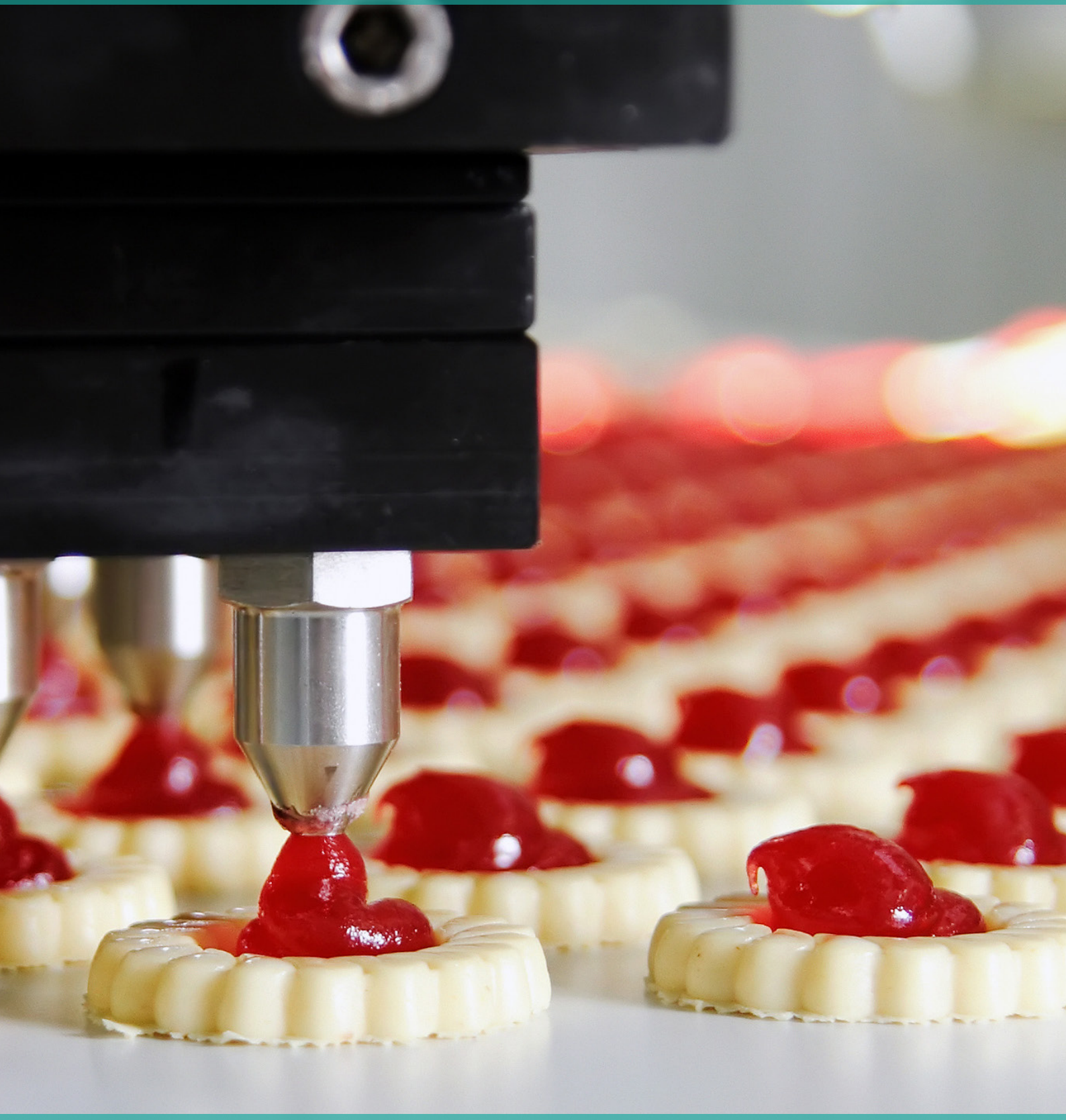
NORTHERN IRELAND FOOD & DRINK

BIRNIECONSULTANCY

STRATEGIC DEVELOPMENT IN AGRI-FOOD

Invest Northern Ireland



ADVANCED FOOD MANUFACTURING NETWORK REPORT

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EXECUTIVE SUMMARY

Introduction

This project, which was led by the Northern Ireland Food & Drink Association (NIFDA), and funded by the Invest NI Collaborative Growth Programme in August 2020, sought to establish the current situation in terms of automation and use of data in a range of food businesses within Northern Ireland. It aimed to identify and summarise the support which was currently available to NI food companies, and to identify where gaps exist; to provide evidence on which the network members, and potentially the wider food sector, can act to guide and access the provision of more focused support; to identify a range of factory structures, equipment and practice around which support should be focused to maximise the uptake of advanced technology, and to investigate the potential for an Advanced Food Manufacturing Network and to demonstrate how it could enhance the Northern Ireland food and drink manufacturing sector.

Project Delivery

The original network membership consisted of NIFDA, Mash Direct, Andrews Flour and Whites Oats, however, seven other Northern Ireland based Food companies became involved in the investigation and delivery of the conclusions and recommendations.. The range of food produced included flours; vegetables and fruits; mushrooms; ready meals; vegan meals; coffee; retail eggs; health foods; breads; baked goods; and cereals, with the companies ranging from small to medium in size, with turnovers between £2 million and £75million, and employee numbers between 15 and 250. All companies provided senior managers to engage with the process, and each gave significant time to providing the information which underpins this report.

To deliver against the aims of the study, a structured methodology was designed and delivered. Work was broadly broken down into 'company analysis' and 'identification of required supports and case studies'. A range of activity was delivered under each section and these are laid out in the following text.

The company analysis involved a series of interviews and the completion of a preliminary questionnaire with each organisation and the creation of an initial SWOT analysis. Following this, a detailed, food production focused 4manufacturing survey was completed, sometimes over two-three meetings which allowed the SWOT analysis to be updated.

The 4manufacturing process involved assessment of company position, intended position and ideal position against approximately 20 indicators which included areas around data gathering and analysis, production line capability, cybersecurity, supply chain integration, automation etc. The companies involved in the project were open and frank about their current and intended positions, which allowed the report to identify a range of areas where support could be provided to accelerate change.

Identification of current support was delivered through desk-based research and interaction with a range of organisations which service manufacturing and food manufacturing.

Project Findings

The project identified five specific areas of need, which, if support was to be provided, would enabled the businesses to make immediate gains in productivity, efficiency and profitability, thereby benefiting both the companies, the wider food sector, and the Northern Ireland economy; these are as follows:

1. **Use of data for management:** All businesses within the project were motivated to collect, aggregate, analyse and use data effectively to manage. However, all acknowledge that this is not being delivered as effectively as it could be. No business has a centralised system which is currently aggregating all the data generated within the business. In reality, the majority have multiple systems currently incapable of communicating with each other. This means the transfer of information must happen either through third party systems, or more often, manually, meaning that errors are almost inevitable. Addressing the decentralised approach to data capture, storage and analysis is a must. Improving data management is essential to accelerate growth in productivity. We strongly recommend further study in this area to identify optimum methods of delivering improvement in data management in food companies across Northern Ireland.

2. **Automation is key to productivity and profitability gains:** The 4manufacturing analysis carried out within the project highlighted challenges and opportunities for business. Nine out of the ten companies in the project reported challenges around attracting enough labour. The need to increase value add per employee is a driving force behind the Industry 4.0 thought process. The implementation of end of line automated packaging is seen as a priority.

   All companies are seeking support from government in terms of capital and advisory funding to improve value added per employee. Increasing levels of productivity in food production processes also carries significant environmental benefits and this was highlighted as important during the delivery of the project.

3. **Availability of training and skills development:** All companies stated that the availability of a trained, skilled and motivated workforce is vitally important to effective implementation of industry 4.0. Upskilling of existing roles and the re-engineering of production lines to incorporate robotization/automation is critical. The ongoing provision of targeted training on advanced manufacturing will continuously improve the value add per employee.

4. **Making connections is important to raise awareness of solutions which can maximise productivity of food production:** Throughout the delivery of the report it became obvious that there is a wide range of available support from government, academia and private businesses which can be used to accelerate the introduction of productivity solutions for NI businesses.

   Many organisations are working in the technology and data use space in Northern Ireland, Ireland and GB and can deliver significant benefit to NI food business. However,

the majority of Food related NI companies are not aware of who these data analytics companies are, or how they could benefit their own business. It is important to create a dynamic and constantly developing database of organisations which can help NI companies to improve their productivity and profitability. Funding provided to develop a number of case studies, which link technology companies and academia, with Food companies, thereby demonstrating productivity and profitability savings would help increase this awareness

5. **An Advanced Food Manufacturing Network should be established to help to move the sector forwards:** Without an Advanced Food Manufacturing Network there is a significant risk that Northern Ireland food businesses will fall behind the competition. The project has identified three main disconnects which are:

    1) Available support from government
    2) Available support from academia
    3) Available support from other commercial organisations

    An Advanced Food Manufacturing Network could function as a hub, collecting & collating information, analysing and interpreting it, and communicating it clearly to businesses where it is of relevance. It it critical that the Network engage senior decision makers if it is to realistically impact in-factory performance.

    A network needs to focus specifically on the delivery of information direct to appropriate businesses, based on first hand knowledge about that business. It is clear that those managing their businesses are keen to introduce new ideas to business management and the production process. It is also clear that those managing each business are time-poor and need useful, relevant information quickly. An ongoing, operational advanced manufacturing network can be of use to local businesses by identifying technology, processes, software and analytical techniques and introducing them to the business.

    Three critical changes are required to ensure the success of an Advanced Food Manufacturing Network:

    1) A database should be created which contains constantly updated information on available support from government, academia and the private sector
    2) Funding should be provided to identify practical case studies and delivery of methods to encourage uptake of advanced practice
    3) Advanced peer-to-peer interaction should be enabled between companies to drive knowledge exchange

    In summary an Advanced Food Manufacturing Network should function as a hub which can collect, analyse and interpret information, while communicating targeted information to key industry players. It should also encourage the development of peer-to-peer knowledge transfer and should promote best practice benchmarking.

Project Recommendations

Provide Specific Expertise for Support of NI Food Companies: It is clear that there is a need for targeted information and support for food companies in Northern Ireland which could be provided by a range of organisations and businesses. These areas include:

1) **Data expertise:** There is a need for a team which can investigate and develop data collection, analysis and use within production environments.

2) **Automation expertise:** There is a need for a team which can investigate the potential for automation within food factories and provide advice on optimum methodologies and the latest technologies.

3) **Delivery or signposting of Skills Training and Development:** There is a need for assistance around the provision of targeted skills training to enable effective uptake of automation.

