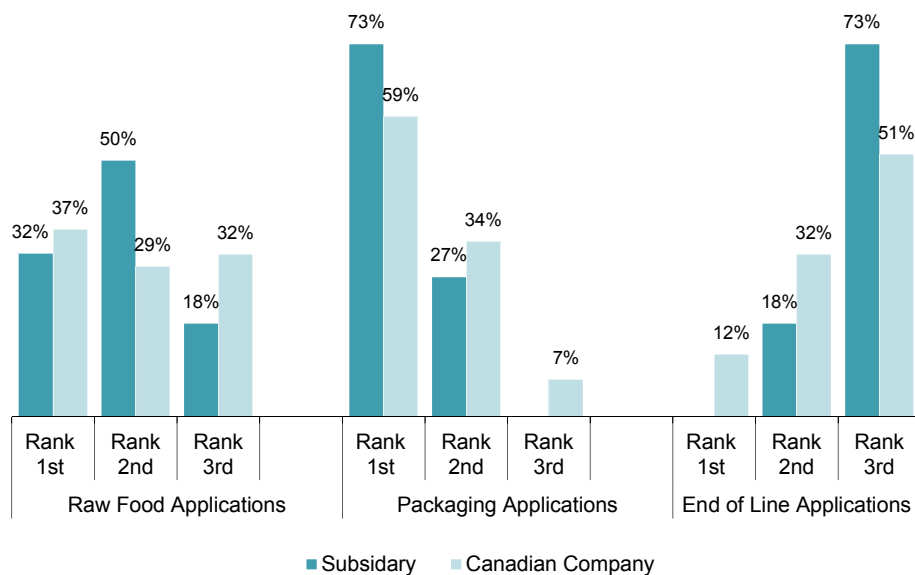
**Figure 25**

**Representation of the current level of automation and robotics by private companies or publicly traded companies.**

The sample contains few companies more than once, representing different business operations. Variation in N stems from how companies answered questions during the interview.

**Number of Private Companies: 41**          **Number of Publicly Traded Companies: 22**



| | Raw Food Applications | | | Packaging Applications | | | End of Line Applications | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rank 1st | Rank 2nd | Rank 3rd | Rank 1st | Rank 2nd | Rank 3rd | Rank 1st | Rank 2nd | Rank 3rd |
| Private Company | 41% | 32% | 24% | 56% | 39% | 5% | 12% | 22% | 56% |
| Publicly Traded | 23% | 45% | 32% | 77% | 18% | 5% | | 36% | 64% |

■ Private Company  ■ Publicly Traded

# Anticipated Level of Capital Investment In Automation and Robotics
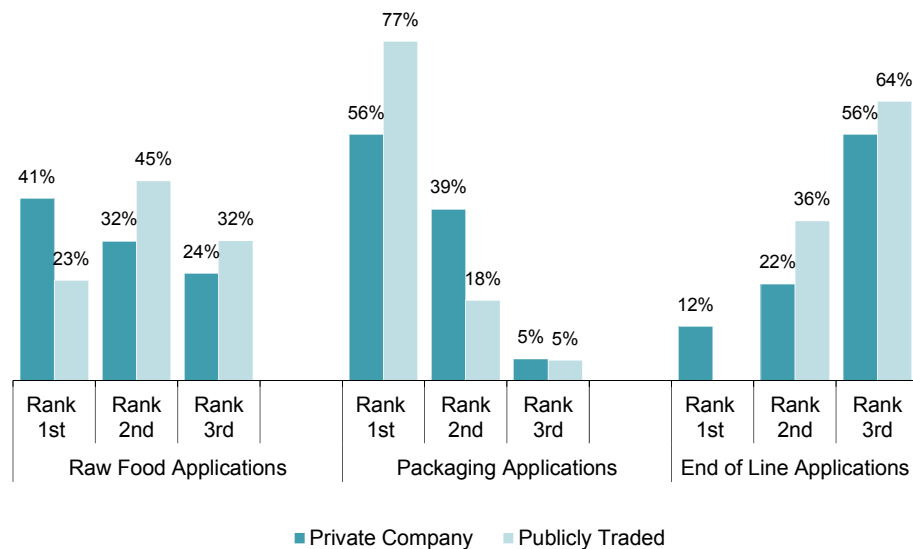
**Figure 26**