4) **Capital funding to assist implementation of 4Manufacturing solutions:** Although the need for advisory support is key to providing direction and process improvement, a lot of the benefit will only be delivered via capital investment. Food companies have always showed an appetite to invest in their production facilities, however, capital incentives, grants, and specific process improvement funding streams, provided by government and their economic support agencies, such as Invest NI, would ensure this activity happens more quickly.

Through the activity of the network, it became apparent some of this support can be delivered through a combination of support from Invest NI, through its Agile 4Manufacturing Team and the follow-on funding of an Automated Food Network, through a Phase Two Collaborative Growth application. These recommendations are outlined further below.

Deliver Targeted Support by the Invest NI Agile Team: Invest NI have a group of experts known as the 'Agile Team' who have expertise around 4Manufacturing and the improvement of factory process. A range of action areas have been identified for each company and the Agile team can bring expertise to each of these areas. Often, development has not been undertaken because the companies either lack the time or the expertise to investigate and implement solutions without external support. The Agile Team can help to address this.

To date, seven of the ten companies engaged by the project have indicated their willingness to engage with the Agile team and begin their automation implementation journey, but as noted above, funding will be required to deliver successful projects due to the capital expenditure envisaged for robotics, or process automation. The network members are exploring ways to provide this funding, which is delaying implementation plans.

Develop an Effective Advanced Food Manufacturing Network. An Advanced Food Manufacturing network would be a useful support for the delivery of advanced manufacturing information. The network would function as first point of contact for any company wishing to undertake advanced automation or practice, it would signpost expertise in automated data collection and analysis, it would signpost expertise in automation and it would signpost appropriate skills training and/or training

material.

The Network would also focus on the creation of symbiotic relationships with a range of organisations to connect information and ensure that it is communicated to the maximum number of businesses. It would communicate with member businesses through the organisation of events and the delivery of information flow to keep businesses informed with highly relevant, targeted material. It would facilitate the involvement of organisations and advisors who can work with NI food businesses to raise productivity. The network members believe this could be facilitated by follow-on Collaborative Growth programme support in terms of a Phase Two project, and are considering an application to deliver this element of the recommendations.

INTRODUCTION

This report was commissioned by the Northern Ireland Food and Drink Association and was designed to provide the following information:

1) To establish the current situation in terms of automation and use of data in a range of food businesses within Northern Ireland.

2) To identify and summarise the support which is currently available to NI food companies, and to identify where gaps exist.

3) To provide evidence on which the network members, and potentially the wider food sector, can act to guide and access the provision of more focused support.

4) To identify a range of factory structures, equipment and practice around which support should be focused to maximise the uptake of advanced technology.

5) To investigate the potential for an Advanced Food Manufacturing Network and to demonstrate how it could enhance the Northern Ireland food and drink manufacturing sector.

SUMMARY METHODOLOGY

To deliver against the aims of the study, a structured methodology was designed and delivered. Work was broadly broken down into 'company analysis' and identification of required 'supports and case studies. A range of activity was delivered under each section and these are laid out in the following text.

Company Analysis

The delivery of analysis on each of the companies involved the following steps.

1) Identification of NI food companies which could potentially become involved in the study.

2) Creation of initial company profiles and gathering of basic information.

3) Review of support which is currently available to NI food businesses.

4) Creation and execution of a high level survey to collect initial practice and performance information on each company.

5) Creation of basic SWOT analysis to identify the key challenges

6) Review and re-design of 4Manufacturing survey to enable it to be used within a food manufacturing context.

7) Completion of 4Manufacturing survey with each company.

8) Review of 4Manufacturing survey with each company.

9) Review of SWOT analysis with each company.

10) Review and agreement of 4 Manufacturing findings and SWOT analysis with each company.

11) Creation of overall Advanced Food Manufacturing Report.

12) Production of recommendations.

Supports and Case Studies

Production of the supports and case studies section of the report involved the following steps;

1) Desk based research to identify the main supports which are available to Northern Ireland food companies.

2) Desk based research to identify case studies which could potentially guide some development work with the project companies.

3) Discussion with individual experts around methodologies and technologies which can be used to improve productivity of food businesses.

4) Identification of a range of experts or service businesses which could potentially inform the AFM network, and arrangement of events at which they could deliver advice.

COMPANY DESCRIPTIONS

Ten Northern Ireland based companies became involved in the project. The companies ranged from small to medium, with turnovers between £2 million and £75million, and employee numbers between 15 and 250. Some were relatively new companies, while others have been established for a very long period of time. The businesses were widely distributed across Northern Ireland and all were interested in developing several aspects of their business. Some of the companies are already involved in development programmes, whereas others are not. Some benchmark their performance, but the majority are unable to determine how they perform against their competition. All companies provided senior managers to engage with the process, and each gave significant time to providing the information which underpins this report.

The range of production outputs included the following:

1) Flours
2) Vegetables and fruits
3) Mushrooms
4) Ready meals
5) Vegan meals
6) Coffee
7) Retail eggs
8) Health Foods
9) Cereals
10) Breads and baked goods

Whilst we have used detailed information from each of these companies in the production of the report, we have not identified or specifically attributed any of the findings due to commercial sensitivity.

SECTION ONE: DATA COLLECTION & ANALYSIS

PROJECT METHODOLOGY: DATA COLLECTION

The findings from this project are based on information collected from multiple sources. A range of companies were identified through discussion with NIFDA and Invest NI and were engaged in the study. Primary data was collected for the project using interviews, discussion and surveys. Secondary supporting information was obtained through desk-based research and engagement with industry specialists.

Primary Data Gathering

Introductory Questionnaire

Each of the companies was engaged using an introductory survey to collect basic information. The responses were used to gain an understanding of each company, to understand their production and production challenges, how they determine and manage performance, what their future development needs are and the factors which are restricting this necessary development. The questions in the survey served as a basis against which further discussion could take place. The information gathered was used to form a company profile and to create a SWOT analysis which was continuously modified throughout the project as further data was gathered. The following table is an excerpt from the initial questionnaire which was used.

POTENTIAL BENEFITS	
35	What benefits would you expect from advanced manufacturing techniques or technologies in the next 5 years?
36	What return on investment period (ROI) would you expect from investments in advanced manufacturing techniques or technologies?
37	First movers are almost three times more successful in combining high revenue increases with significant gains in cost reduction - how can this best be addressed?
HARDWARE, SOFTWARE AND INFRASTRUCTURE	
38	What software systems do you currently use in your factory?
	Bespoke software?
	ERP system?
	Can all your factory systems communicate and share data?
	Are all systems linked to a central database?
39	Is broadband speed and stability to your factory a limiting factor to you adopting industry 4.0 technology?
40	Does your factory have adequate network points or wireless connectivity throughout?
41	Is the lack of hardware or outdated hardware (e.g. scanners, data terminals, scales etc) a limiting factor within the factory?

4Manufacturing Survey

Following the execution of introductory survey and the production of the initial SWOT analysis, the much more detailed 4Manufacturing survey was used to engage with each of the companies. This 4Manufacturing survey was adapted for the food sector from the original which was focused on machinery manufacture. The format of the survey was significantly revised but the majority of the components from the original survey where retained because they were applicable to the food sector.

The 4Manufacturing survey has been designed to investigate a wide range of adoption indicators and development opportunities. The table below is an excerpt from the modified survey and shows how current status and required development data was gathered from each company. The survey uses definitions to score a company's current status for the 21 adoption indicators on a 1-5 scale, and allows the future target levels for the company to be documented. The numerical scoring allows analysis of current company performance against target company performance, or alternatively, current company performance against ideal performance in each indicator area. Not all indicator sectors are applicable to every company, but all have applicability to the food sector as a whole.

ENABLING TECHNOLOGIES	CURRENT ATTAINMENT LEVEL	TARGET LEVEL
1 Additive Manufacturing: Technologies that build 3D objects by depositing layer-upon-layer of material. This criteria addresses this technology and how this translates to manufacturing.		
2 Digitally Assisted Assembly: Digital technologies to facilitate the assembly processes using fixed, mobile and wearable platforms.		
3 Robotics and Automation: Systems such as industrial robots that complete a process independently, with minimal or reduced human intervention, to achieve higher quality, speed, or reduced cost within a process.		
4 Flexible Manufacturing Cells: Flexible manufacturing system (FMS) is a process that can easily adapt to changes in the product being manufactured and its production levels.		
5 Predictive Maintenance: Techniques designed to monitor the condition of in-service equipment in order to predict when maintenance should be performed, rather than carrying out periodic maintenance.		
6 Industrial Energy Efficiency: Energy-efficient technologies and management practices implemented in the manufacturing sector to reduce energy consumption.		

PROJECT METHODOLOGY: DATA ANALYSIS

As previously described, a range of qualitative data was collected throughout the project. Some of this data in conjunction with a scoring scale to allow quantitative analysis of the data. The remaining qualitative data was used to explain and interpret the data to allow the production of recommendations.

The following table shows the combined analysis from the 4Manufacturing assessment for all of the companies which were involved in the study. Column three shows the average company attainment (on a scale of 1-5) versus average company target for each of the 10 companies in the programme. The company target is not always set at level 5 (the ideal target). Column 4 shows the difference between the average attainment of the company and the ideal achievement level.

Each company undertook this survey and the scores were then discussed in detail. Some of the areas were debated extensively (as it is often matter of judgement to determine exactly where company attainment stands at present) to agree the level which the company is targeting. It is sometimes tempting to set very high targets in each area, but this is not realistically achievable in all situations, and the companies recognised this.

1	2	3	4
INDUSTRY 4.0 SECTION		**AVERAGE COMPANY ATTAINMENT VS AVERAGE TARGET**	**AVERAGE COMPANY ATTAINMENT VS IDEAL TARGET**
1 Additive Manufacturing: Technologies that build 3D objects by depositing layer-upon-layer of material. This criteria addresses this technology and how this translates to manufacturing.	**ADDITIVE MANUFAC-TURING**	**0.20**	**4.00**
2 Digitally Assisted Assembly: Digital technologies to facilitate the assembly processes using fixed, mobile and wearable platforms.	**DIGITALLY ASSISTED ASSEMBLY**	**1.40**	**4.00**
3 Robotics and Automation: Systems such as industrial robots that complete a process independently, with minimal or reduced human intervention, to achieve higher quality, speed, or reduced cost within a process.	**ROBOTICS AND AUTOMATION**	**2.50**	**3.35**
4 Flexible Manufacturing Cells: Flexible manufacturing system (FMS) is a process that can easily adapt to changes in the product being manufactured and its production levels.	**FLEXIBLE MANUFAC-TURING CELLS**	**1.70**	**3.60**
5 Predictive Maintenance: Techniques designed to monitor the condition of in-service equipment in order to predict when maintenance should be performed, rather than carrying out periodic maintenance.	**PREDICTIVE MAINTENANCE**	**2.50**	**3.50**
6 Industrial Energy Efficiency: Energy-efficient technologies and management practices implemented in the manufacturing sector to reduce energy consumption.	**INDUSTRIAL ENERGY EFFICIENCY**	**2.60**	**3.20**

1	2	3	4
INDUSTRY 4.0 SECTION		**AVERAGE COMPANY ATTAINMENT VS AVERAGE TARGET**	**AVERAGE COMPANY ATTAINMENT VS IDEAL TARGET**
7 Factory Floor and Production Systems: Integrated digital production management systems within a business for control and optimisation of all manufacturing, product life cycle and resource management processes.	**FACTORY FLOOR AND PRODUCTION SYSTEMS**	**2.80**	**3.70**
8 Internet of Things: Inter-connectivity and integration between industrial control systems, business processes and data analytics for improved performance, integration between industrial control systems, business processes and data analytics for improved performance.	**INTERNET OF THINGS**	**2.35**	**3.60**
9 Sensors (including RFID): Devices that can monitor and or collect data from a physical process and/or an event process and/or an event, location.	**SENSORS (INCLUDING RFID)**	**2.05**	**3.70**
10 Big Data and Artificial Intelligence in manufacturing: High-volume and high-variety of process data. Big Data and Artificial Intelligence addresses how this translates to manufacturing for enhanced understanding and decision making. Using technologies including artificial intelligence and machine learning whereby computer systems enhance decision making.	**BIG DATA AND AI**	**2.15**	**3.05**
11 Digital Twin and Simulation: Digital model of a physical machine, system or process, to enable virtual verification and validation.	**DIGITAL TWIN AND SIMULATION**	**0.60**	**4.00**
12 Cyber Security: The technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorised access. This theme addresses how these technologies can be applied to manufacturing.	**CYBER SECURITY**	**1.10**	**2.20**
13 Augmented and Virtual Reality (AR & VR): Immersive technologies, including virtual reality, where a user is immersed into a simulated environment, and augmented reality, where virtual information is incorporated into a physical environment.	**AUGMENTED AND VIRTUAL REALITY**	**1.10**	**4.00**
14 Paper to Digital Processes: The process of performing paper-based tasks (documentation, sign- off, etc.) through the use of digital equipment (PC, tablets).	**PAPER TO DIGITAL PROCESSES**	**2.50**	**3.60**
15 Circular Economy: Keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and generate products and materials at the end of each service life. Remanufacturing is a process that returns a used product to a new condition, with a warranty, that matches the quality of the original product. It is a key part of a well-functioning circular economy.	**CIRCULAR ECONOMY**	**0.85**	**2.90**

1	2	3	4
INDUSTRY 4.0 SECTION		**AVERAGE COMPANY ATTAINMENT VS AVERAGE TARGET**	**AVERAGE COMPANY ATTAINMENT VS IDEAL TARGET**
16 Supply Chain Integration: Digital connection and coordination of all companies within a supply chain, from raw material supplier to end user, utilising shared information for operational efficiency.	**SUPPLY CHAIN INTEGRATION**	**1.55**	**2.70**
17 Servitisation: The transformation a manufacturing company undergoes to create new ways of doing business that combine products and services as parts of integrated offerings to the market.	**SERVITISATION**	**0.00**	**4.20**
18 Web based Customer Order tracking: Enabling digital customer ordering and tracking across different stages of manufacturing.	**Web based Order tracking**	**1.60**	**3.40**
19 Mass Customisation: Technique that combines the flexibility and personalisation of custom-made products with the low unit costs associated with mass production.	**MASS CUSTOMISA-TION**	**0.20**	**3.40**
20 Digital Manufacturing Readiness: Manufacturing readiness to determine a company's stage of development towards a new manufacturing process or innovation.	**DIGITAL MANUFAC-TURING READINESS**	**0.80**	**3.60**
21 Design for Manufacture: The integration of product design and process planning into one common activity, often using digital tools such as CAD and CAM, in order to design a product that is easily and economically manufactured.	**DIGITAL FOR MANU-FACTURE**	**0.35**	**3.10**
22 Continuous Improvement: The ongoing effort to improve products, services or processes, seeking incremental improvements over time.	**CONTINUOUS IMPROVEMENT**	**2.50**	**3.00**

The above table details the indicator areas in the 4Manufacturing survey which were covered with the companies in the study. Each area was discussed in detail with representatives from each company and the current level of attainment was determined. Further discussion took place on the medium and longer-term targets of each company, agreeing where the company should aim to be over the next 2-5 years.

No company representative stated that they wanted to achieve level 5 in every case, and this is completely acceptable. Some of the identified indicators are not applicable for every company, and in other cases, the investment or effort required to achieve level 5 would outweigh any benefits that might be achieved.

There was almost universal agreement that a targeted, sequential long-term development programme for each company is the most suitable, focusing initially on one or two development areas. This is discussed in more detail later in the document.

The pace of development can be accelerated by the provision of targeted support. It became clear from the study that, whilst all development plans must be company specific, the individual development areas which were identified showed a high degree of overlap.

Figure 1 summarizes the information in the above table. Figure 1 shows average company attainment against the company average target. The higher the score, the further away the companies are from their target.

Figure 1: Graph Showing Average Company Attainment Against the Company Average Target

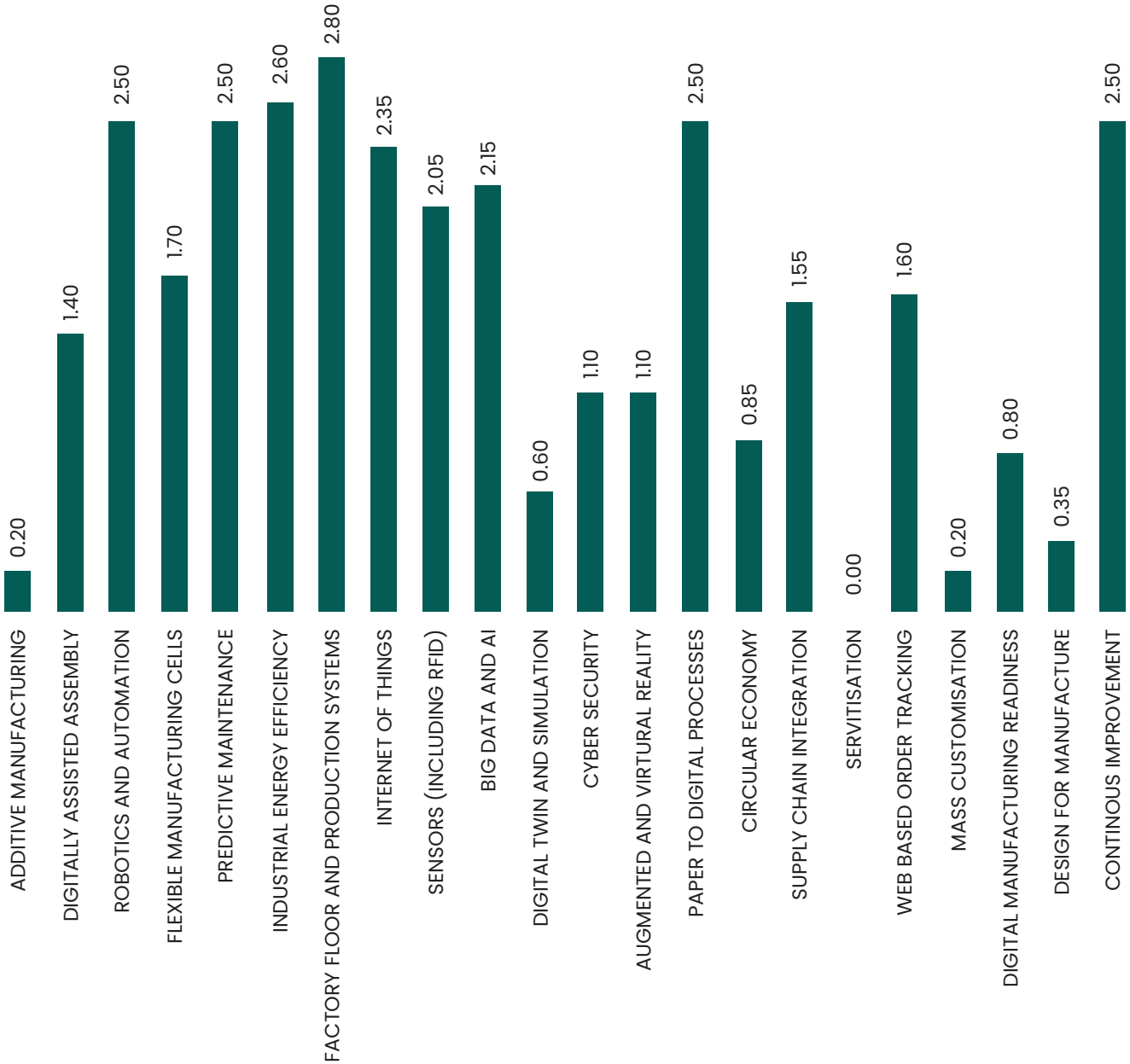


Figure 2 summarizes the information in the main table, relating company attainment to the ideal target. The higher the score, the further away the companies are from the target. As can be seen the companies acknowledge that they are a good distance away from the ideal in many of the sections.