**Meat, Fish and Seafood**

Least Important  —  0.42  —  0  —  1.04  —  1  —  1.63  —  2  —  Most Important

| Meat, Fish & Seafood | N | Raw Food Applications ⬤ | Packaging Applications ⬤ | End-of-Line Production ⬤ |
|---|---|---|---|---|
| **Weighted Average** | 27 | 1.04 | 1.63 | 0.42 |
| **Rank 1st** | | 30% | 70% | 4% |
| **Rank 2nd** | | 44% | 22% | 35% |
| **Rank 3rd** | | 26% | 7% | 62% |
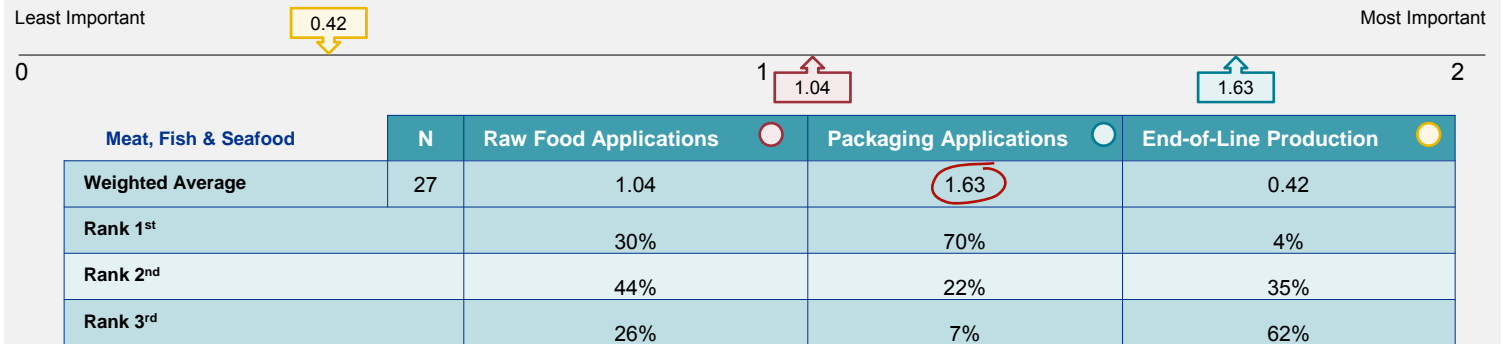
**Figure 27**

**Prepared Meals, Bakeries, Fruits & Others**

Least Important  —  0.42  —  1.00  —  1.46  —  0  —  1  —  2  —  Most Important

| Prepared Meals, Bakeries, Fruits & Others | N | Raw Food Applications ⬤ | Packaging Applications ⬤ | End-of-Line Production ⬤ |
|---|---|---|---|---|
| **Weighted Average** | 35 | 1.00 | 1.46 | 0.42 |
| **Rank 1st** | | 43% | 54% | 12% |
| **Rank 2nd** | | 37% | 37% | 18% |
| **Rank 3rd** | | 20% | 9% | 70% |

# Anticipated Level of Capital Investment In Automation and Robotics

**Figure 28**

### Dry Food

Least Important        0.50                        Most Important

0        0.43             1             1.80     2

| Dry Food | N | Raw Food Applications ⬤ | Packaging Applications ⬤ | End-of-Line Production ⬤ |
|---|---|---|---|---|
| Weighted Average | 15 | 0.43 | 1.80 | 0.50 |
| Rank 1st | | 33% | 80% | 8% |
| Rank 2nd | | 33% | 20% | 33% |
| Rank 3rd | | 33% | 0% | 58% |

**Figure 29**

### Other Packaged Food and Ingredients
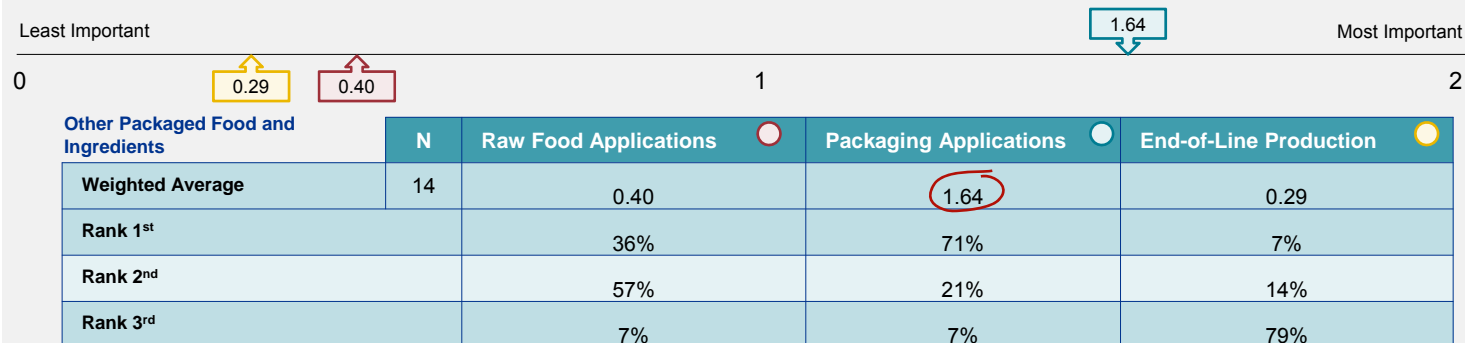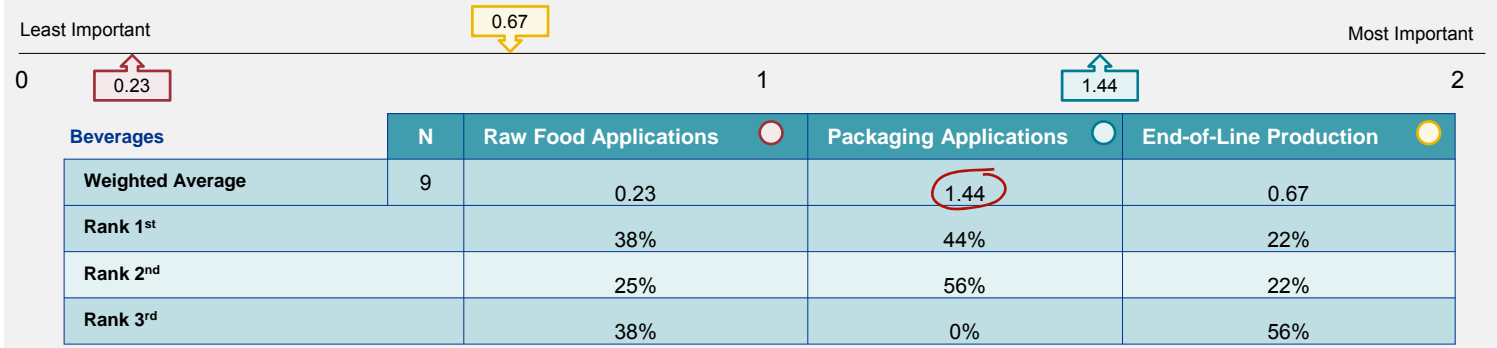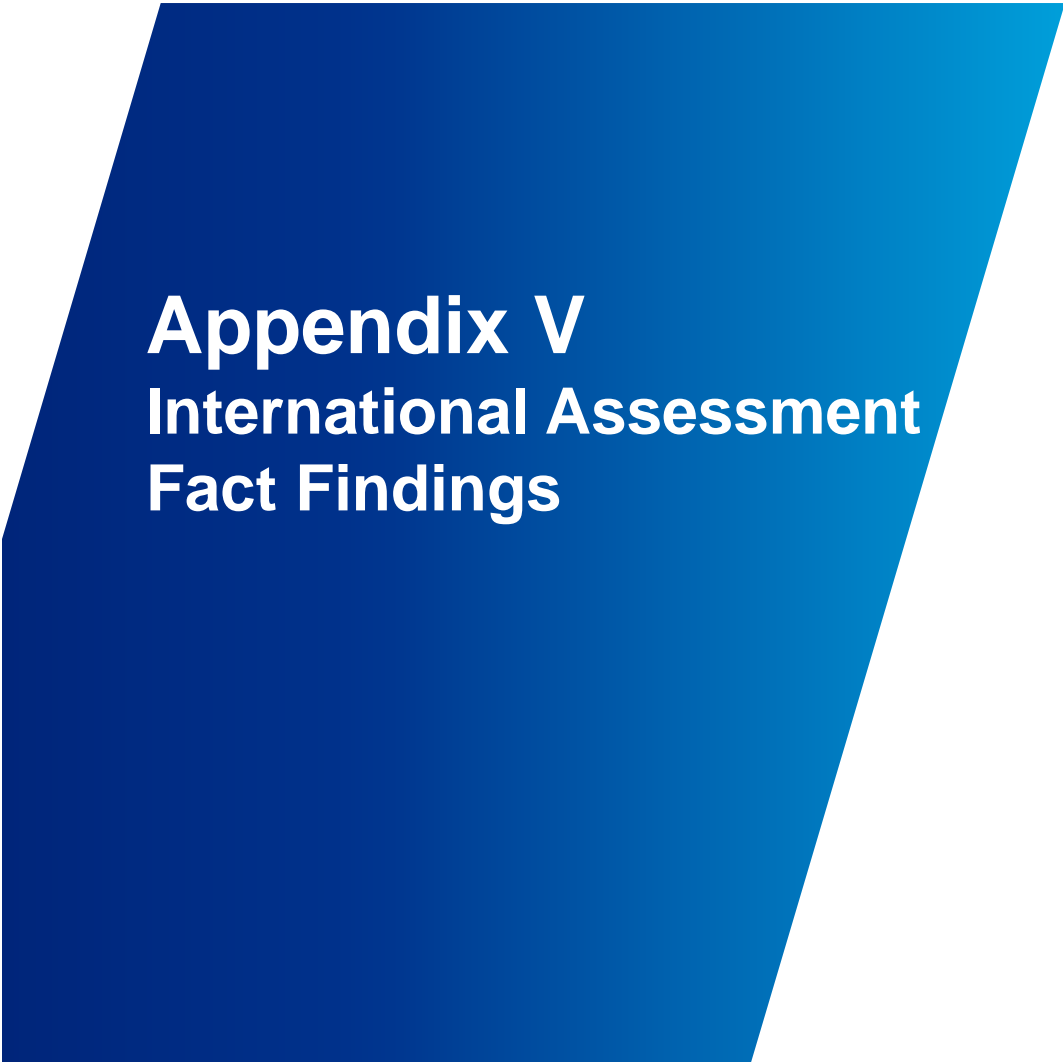
Least Important                         1.64        Most Important