Figure 2: Graph Showing Average Company Attainment Against the Ideal Target

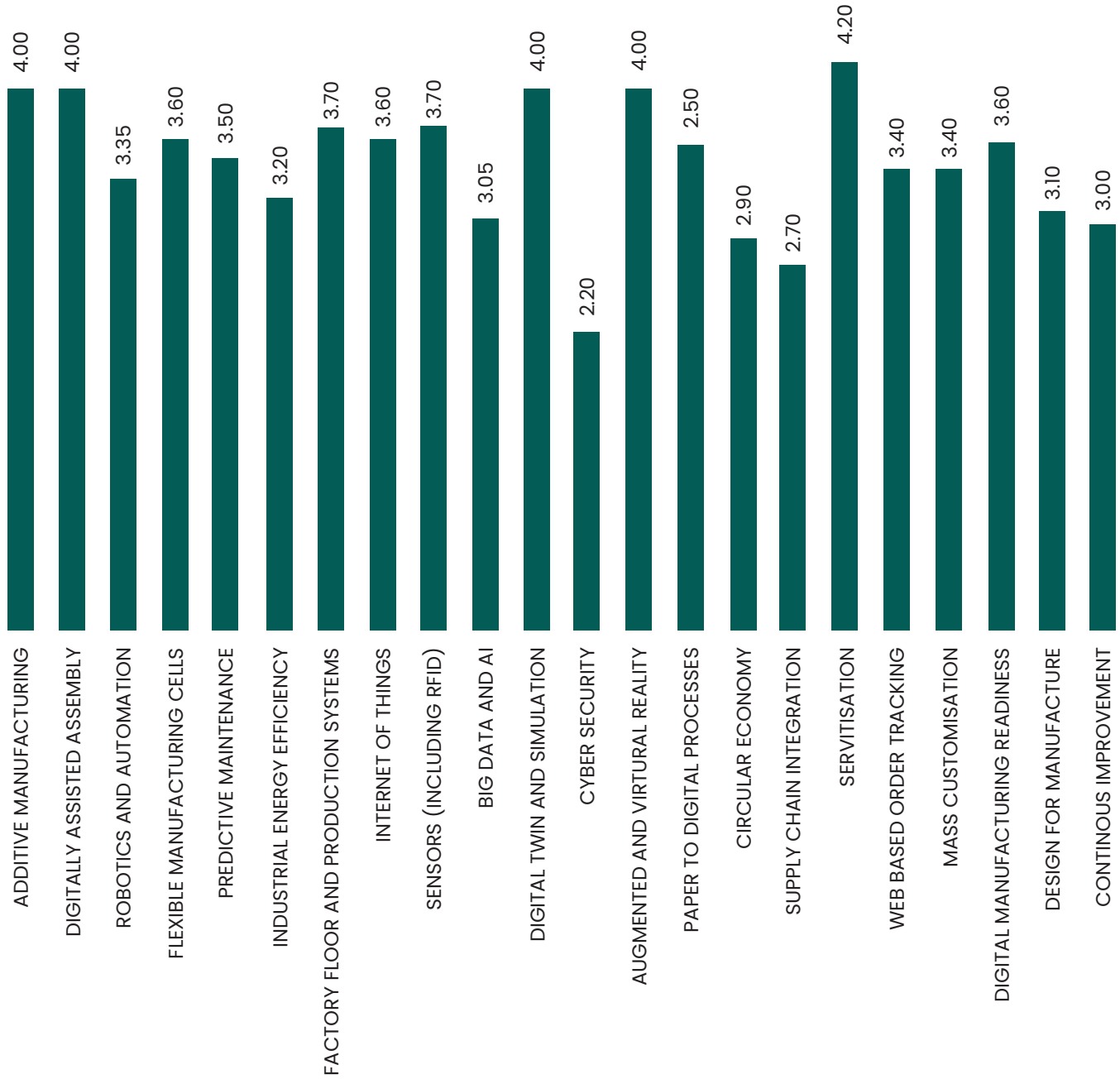


Figure 3 is key to the understanding of the findings from this project. We have colour coded graph into red, orange and green.

- The **green bars** reflect the development components which we do not believe it is necessary to focus on at present as they are either less relevant to the companies involved, or they are unlikely to provide the same return on investment as other areas.

- The **orange bars** are areas which the companies did not rate as highly important, but we believe are not as well understood as they could be and are much more important than is currently recognised. This is shown in the comparison between Figure 3 and Figure 4. In Figure 3, the orange bars are relatively low because attainment is low, but targets set by the companies are also low. Figure 4 shows the same bars when compared to the ideal target. Education and information is required around these areas, with a particular focus on presentation of case studies and practical demonstrations.

- The **red bars** are the areas where performance is low and a development focus is necessary. Although there are several components identified in the graph, these can be broadly summarized under three main headings

    1) Robotisation and automation to improve productivity
    2) Digitization, collection and use of data to improve business management
    3) Cybersecurity improvements

Figure 3a: Graph Showing Average Company Attainment Against the Company Average Target

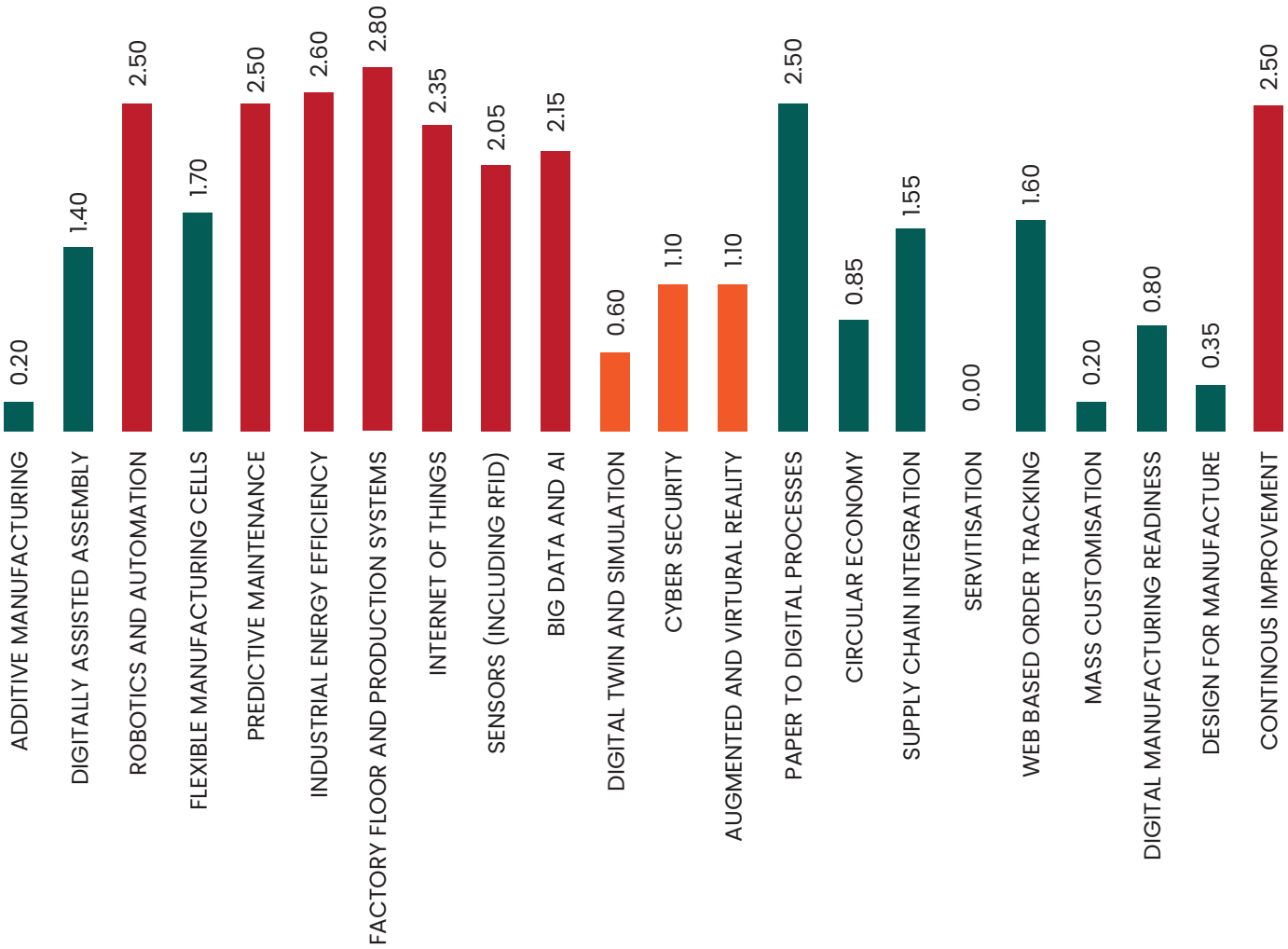


Figure 3b: Graph Showing Key Six Focus Areas for Average Company Attainment Against the Company Average Target

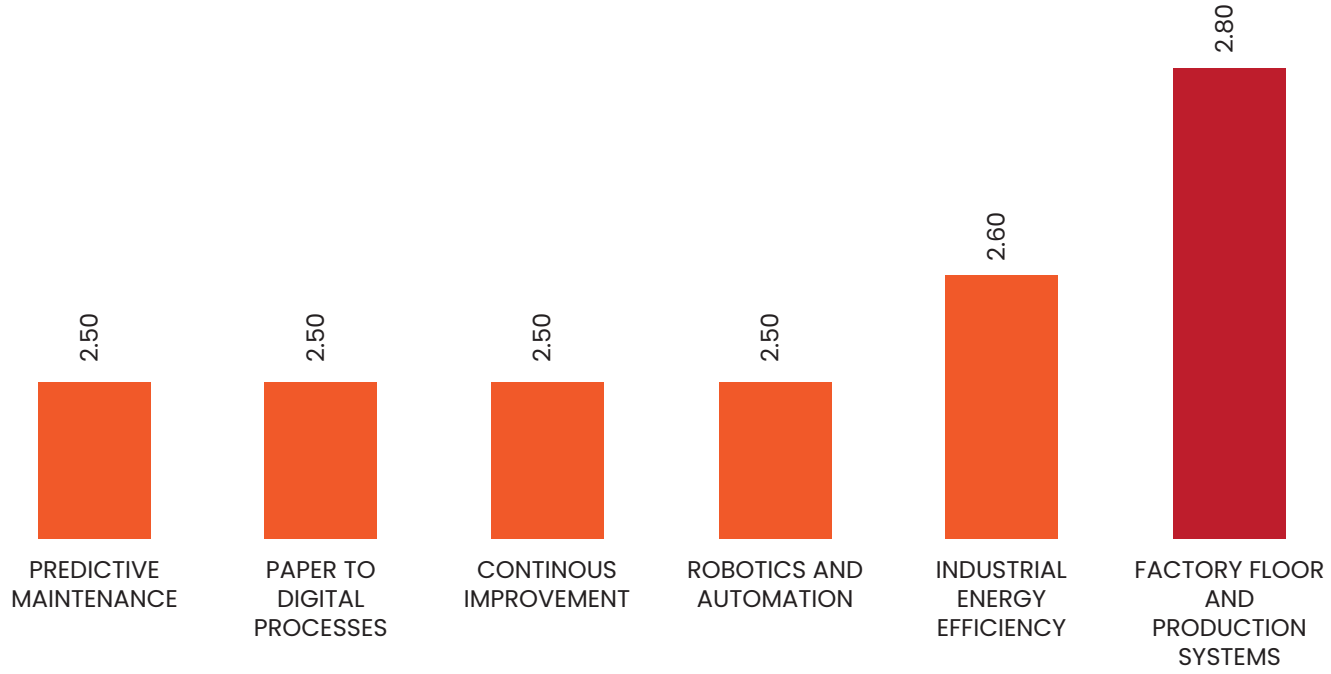
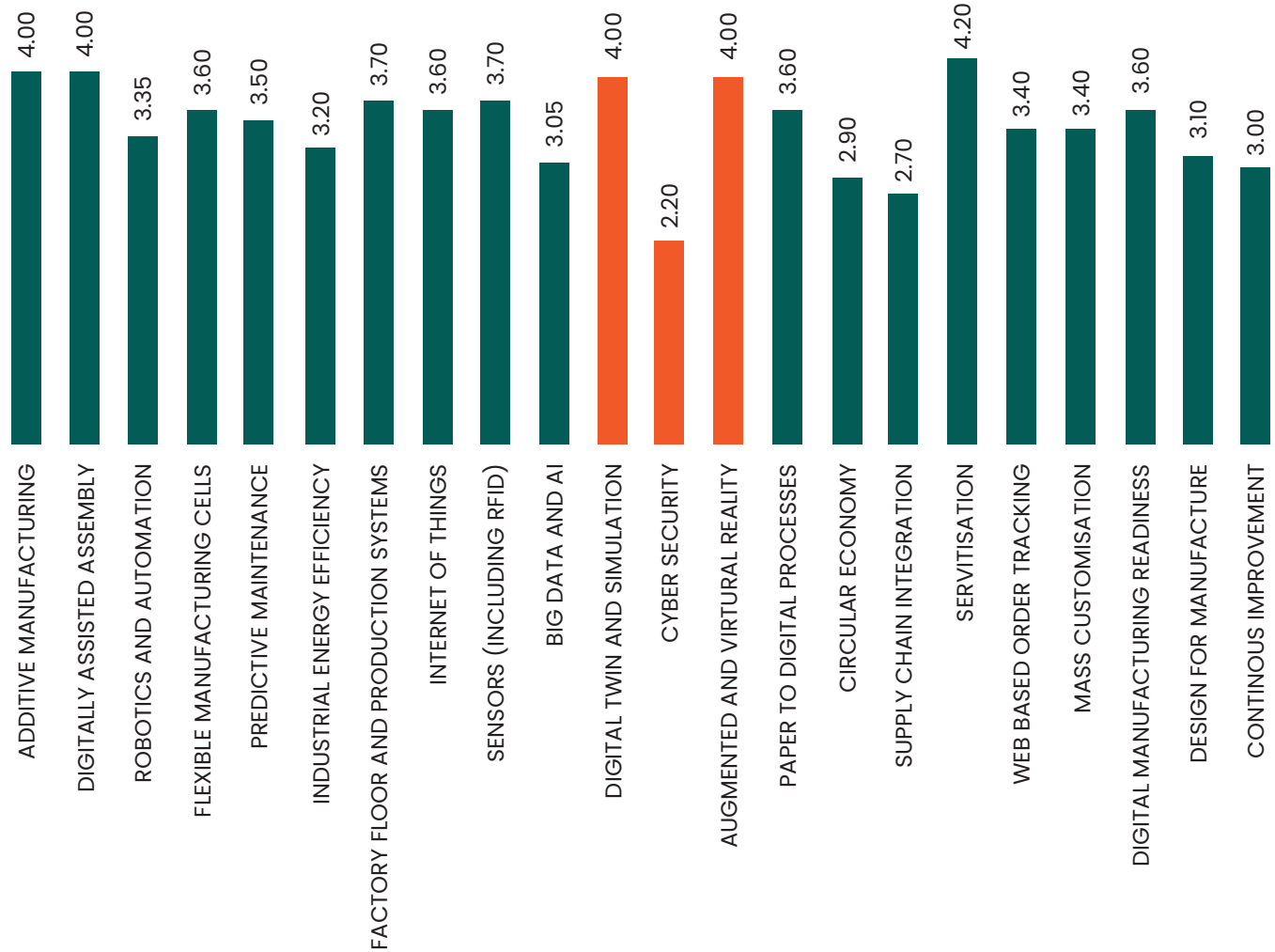


Figure 4a: The difference between average attainment and the ideal target for all components in the project



Figures 4a above is less important than **Figures 3a & 3b**, but the bars in orange identify areas which could potentially provide significant business advantage, but are not currently a priority for the organisations in the project.

Digital twinning is a process which could be used to model areas of improvement, and although its abilities are currently not recognised, it could offer significant benefit.

Augmented and Virtual reality functions are also not recognised as important but could actually be used to substantially improve accuracy of processes on the factory floor, improving product quality and food safety.

Most companies believed that their **Cybersecurity** was already adequate, but outside of this project there is much evidence that company cybersecurity is actually sub-standard in many cases.

Combined SWOT Analysis

SWOT analysis were created for each individual business in the project. Because much of this information is sensitive it cannot be individually outlined in this report. However the following SWOT anonymizes and combines the findings into one SWOT which is shown below. The diagram below summarises the findings and more detail is given in the following text.

STRENGTHS

1) Data is recognised as important by all of the companies in the project.
2) Some of the production lines in some of the businesses have good data capture facilities.
3) All of the businesses are collecting some data.
4) Most businesses undertake some form of data analysis and use for management on a regular basis.
5) Several businesses have ERP systems which can be used to collect and manage data, others have simple enough production processes to be managed effectively without an ERP system.
6) Almost all companies are willing to invest in business development if a return on investment can be demonstrated.
7) Businesses are prepared to take a long-term view on investment.
8) All companies have a very clear line of authority.
9) Most businesses have very good broadband.
10) Most businesses are single site which makes management easier.

WEAKNESSES

1) Not enough data is collected or effectively used.
2) The equipment in almost all of the factories is not IOT ready and will not enable full connectivity.
3) The tools used to collect and analyse data are predominantly manual
4) Most data infrastructure is not currently centralized and connected.
5) Predictive analytics are not used in almost all the factories to minimize machinery down time.
6) In many companies, data is analysed too infrequently to respond to emerging challenges.
7) Companies do not have a clear understanding of all the advanced technologies which are available to impact production and productivity.
8) Factory floor space is a challenge in places, making it difficult to automate.

THREATS

1) A rising minimum wage could eliminate profitability
2) A lack of available skills in the workforce restrict potential change
3) Comparative productivity of individual NI food businesses is unknown
4) The lack of effective data collection and use and data integration means that meaning that management decisions are made on inadequate information
5) A lack of flexibility of the production lines restricts production range
6) Access to raw material supply is a major threat
7) NI could lose some access to the GB market because of the additional documentation which is required to supply GB.
8) A lack of ability to prove sustainable production practices could limit the number of markets which are open to NI companies in the future.
9) Changing customer demands will require investment in new equipment. Underinvestment will result in loss of business.
10) The ability to prove sustainability is going to be vitally important to be able to demonstrate sustainability improvements.

OPPORTUNITIES

1) Effective data collection and use for management and increased automation are the two largest opportunities for NI businesses.
2) Automation of data collection through smart sensors should be considered.
3) Increasing data capture from the production floor
4) Sharing of performance data analysis across Senior Management Teams within companies will substantially raise awareness of improvement options
5) Digital modelling of the production lines can identify improvement options
6) Automation at end of line to replace manual labour
7) Automation at identified pinch points to improve factory productivity.
8) Raise knowledge of advanced equipment
9) Workforce training to enable use of new equipment and processes
10) Provision of specialist advice to guide implementation.
11) Use of relevant case studies and visits to guide factory investment.

Strengths

A range of common strengths were identified;

1) Data is recognised as important by all of the companies in the project.
2) Some of the production lines in some of the businesses have good data capture facilities.
3) All of the businesses are collecting some data.
4) Most businesses undertake some form of data analysis and use for management on a regular basis.
5) Several businesses have ERP systems which can be used to collect and manage data, others have simple enough production processes to be managed effectively without an ERP system.
6) Almost all companies are willing to invest in business development if a return on investment can be demonstrated.
7) Businesses are prepared to take a long term view on investment.
8) All companies have a very clear line of authority.
9) Most businesses have very good broadband.
10) Most businesses are single site which makes management easier.

Weaknesses

A range of common weaknesses were identified;

1) Not enough data is collected to be aware of all performance challenges.
2) Not all data already collected is effectively used.
3) The equipment in almost all of the factories is not IOT ready and will not enable full connectivity.
4) The tools used to collect and analyse data are predominantly manual, and the majority of data is typed in (leading to transcription errors).
5) Data infrastructure is not currently centralized and connected. For most of the businesses, factory ERP systems do not communicate directly with other databases or software systems in the factory, requiring manual intervention, introducing error and making analysis difficult.
6) Predictive analytics are not used in almost all the factories to minimize machinery down time.

7) In many companies, data is analysed too infrequently to respond to emerging challenges.

8) Many companies do not have a clear understanding of all the advanced technologies which are available to impact production and productivity.

9) Factory floor space is a challenge in places, making it difficult to automate.

Opportunities

A range of common opportunities were identified, broken into several development areas;

1) Data

- Effective data collection and use for management is a real opportunity. No business in the programme has yet optimized this, and most data is currently decentralized. Software integration to manage data is a critically important development area.
- Automation of data collection would allow additional, more accurate data flow which could be used for management.
- Increasing data capture from the production floor would substantially benefit the performance of the majority of businesses in the programme. This data would include (but is not limited to):
- Production flows
- Product quality
- Completion status
- Spare capacity
- Production bottlenecks
- Enabling the sharing of performance data analysis across Senior Management Teams within companies could substantially raise awareness of improvement areas within individual businesses.

2) Technology

- Use of sensors to make traditional machinery 'smart' could substantially increase the amount of data which is collected and would provide significant benefits.
- Automation of end of line labour is wanted by almost every company to replace jobs which are highly manual, repetitive and don't add value.
- Digital modelling of the production lines may be able to identify the most appropriate use of industry 4.0 within the factory environment.
- Product finishing is an area of real interest (e.g. papers for traybakes, robots for traying up products, or product finishing). Vision driven equipment could be or interest here.

- A wide range of options exist to enable automation within many of the companies in the project.
- Technology/automation should be selected on best-fit/best in class rather than being restricted to what would work with certain software systems and/or hardware.
- Automation at identified pinch points would improve factory productivity and several businesses are interested in studying this.
- Raising knowledge of the industry 4.0 technology which is available would assist companies in choosing which technology to implement.

3) Workforce

- The workforce in most businesses is relatively open to change, but will need to be carefully worked with to build the skills and the processes to deliver this.
- A carefully targeted staff training programme will enable change to be implemented.

4) Support and Information

- Access to trained people would enable implementation.
- Obtaining ongoing access to specialist advice could help with implementation.
- Relevant case studies would be very useful in guiding investment into the factory.
- Receiving financial support for improvements/automation would encourage uptake of Industry 4.0 technology.

Threats

A range of threats were identified, broken into several different focus areas;

1) Staff and Workforce

- A rising minimum wage is a threat to the ongoing profitability of many of the businesses.
- Many businesses have identified a lack of available skills in the workforce as their most significant challenge.
- Skill levels and knowledge of the team is a challenge – the product and production process is specialized and needs to be carefully handled.

2) Data

- Productivity of individual NI food businesses in comparison to other factories is unknown and it is possible that it is below comparable factories in GB, Ireland and mainland Europe, meaning that NI businesses are becoming increasingly uncompetitive.
- The lack of data collection and data integration means that company performance

is often unknown, meaning that management decisions are made on inadequate information, or alternatively that areas for improvement are not identified at all.