0       0.29   0.40            1                   2

| Other Packaged Food and Ingredients | N | Raw Food Applications ⬤ | Packaging Applications ⬤ | End-of-Line Production ⬤ |
|---|---|---|---|---|
| Weighted Average | 14 | 0.40 | 1.64 | 0.29 |
| Rank 1st | | 36% | 71% | 7% |
| Rank 2nd | | 57% | 21% | 14% |
| Rank 3rd | | 7% | 7% | 79% |

# Anticipated Level of Capital Investment In Automation and Robotics

**Figure 30**

## Beverages

Least Important

0.67

Most Important

0         0.23          1         1.44         2

| Beverages | N | Raw Food Applications ● | Packaging Applications ● | End-of-Line Production ● |
|---|---|---|---|---|
| **Weighted Average** | 9 | 0.23 | 1.44 | 0.67 |
| **Rank 1st** | | 38% | 44% | 22% |
| **Rank 2nd** | | 25% | 56% | 22% |
| **Rank 3rd** | | 38% | 0% | 56% |

# Appendix V
## International Assessment
## Fact Findings

# Sample Description

## Sample Description

Interviews were conducted with Food and Beverage processing companies operating in the following sub-sectors:

- Alcoholic Beverages: Wines, spirits and Beers (2);

- Energy Drinks (1);

- Fish and Seafood (3);

- Rice (1);

- Bread and Bakeries (1);

- Fruits and Vegetables (4); and

- Confectionery (3)

The information for the above interviews (15) was compiled in a similar way to the National Assessment. Results are presented in this Appendix per question.

The size distribution of the above sample was as follows.
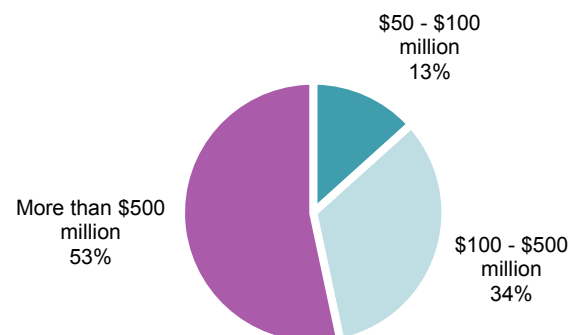
Other interviews were conducted with other Food and Beverage processing firms, machine and equipment (M&E) builders and providers and a number of associations that are not part of the above sample. These interviews provided qualitative information in the form of discussions on various geographical regions and sub-sectors. These included a total of:

- International associations and M&E providers (6);

- Canadian associations and M&E providers (7); and

- Canadian Food and Beverage processing firms (6) who shared their knowledge of the international competition (including beverages, prepared meals, fruits and vegetables sub-sectors).