- The artisan approach of some companies can lead to a large number of SKUs, resulting in slower production processes that can make effective data collection challenging.

3) Equipment and material

- A lack of flexibility of the production lines could be a challenge and can restrict the range of production from each line.
- Access to material for processing was raised as an issue by several companies.
- The artisan approach, resulting in a large number of SKUs, reduces opportunities for automation.

4) Markets

- A loss of markets for NI products is a recognised threat because of the additional documentation required to supply GB.
- A lack of ability to prove sustainable production practices could limit the number of markets which are open to NI companies in the future.

5) Customer focus

- Changing customer demands will require investment in new equipment. Underinvestment will result in loss of business.
- The ability to prove sustainability is going to be vitally important to be able to demonstrate sustainability improvements.

6) Development Programme

- There is the desire to move forward quickly, but development could be carried out across a wide number of fronts, and it is important to focus on the development of a manageable number of processes at one time.

The key development areas identified during the production of the SWOT analysis are discussed and addressed in the next section.

Focus Areas

A summary of the key areas for focus are shown in the diagram below and are more fully explained in the following text.

DATA FOR MANAGEMENT AND DATA SECURITY

- Only some factories have the ideal combination of high-speed broadband supply and adequate network points/strong wireless coverage across the whole factory.
- The majority of current equipment does not have effective data capture capability. There is a lack of real time information flow and data analysis to aid factory management. Much data is collected in manual format
- Data is recognised as important by all the companies, but the pathway to optimum data management is not clear for most.
- Most companies have a range of non-interoperable software systems across the production floor. There is often an overall lack of connectivity between factory floor systems, financial systems and central data management systems.
- Few companies have specialist data analysts who provide information to management to make data based decisions.
- Data security was identified as a risk by a several companies, although the risk is probably more substantial than most realise.

KNOWLEDGE/UNDERSTANDING

- There is a lack of understanding of available advanced Industry 4.0 equipment which could be applied to specific situations in the individual business.
- There is a lack of case studies to demonstrate implementation and use of advanced technology.
- Companies are not aware of organisations or companies which may be well placed to help their business.
- Many companies don't know the range of advancements that are available, and almost no comparison is happening between comparable businesses, meaning that many factories not actively looking at what changes are realistically possible.
- Knowledge and skill levels of staff were identified as a challenge to effective implementation.

STAFF AVAILABILITY AND DEVELOPMENT

- Competition for available labour is increasing. The majority of factories in the programme are not highly automated and are dependent on a readily available labour pool.
- Concern has been expressed about the current ability of staff to use advanced equipment, and their willingness to do so.
- Almost all companies identified the need for substantial staff training if the technological levels in the factory were to be substantially raised. This would focus on the use of the interfaces, the importance of the data collection and how it would be used to improve company profitability.
- Several companies highlighted the need for culture and attitude change across the floor staff to encourage the uptake of new practice. Some companies identified that the unionisation of staff inhibited the implementation of new practice.
- Senior Management need more time to focus on business development. Any programme which helps Senior Management to make rapid, effective decisions which enable the implementation of change is likely to be highly effective.

FINANCING SOLUTIONS

- Financing change is a significant challenge and can retard development.
- Almost all of the companies were clear that a development budget was available, but that there needed to be a proven return on investment, preferably within 18 months.
- There is a need for a cost benefit analysis for a range of new technologies. Access to these would encourage investment.

The analysis has clearly identified a range of areas where support can be focused to help Northern Ireland food businesses to develop their competitiveness. We have summarized these development areas below.

Data for management and data security

None of the companies in the study made full use of the opportunities which data collection, analysis and use presents. All the companies were aware of this, and it was highlighted as one of the most important development areas. It was clear that many of the managers involved in the project have thought through the area of data collection and they have identified a range of challenges which need to be addressed. Not all of the following apply to every business, but they are a good summary of those which are facing the group as a whole.

- Only some of the factories have the ideal combination of high-speed broadband supply and adequate network points/strong wireless coverage across the whole factory.
- The equipment in the factories is a range of types, ages and technological advancement. The majority of the equipment does not have effective data capture capability.
- Just under half of the companies in the study were almost completely dependent on manual data collection.
- None of the companies collect all the data that they believe they should. There is a lack of real time information flow and data analysis to aid factory management.
- Data is recognised as important by all the companies, but the pathway to optimum data management is not clear for almost all.
- Almost all of the companies had a range of software systems across the production floor, many of which are not interoperable and are not capable of sharing data effectively, meaning that data is decentralised.
- The majority of the companies do not a have an ERP system which is capable of combining a range of data flows, interpreting the data and producing a range of management information. There is an overall lack of connectivity between factory floor systems, financial systems and central data management systems.
- The data requirements for each company are different, as are the key performance indicators.
- Virtually no companies have specialist data analysts who provides information to management to make data based decisions.
- Data security was identified as a risk by a several companies, although the risk is probably more substantial than most realise. Some companies are at less risk because

their equipment is not 'smart' and they do not carry significant volumes of data.

Staff Availability and Development

- Most, but not all companies expressed concern around rising minimum wage and the growing disincentive to pay staff to deliver highly manual, repetitive tasks. A rising minimum wage is challenging for a low margin industry. Paying above minimum wage to attract additional staff would strongly impact the already low profitability.
- There is a smaller overall labour pool caused by both Brexit and Covid meaning that the competition for available labour is increasing. The majority of factories in the programme are not highly automated and are dependent on a readily available labour pool.
- There has been a reduction in skills training as a result of Covid, meaning that availability of specialized labour is substantially reduced e.g. delivery drivers.
- Many of the company representatives expressed concern about the current ability of staff to use advanced equipment, and their willingness to do so. One manager noted that all staff were capable of working phones and if equipment could be implemented which was operated by a similar interface to a phone, this would accelerate uptake.
- Almost all companies identified the need for substantial staff training if the technological levels in the factory were to be substantially raised. This would focus on the use of the interfaces, the importance of the data collection and how it would be used to improve company profitability.
- Several companies highlighted the need for culture and attitude change across the floor staff to encourage the uptake of new practice. Some companies identified that the unionisation of staff inhibited the implementation of new practice.
- A highly significant challenge identified during the research was that there is a major challenge around freeing up Senior Management to focus on business development. Any programme which helps Senior Management to make rapid, effective decisions which enable the implementation of change is likely to be highly effective. Addressing the upskilling requirements of the workforce as a whole would help to bridge this gap.

Knowledge/Understanding

- There is a lack of understanding of advanced Industry 4.0 equipment which could be applied to specific situations in the individual business.
- There is a lack of case studies to demonstrate implementation and use of advanced technology.
- Companies are not aware of organisations or companies which may be well placed to help their business.

- Many companies don't know the range of advancements that are available, and almost no comparison is happening between comparable businesses, meaning that many factories not actively looking at what changes are realistically possible.
- Knowledge and skill levels of staff were identified as a challenge to effective implementation.

Financing Solutions

- Financing change is a significant challenge and can retard development. Almost all of the companies were clear that a development budget was available, but that there needed to be a proven return on investment, preferably within 18 months. A lack of understanding of what the likely payback is holds businesses back.
- There is a need for a cost benefit analysis for a range of new technologies. Access to these would encourage investment.

Delivering Change

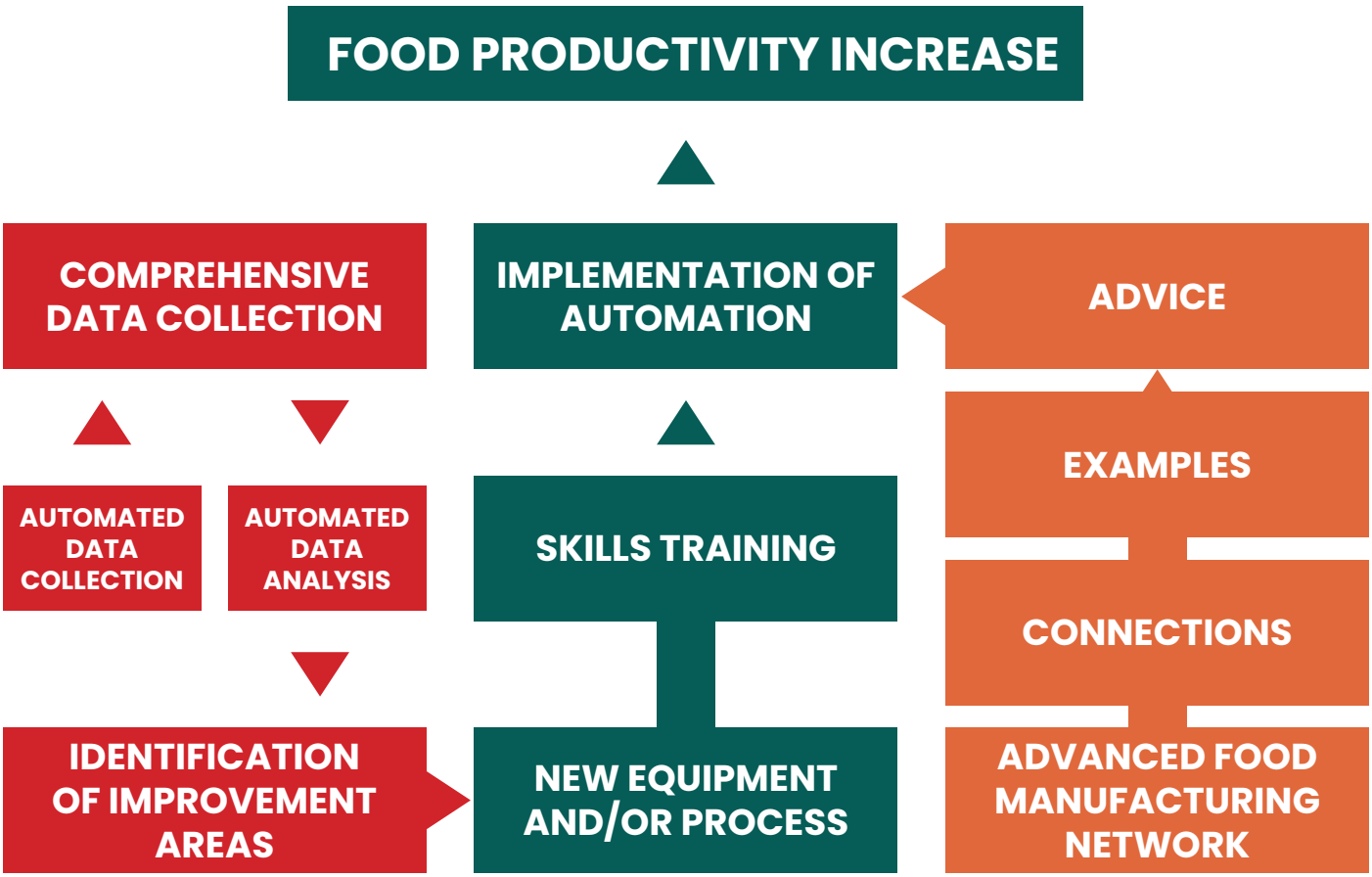
Clear practical evidence is required to deliver change within a factory environment. These include the following;

1) Knowledge about current performance
2) Knowledge about potential performance
3) Knowledge about specific methodologies which can be used to deliver the necessary performance improvement.
4) Knowledge about specific software which can be used to provide solutions
5) Knowledge about specific equipment which can be used to deliver solutions
6) Practical demonstration of the likely return on investment
7) Availability of the necessary skills to deliver the required changes
8) Finance available to implement change
9) Measurement of the effect of the changes which have been implemented and proving of the return on investment

Addressing each of the above components will enable companies to increase the uptake of new technology.