**Figure 1**



$50 - $100 million 13%

More than $500 million 53%

$100 - $500 million 34%

# Question 5b – Current Level of Automation and Robotics

## Description of the Question

Participants were asked to characterize the level of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the below scale.

| Scale | Description |
|---|---|
| 1 (0) | Not automated (0% automated) |
| 2 (1) | Less automated (less than 40% automated) |
| 3 (2) | Partially automated (between 40% and 70% automations) |
| 4 (3) | Very automated (over 70% automated) |

Answers were compiled for all the interviews. The answers were rescaled from 0 to 3 for presentation purposes, with 0 corresponding to not automated and 3 corresponding to very automated.

## Overview of Results

Overall, the current level of automation varied across sub-sectors and firms.

The Raw Food/Processing and Packaging applications groups were ranked the most automated, although the automation remains only partial amongst interviewed firms. End-of-line applications tend to be less automated.

### Figure 2
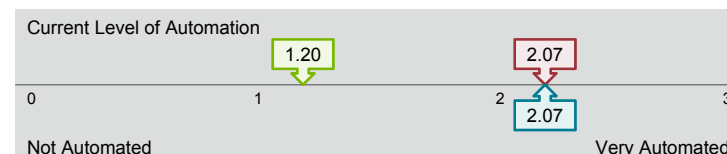


The following table highlights the breakdown of responses.

### Table 1



| N = 15 | Weighted Average | Automation | | | |
|---|---|---|---|---|---|
| | | Not | Less | Partially | Very |
| Raw Food Applications | 2.07 | 0% | 40% | 13% | 47% |
| Packaging Applications | 2.07 | 0% | 27% | 40% | 33% |
| End-of-Line Production | 1.20 | 27% | 40% | 20% | 13% |

# Question 6 – Importance of Automation and Robotics

**Description of the Question**

Participants were asked to characterize the importance of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the below scale.

| Scale | Description |
|---|---|
| 1 (0) | Not important |
| 2 (1) | Less important |
| 3 (2) | Somewhat important |
| 4 (3) | Very important |

Answers were compiled for all the interviews. The answers were rescaled from 0 to 3 for presentation purposes, with 0 corresponding to not important and 3 corresponding to very important.

**Overview of Results**

Overall, the importance given to each Food and Beverage processing application varied across sub-sectors and firms.

Packaging applications were considered the most important to automate, followed closely by raw food/processing applications. On average, less importance was attributed to the adoption of automation and robotics for end-of-line applications.

**Figure 3**
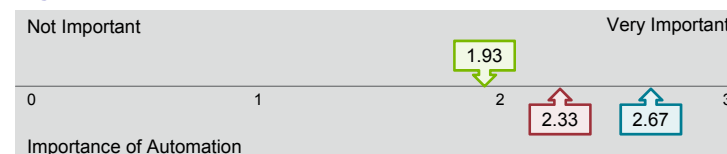


The following table highlights the breakdown of responses.

**Table 2**

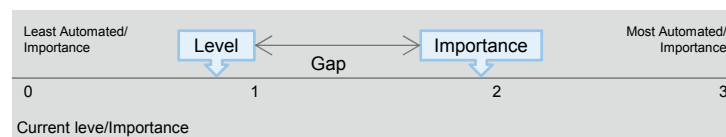| N = 15 | Weighted Average | Importance | | | |
|---|---|---|---|---|---|
| | | Not | Less | Somewhat | Very |
| Raw Food Applications | 2.33 | 0% | 27% | 13% | 60% |
| Packaging Applications | 2.67 | 0% | 13% | 7% | 80% |
| End-of-Line Production | 1.93 | 7% | 27% | 33% | 33% |

## Description

Analysis was conducted to characterize the difference (gap) between the level and the importance of automation and robotics for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

Given that the assessment of the current level of automation (Question 5b) and the importance of automation (Question 6) were answered based on the same scale, answers were compared for the various business operations of interviewed firms and gaps were calculated as the difference between the importance and the level.

### Figure 4

Least Automated/ Importance ← Level — Gap — Importance → Most Automated/ Importance

0 — 1 — 2 — 3

Current leve/Importance

Calculations were compiled for all of the interviewed operations for each processing applications group. The calculations were scaled from 0 to 3 for presentation purposes, with 0 corresponding to no gap between the level and the importance of automation and robotics.

## Overview of Results

Overall, the gaps between the level and the importance of automation and robotics varied across sub-sectors and firms.

Raw food applications are leading by having the smallest gap of all three application groups. Packaging and end-of-Line production respectively follow in the extent of their measured gaps. None of the applications have a gap greater than 1.

### Figure 5

Full Gap

0.26

0 — 0.60  0.73 — 1 — 2 — 3

Size of Gaps

| | |
|---|---|
| Raw Food Applications | ○ |
| Packaging Applications | ○ |
| End-of-Line Production | ○ |

# Gaps Between the Level and Importance of Automation and Robotics

**Figure 6**

Not automated /Important                                                                 Very automated/Important

0.26

0 ————————————————— 1 ————————————————— 2 [2.07] ————— [2.33] ————— 3

| N = 15 | **Raw Food Applications** |
|---|---|
| **Current Level** ⭕ | 2.07 |
| **Importance** ⭕ | 2.33 |
| **Gap** ⭕ | 0.26 |

0.60

0 ————————————————— 1 ————————————————— 2 [2.07] ————— [2.67] ————— 3

| N = 15 | **Packaging Applications** |
|---|---|
| **Current Level** ⭕ | 2.07 |
| **Importance** ⭕ | 2.67 |
| **Gap** ⭕ | 0.60 |

0.73

0 ————————————————— 1 [1.20] ———————— [1.93] ———————————————— 3

| N = 15 | **End-of-Line Production** |
|---|---|
| **Current Level** ⭕ | 1.20 |
| **Importance** ⭕ | 1.93 |
| **Gap** ⭕ | 0.73 |

# Question 8a – Maturity of the Current Robotics and Automation per Applications

## Description of the Question

Participants were asked to provide an estimate of the age of their robots and automation technology for each of the following Food and Beverage processing applications.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

The assessment was performed for the various business operations of interviewed firms using the below scale.

| Scale | Description |
|---|---|
| 5 (0) | 0-4 years |
| 4 (1) | 5-9 years |
| 3 (2) | 10-14 years |
| 2 (3) | 15-20 years |
| 1 (4) | 20 years + |

Answers were compiled for all of the interviewed operations. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to 0-4 years of age and 4 corresponding to 20 years + of age.

## Overview of Results

Overall, the age of current automation and robotic technologies varied across sub-sectors and firms.

On average, the age of the technology across all segments ranged between 10-14 years old. Overall, end-of-line and packaging applications tend to use more recent automation technology and robotics, although for all application groups, there is a mix of very old and new.

### Figure 7
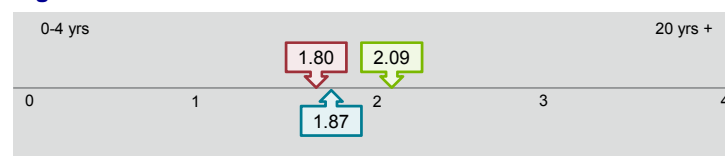


The following table highlights the breakdown of responses.

### Table 3

| N = 15 | Weighted Average | Maturity (years) | | | | |
|---|---|---|---|---|---|---|
| | | 20 + | 15-20 | 10-14 | 5-9 | 0-4 |
| Raw Food Applications | 1.80 | 20% | 0% | 47% | 7% | 27% |
| Packaging Applications | 1.87 | 27% | 0% | 27% | 27% | 20% |
| End-of-Line Production | 2.09 | 27% | 0% | 36% | 27% | 9% |

# Question 8b – Is the Technology used Leading-Edge/Top-of-the-Line?

## Description of the Question

Participants were asked to provide a general assessment of the technologies used in all of their processing applications. The assessment was performed for the various business operations of interviewed firms, selecting one of the following statements as most representative of the current state of their automation and robotic technologies.

| Possible Answers |
| --- |
| Most of the automation technology and robotics are leading-edge/top-of-the-line |
| Some of the automation technology and robotics are leading-edge/top-of-the-line |
| The automation technology and robotics are not leading-edge/top-of-the-line |

Leading-edge/top-of-the-line was used to describe technology that is most recent in advancements. Some solutions may be 5-10 years old. However, if no further advancement occurred since the technology was purchased, it might still be top-of-the-line.