DEVELOPMENT AREAS

A range of focused development options have been identified from the data collection and analysis in the project. They are shown in the diagram below and then described in further detail in the following paragraphs. The key improvement areas can be summarised as **1) data collection and use for management (red), 2) the identification of new practice and assistance with implementation (orange) and 3) the delivery of skills training and automated equipment within the factory (green).**



The following diagram provides additional detail around the key development areas

DATA MANAGEMENT

- All businesses are interested in collecting, aggregating, analysing and using data effectively to manage their business.
- All know that this is not being delivered as effectively as it could be.
- No business has a production floor which is capable of automatically collecting a full range of data.
- Equipment modification is required to enable automated data flow
- No business has a centralised system currently capable of aggregating all the data generated within the business.
- Addressing the decentralised approach to data capture, storage and analysis is a must.

CONNECTIONS

- Many organisations are working in the technology and data management
- Many of these specialist organisations can deliver significant benefit
- It is important to create a dynamic and constantly developing database of organisations which can help NI companies to improve their productivity and profitability.
- A food network can function as a hub, collating information, analysing and interpreting it, and communicating it clearly to businesses where it is of relevance.

AUTOMATION

- The investigation of end of line packaging automation/ robotization options and the application of these is seen as important by almost all of the companies.
- The need to reduce dependency on manual labour is a large driver.
- All of the businesses in the network are interested in automating to a great
- Focus is on the most repetitive end-of-line jobs which are highly manual and do not add value.

SKILLS DEVELOPMENT

- A trained, skilled and motivated workforce is essential to effectively implement industry 4.0.
- The provision of useful, focused, short and inexpensive training facilities and courses would accelerate uptake.

AFM NETWORK

- Businesses are keen to introduce new ideas to business management and production process.
- Business managers are time-poor and need useful, relevant information quickly
- An ongoing operational advanced manufacturing network can be of use to local businesses by identifying technology, processes, software and analytical techniques and introducing them to businesses

The following section provides further commentary and information around each of the identified development areas.

1) Use of data for management needs to be improved

- All businesses are interested in collecting, aggregating, analysing and using data effectively to manage their business, but know that this is not being delivered as effectively as it could be. No business has a production floor which is capable of automatically collecting the full range of data. Most machinery and equipment cannot collect data. There is a need to modify equipment to enable data flow and then to use this data to manage the production process.
- No business has a centralised system currently capable of aggregating all the data generated within the business. In reality, the majority have multiple systems currently incapable of communicating with each other. This means the transfer of information must happen either through third party systems, or more often, manually, meaning that errors are almost inevitable. Addressing the decentralised approach to data capture, storage and analysis is a must.

2) Automation is of interest to all companies

- The investigation of end of line packaging automation/robotization options and the application of these is seen as important by almost all of the companies. The need to reduce dependency on manual labour is a large driver. All of the businesses in the network are interested in automating to a greater or lesser degree mainly around the most repetitive end-of-line jobs which are highly manual and do not add value.

3) Availability of training and skills development is important

- The availability of a trained, skilled and motivated workforce is vitally important to effective implementation of industry 4.0. A focus on data collection to guide management requires accurate (and ideally real-time) data collection to enable rapid interventions to prevent problems and maintain factory throughput.
- The provision of useful, focused, short and inexpensive training facilities and courses would accelerate uptake.

4) Making connections to maximise the productivity and effectiveness of food production

- Many organisations are working in the technology and data use space in Northern Ireland, Ireland and GB. Many of these specialist organisations can deliver significant benefit to NI food business, but the majority of NI companies are not aware of who they are or how they could benefit their own business.

- It is important to create a dynamic and constantly developing database of organisations which can help NI companies to improve their productivity and profitability.
- A food network can function as a hub, collating information, analysing and interpreting it, and communicating it clearly to businesses where it is of relevance. A central communication process is necessary to be able to communicate useful information. This is not necessarily focused on social media and a website (although these are important), and it needs to focus specifically on delivery of information direct to appropriate businesses, based on knowledge about that business.

5) An Automated Food Manufacturing Network can help to move the sector forwards

- It is clear that those managing their businesses are keen to introduce new ideas to business management and production process.
- It is also clear that those managing each business are time-poor and need useful, relevant information quickly.
- An ongoing operational advanced manufacturing network can be of use to local businesses by identifying technology, processes, software and analytical techniques and introducing them to the business
- The 4Manufacturing assessment is useful for understanding the general position of each company across a wide range of factors which affect factory productivity and performance.

SECTION TWO: AVAILABLE SUPPORT

NORTHERN IRELAND LEVEL SUPPORT

Summary of General Support Areas

The main support areas for businesses in Northern Ireland are as follows;

Invest Northern Ireland (NI) - provides a wide-ranging support service to businesses in Northern Ireland. Read about Invest NI's support for developing products and services.

The **Enterprise Europe Network (EEN)** - offers help and advice to businesses.

Business incubators - nurture new companies by providing premises along with business, financial and technological support.

Business innovation centres help to support and develop innovative business projects. Read more about business innovation centres and support networks and facilities for R&D.

UK Government and European Union schemes encourage manufacturing through a range of official initiatives, partnerships and programmes.

Business networks, trade associations and professional bodies provide a useful source of information and best practice. Examples include the Chambers of Commerce, Trade Association Forum, the Confederation of British Industry, the Engineering Employers' Federation and the Institution of Mechanical Engineers.

Training providers can develop innovative thinking and practices.

Knowledge Transfer Partnership (KTP) scheme help to identify universities and research organisations with expertise relevant to a project that your business is undertaking. Read more about Knowledge Transfer Partnerships.

Engineering departments in universities can offer specialist information and advice. Find out how to work with UK universities and colleges.

Specific Information on NI Support Areas

Industrial Strategy Challenge Fund (ISCF) from InvestNI

The ISCF is open to companies from Northern Ireland and financial support for research & development of commercial solutions which overlap with Industry 4.0 solutions. Working together the Government, businesses and academics have identified the biggest core industrial challenges where the UK has a world-leading research base and there is a large or fast growing and sustainable global market. These challenges have been aligned to the four 'Grand Challenges' set out in the Industrial Strategy White Paper. The grand challenges are: Artificial Intelligence (AI) and the data economy, Clean growth, The future of mobility, Meeting the needs of an ageing society

Invest NI can help to identify the most appropriate ISCF funding call, provide financial support for preparing an application, advise on funding rules, regulations and eligibility criteria. Assist businesses to find the right partners through e.g. the Enterprise Europe Network (EEN) and the Knowledge Transfer Network (KTN). Signpost businesses to further specialist events and advice

KTN – 4Manufacturing (Northern Ireland)

KTN are working with a small cohort of regional partners to test and refine the 4Manufacturing approach and the digital tool for market, through capacity building of the business advisors in the region. One of the early partners are Invest NI, who are working with SME manufacturers to help them adopt digital technologies in their quest to align with the objectives of #Industry4.0. The 4Manufacturing tool has been focused on manufacturing businesses in Northern Ireland to improve their productivity and their overall competitiveness against businesses across the whole of the UK, and this is now being trialled in the Food Sector.

AMIC – The Factory of the Future – Queen's NI

Responding to the needs of industry, Queen's has led a proposal within the Belfast Region City Deal (BRCD) to establish Northern Ireland's own Factory of the Future. The Advanced Manufacturing Innovation Centre (AMIC) is a proposal that will establish a new facility that will integrate all the streams of manufacturing and materials technology development within Queen's. It will provide a collaborative working space in which the latest IDTs can be deployed for experimental and pilot-production purposes. AMIC is being established to integrate with UK and international digital manufacturing initiatives to act as a connector to the UK's High Value Manufacturing Catapult centres. It is intended to support local companies in accessing innovation funding, particularly under Industry 4.0 programmes flowing from the UK's Industrial Strategy. The capabilities of AMIC will be shaped to ensure that Northern Ireland is strategically placed to address the challenges, while exploiting the opportunities afforded by Industry 4.0.

Things Connected Service NI (By Digital Catapult)

This is a programme led by Ulster University which invites SMEs to make use of the Things Connected Internet of Things (IoT) network to tackle long-standing challenges. Things Connected NI is delivered by a consortium of partner organisations including all of the councils in Northern Ireland and a number of the country's leading private sector industry technology experts and business leaders. The low power, wide area network (LPWAN), which covers the whole country and is free-to-use, enables SMEs, makers and researchers to develop IoT solutions that need to communicate with services across large geographic areas while using the least amount of energy possible. The programme is supported by Ulster University's world-leading research in connected health and data analytics. It has also developed a new IoT Masters programme to respond to the emerging importance of careers in the field across all sectors.

Digital Catapult (NI)

Digital Catapult Northern Ireland connects industry and academia to build innovative partnerships, helping organisations of all sizes to work smarter by originating and adopting advanced digital technologies and is intended to accelerate the adoption of emerging technologies for commercial benefit. It has a wide network of collaborative partners across multiple technologies, supporting

knowledge transfer and creating opportunities for local companies. Working closely with InvestNI, the Department for the Economy and FSNI, Digital Catapult Northern Ireland introduces businesses to new possibilities by sharing use cases that demonstrate how emerging technologies are being deployed in industry.

It helps businesses to leverage the opportunities being presented, particularly by artificial intelligence and immersive technology.

- Through the Immersive Lab, start-ups, scale-ups and organisations of all sizes can experience the latest immersive technologies, including virtual reality and augmented reality. This space can also be used to demonstrate and test their own immersive content.
- Through the internet of things (IoT), organisations can gather and process data, which can then be analysed using artificial intelligence to deliver key insights.
- Businesses can also apply to join the Digital Catapult Machine Intelligence Garage programme, which opens a global door to accelerate their AI capabilities and ambitions.