Answers were compiled for all interviewed operations. The answers were rescaled from 0 to 2 for presentation purposes, with 0 corresponding to not leading-edge and 2 to most are leading-edge.

Note that this assessment only took into consideration the technology currently used by the interviewed firms.

## Overview of Results

While some of the interviews qualified their automation technology and robots as not leading-edge/top-of-the-line, others considered most of them as leading-edge/top-of-the-line. Generally, the technology used by international operations is only partially leading-edge/top-of-the-line.
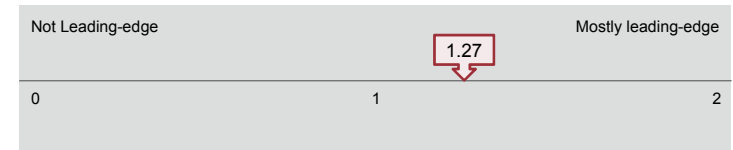
### Figure 8



### Table 4

| N = 15 | Distribution |
| --- | --- |
| Weighted Average | 1.27 | |
| Most are | 33% |
| Some are | 60% |
| None are | 7% |

# Question 9 – Drivers to the Adoption of Automation and Robotics

## Description of the Question

Participants were asked to rank in order of importance the following drivers to the adoption of automation and robotics.

| Drivers | Description |
|---------|-------------|
| Production | Cost savings, improve productivity, improve efficiency of operations, product and input waste management |
| Employees | Improve working conditions, decrease rate of accidents, decrease cost of labour per unit of finished good |
| Consumers | Introduce product innovation, improve product safety and quality control, address consumer preferences |
| Legislation | Quality and safety legislations and regulations |
| Market share | Potential new international trade agreements, global and national competitors' level of automation and robotics |

Answers were compiled for all of the interviewed operations. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to the least important driver and 4 corresponding to the most important driver for the adoption of automation and robotics.

## Overview of Results

Overall, the importance of these drivers to the adoption of automation and robotics varied across sub-sectors and firms.

Production-related factors were ranked the most important driver to automation and robotics, followed closely by employee-related factors and consumers. Essentially, the adoption of automation and robotics can help firms produce cost-efficient and safe products of quality. Quality and safety legislations and market share factors were typically not considered drivers to the adoption of automation and robotics.

### Figure 9



Drivers for all sub-sectors
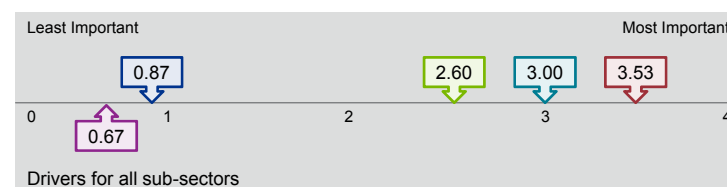
The following table highlights the breakdown of responses.

### Table 5

| N = 15 | | Weighted Average | Rank | | | | |
|--------|--|------------------|------|--|--|--|--|
| | | | 1st | 2nd | 3rd | 4th | 5th |
| Production | ○ | 3.53 | 73% | 7% | 20% | 0% | 0% |
| Employees | ○ | 3.00 | 13% | 73% | 13% | 0% | 0% |
| Consumers | ○ | 2.60 | 27% | 13% | 53% | 7% | 0% |
| Legislation | ○ | 0.67 | 7% | 0% | 0% | 40% | 53% |
| Market Share | ○ | 0.87 | 7% | 0% | 7% | 47% | 40% |

# Question 10 – Barriers to the Adoption of Automation and Robotics

## Description of the Question

Participants were asked to rank in order of importance the following barriers to the adoption of automation and robotics.

| Barriers | Description |
|---|---|
| Cost | Initial cost of robots and automation, cost of training/ hiring/maintenance, legacy robots/automation/ system |
| Operations | Size of robots available and space required for automation, product support, and maintenance services availability, culture of the company |
| Market and Financing | Market perception, poor return on investment, funding availability |
| Perceived risks | Cost vs. Short-term payback, unpredicted cost, operational delays, and other issues and frictions with implementation |

Answers were compiled for each of the interviewed operations. The answers were rescaled from 0 to 4 for presentation purposes, with 0 corresponding to the least important barrier and 4 corresponding to the most important barrier for the adoption of automation and robotics.

## Overview of Results

Overall, the importance of these barriers to the adoption of automation and robotics varied across interviewed operations. Return on investment and funding availability (Market & Financing) were considered the first or second most important barriers to automation and robotics in 73% of interviews. The initial and affiliated costs of these technologies were considered the first or second most important barriers in 66% of interviews.

### Figure 10



Barriers for all sub-sectors
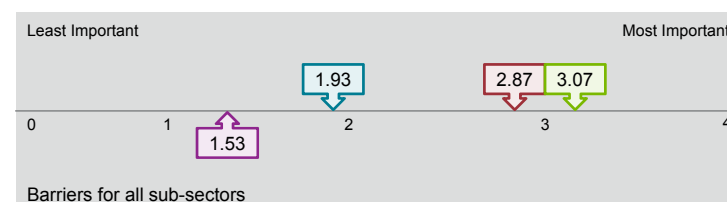
The following table highlights the breakdown of responses.

### Table 6

| N = 15 | | Weighted Average | Rank | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1st | 2nd | 3rd | 4th | 5th |
| Cost | ○ | 2.87 | 33% | 33% | 20% | 13% | 0% |
| Operations | ○ | 1.93 | 0% | 13% | 67% | 20% | 0% |
| Market & Financing | ○ | 3.07 | 60% | 13% | 0% | 27% | 0% |
| Perceived Risks | ○ | 1.53 | 7% | 20% | 13% | 40% | 20% |

# Question 11 – Anticipated Level of Capital Investment In Automation and Robotics

### Description of the Question

Participants were asked to rank in order of priority the following applications in terms of future capital investment in automation and robotics.

| Processing application | Description |
|---|---|
| Raw Food/ Processing Applications | These include material handling, feeding and dosing, transport/conveying, actual processing (cleaning, mixing, cooking, cutting, etc.), quality control |
| Packaging Applications | These include picking and packing, labeling, safety control, secondary packaging, palletizing |
| End-of-Line Applications | These include storage, pick-and-place, logistics, distribution, tracking |

Answers were compiled for each of the interviewed operations. The answers were rescaled from 0 to 2 for presentation purposes, with 0 corresponding to last priority application groups and 2 to the first priority application groups for capital investment in automation and robotics in the near future.

Note that some interviews may have ranked two or all of the applications as equal priorities in terms of future capital investment in automation and robotics.

### Overview of Results

Overall, the priority for capital investment varied across interviewed firms. Raw food/processing and packaging applications were most often ranked as a top priority in terms of future investment in automation and robotics across all segments of analysis. End-of-line applications were unanimously considered a last priority.

### Figure 11
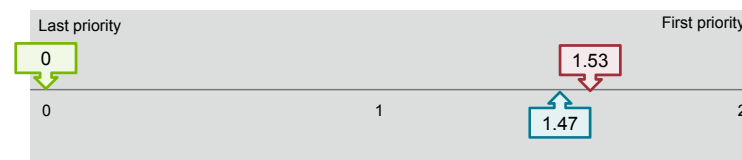


The following table highlights the breakdown of responses.

### Table 7

N = 15

| | Weighted Average | Rank | | |
|---|---|---|---|---|
| | | 1st | 2nd | 3rd |
| Raw Food Applications ○ | 1.53 | 53% | 47% | 0% |
| Packaging Applications ○ | 1.47 | 47% | 53% | 0% |
| End-of-Line Production ○ | 0 | 0% | 0% | 100% |

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31214CA_Distilleries in Canada
C1112-GL_Fruit and Vegetables
C1113-GL_Candy and Chocolate
C1114GL_Bakery Goods
C1115GL_Sugar
C1116GL_Cheese

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OSEC – South Africa – Food & Beverage Industry – Food Processing
http://www.s-ge.com/sites/default/files/Food%20&%20Beverage%20South%20Africa_SBHSA_December-2011.pdf

a. Number reflects all employees with salaries, but excludes independent workers
b. IFR statistics are based on participating firms
c. N.B. Robots are considered useful proxy for automation trends across industrial sectors (The Planning Group, 2014)
d. The CAPI Processed Food Sector Research Program used the World Customs Organization's Harmonized Commodity Description and Coding System (HS) for sub-sector identifications
e. Or 100% manually operated, with or without mechanical assistance
f. The CAPI Processed Food Sector Research Program used the World Customs Organization's Harmonized Commodity Description and Coding System (HS) for sub-sector identifications