A report by Deloitte on Industry 4.0 in 2015 made some comments which are still highly relevant:

"Machines are moving from collections of separate devices to singular collaborative networked systems which can accept and communicate data allowing for operational improvements to occur both automatically, or through user intervention"

and

"Manufacturers will not only need to attract employees who are comfortable and skilled to operate new technologies, but will face increasing competition for data scientists and database managers skilled in interpreting and leveraging intelligence from new data streams. Manufacturers will also need to identify entrepreneurial talent internally and externally to work in emerging, dynamic business environments considering opportunities holistically across the business, and be prepared to act outside of traditional organizational silos."

It is important that support is provided which allows our companies to develop both their factory floors and their employees.

GAPS IN SUPPORT

It is clear from the work carried out in this study that there are some highly specific needs within food businesses in Northern Ireland. Addressing these gaps will accelerate the progress of food companies. The main gaps are as follows;

1. Support to measure and understand current factory performance in detail, with a really key emphasis on industry specific measures which can be directly benchmarked against other similar companies
2. Provision of or significant support in employing analytic specialists to work alongside

the increasingly time deprived senior management

3. Specific on-site intensive training initiatives with experts to address company specific issues in the adoption of industry 4.0 techniques
4. Assistance to digitally model one or two production processes to create an initial case study
5. Ongoing support for introduction and use of robotics and AI
6. Funding to replace outdated / unsupported hardware and software with modern smart capable replacements
7. Organising company relatable case study presentations and visitations
8. Provision of a technology strategy manager or support in employing / contracting a technology expert to work through and document the potential industry 4.0 related improvements
9. Provision of specialised training which can raise the performance of senior production staff and enable them to train and build their teams.

SECTION THREE: RECOMMENDATIONS TO ADDRESS THE DEVELOPMENT NEEDS

RECOMMENDATIONS TO ADDRESS THE DEVELOPMENT NEEDS

To address the identified development needs, we recommend the following:

Provide Specific Expertise for Support of NI Food Companies

It is clear that there is a need for targeted information and support for food companies in Northern Ireland which could be provided by Invest NI and by a range of other organisations and businesses. These areas include:

1) **Data expertise:** There is a need for a team which can investigate and develop data collection, analysis and use within production environments. This team would understand the general processes within a factory environment, focusing on:

    a. Identifying methods and suppliers which can enable data collection from factory equipment.

    b. Identifying and implementing software solutions which can gather and integrate data flows from the factory floor.

    c. Identifying effective methodologies for summarising and using data for effective management.

2) **Automation expertise:** There is a need for a team which can investigate the potential for automation within food factories and provide advice on optimum methodologies.

    a. Identification of suppliers which can provide automation solutions for companies

    b. Creation of a continually updating directory of automation suppliers and available support

    c. Provision of implementation support

3) **Delivery or signposting of Skills Training and Development:** There is a need for assistance around the provision of targeted skills training to enable effective uptake of automation.

a. Identification of/modification of skills courses which deliver effectively against data and automation needs

b. Provision of refresher training

Much of the above support can be delivered through the combination of support from Invest NI and through the operation of a Food Network. These recommendations are shown below.

Deliver Targeted Support by the Invest NI Agile Team

Invest NI have a group of experts known as the 'Agile Team' who have expertise around 4Manufacturing and the improvement of factory process.

The work with the businesses in the study identified considerable potential for development, much of which can be assisted by the NI Agile team. A range of action areas have been identified for each company and the Agile team can bring expertise to each of these areas. Often the development areas identified by the companies have not been undertaken because the companies primarily either lack the time or the expertise to investigate and implement solutions.

Five of the businesses from the network indicated their willingness to become involved immediately with the Agile Team and one business has indicated willingness to work with the team from January 2022 onwards. The Team would be able to work with a Food Network to identify solutions (where available) and project work/funding to enable the development of solutions where they are not available.

Develop an Effective Advanced Food Manufacturing Network

An Advanced Food Manufacturing network would be a useful support for the delivery of advanced manufacturing information. The function of the network would be:

1) **To function as first point of contact for any company wishing to undertake advanced automation or practice**

2) **To signpost expertise in automated data collection**

   a. Methods of collecting data on production lines (making machines smart)
   b. Methods of collecting data from production lines and storing and organising it
   c. Methods of analysing data and turning it into useful management information
   d. Identification of equipment and/or software which can be implemented to manage factory data really effectively

3) **To signpost expertise in automation**

   a. Creation of a library of information on automation equipment
   b. Creation of a library of information on automated data management

4) **To signpost appropriate skills training and/or training material**

   a. Data handling and analysis
   b. Turning data into information
   c. Managing advance equipment

5) **To create symbiotic relationships with a range of organisations to connect information and ensure that it is communicated to the maximum number of businesses. The organisations include:**

   a. NIFDA
   b. Invest NI
   c. Development organisations
   d. Research organisations
   e. Technology providers
   f. Skills providers
   g. Cybersecurity providers

6) **To effectively communicate through the organisation of events and the delivery of information flow to keep businesses informed with highly relevant, targeted material.**

   a. Identification of knowledge gaps which need to be addressed
   b. Communication of solutions to businesses within the network

SECTION FOUR

CASE STUDIES

During the execution of this study we have identified a wide range of case studies which could be applicable to companies in Northern Ireland. The majority of the case studies have been identified using published literature and websites to ensure that relevant examples could be found. Broadly, we have found that there are existing case studies available to show businesses what might be possible, and how the implementation of the project will be managed.

We identified around 50 potential case studies which could be relevant to companies within the programme. These have been cut down to a smaller number of studies for inclusion in this report. We have listed the case studies under their key delivery output. Three case studies are identified from Nottingham University, and it is clear that this is an institute with which the NI industry should be interacting.

Use of Case Studies

A range of selected case studies are shown below. These case studies focus on a range of components which could be implemented in some or all of the factories in the project.

Reduction of downtime

Case Study: Premiere Moisson

Première Moisson is based in Canada and specializes in the manufacture of bakery and pastry goods. The challenge facing the company was to increase machine availability (though reduced downtime) and to maintain a high production line speed (running as fast as 15,000 units per hour). The company wanted to increase data collection from the lines and to use this information to control the process to enable the high line speed and downtime reduction. They partnered with a technology company (Worximity) to implement smart sensors to provide real-time monitoring and data flow. These sensors enabled production speed to be compared to the necessary targets. The system was linked to alarms and automatic emails if under performance was identified, allowing corrections to be made. The analytic system was initially implemented on one line the information used to manage it. The team quickly saw returns from the installation and connected a second production line. Première Moisson saw clear, attributable improvement across production KPIs. These included:

1) A 58% increase in productivity
2) A decrease of 29% in the amount of downtime
3) A 6% decrease in the direct labour cost per unit
4) Increased production by over 6000 units per month

Quality Monitoring

Case Study: Brewnet

The University of Nottingham has been working with the University of Leeds and Totally Brewed (a SME craft brewer) to demonstrate how low-cost ultrasonic sensors and machine learning can be used to monitor craft beer fermentation processes. Real time sensor measurements were used to enable brewers to predict the optimal time to end the fermentation and to provide warning of problems occurring during the process. Two methods were identified to predict ABV%, and both were successful, allowing ongoing monitoring of beer production, and intervention if problems are detected.

Source: https://ifst.onlinelibrary.wiley.com/doi/10.1002/fsat.3304_6.x

Hygiene and Food Safety

Case Study: IOT Enhanced Factory Cleaning

Cleaning of processing equipment is a vital component of food production. However, it does come with a substantial economic and environmental cost. The University of Nottingham has been working with Loughborough University and several industrial partners to develop an intelligent multi- sensor technology to monitor the removal of surface fouling during cleaning of processing equipment. Trials have been performed at pilot and full production scale to determine the most suitable sensor configurations and machine learning methods. In this project, several different machine learning methods were studied to determine their performance for predicting the presence of fouling using measurements detected by ultrasonic sensors. A test section with transparent sides was built so images could also be recorded during cleaning to help train and test the models. The results show that the machine learning methods give acceptable predictions (>99%)

Source: https://ifst.onlinelibrary.wiley.com/doi/10.1002/fsat.3304_6.x

Case Study 4: Allergen Detection

The University of Nottingham is also working on several projects investigating the use of sensors, data and robotics to transform cleaning and allergen detection within food factories. As part of this work researchers have been investigating the use of small and low cost Near Infrared (NIR) sensors and supervised machine learning to identity different powdered foods containing known allergens. NIR spectra were recorded from over 50 different powdered foods and different machine learning algorithms were tested to determine their capabilities. A specific measurement method (The nearest neighbour or KNN method) was found to have the best classification accuracy with results over 98%. Further development is necessary, but the system shows strong potential.

Source: https://ifst.onlinelibrary.wiley.com/doi/10.1002/fsat.3304_6.x

Labour Productivity

Case Study: Kawasaki Robots for Palletising

Almost all of the companies in the study identified the need for automation to increase labour productivity. Robots can help manufacturers to replace labour which does not add value. Cecelia

farms in Ontario have worked with Caxton-Mark (a robotic integrator) to robotize palletization of cardboard boxes through a fully automated end-of-line system and a Kawasaki robot. The system was developed to take factors such as increased pallet heights and ergonomic concerns into consideration via a completely custom solution for the large-scale farm. The requirements from the product were as follows:

- Stacking of pallets up to 20 boxes high (120 boxes total per pallet) while staying balanced
- Eliminate ergonomic concerns for operators incurred by tall pallet heights
- Create a custom end-of-arm tool (EOAT) that handles boxes without damaging fragile product
- Maintain a production speed of 6 pallets/hour without crushing the product

The CP180L robot meets their 6 pallet per hour goal at 80% robot speed. With some changes this will rise to 90%, increasing throughput by an additional pallet per hour. Automating this system also increased throughput because Cecelia Farms no longer had to take breaks into consideration. The robot can run up to 24 hours a day without stopping.

Source: https://www.robotics.org/content-detail.cfm/Industrial-Robotics-Case-Studies/Case-Study-Creating-a-Customized-Kawasaki-Robotic-Solution-for-Produce-Palletizing/content_id/7910

Case Study : CKF Robots for Palletising 2

CKF has recently designed, installed and commissioned an extensive new case feed and palletising system for Laithwaites Wine, an e-commerce and retail business based in Gloucester. The new system enabled Laithwaites to handle a 50% increase in demand during 2020 and improve productivity from 65% to 98%. An increase in customer demand for online purchasing meant the ageing plant at their Gloucester facility was no longer fully supporting their needs. Towards the end of 2019 CKF was approached by the Laithwaites team to develop and deliver a new automated palletising solution to meet their current and projected future requirements.

The new CKF fully automated system was installed and commissioned in two phases through 2020 working closely with the Laithwaites team to eliminate any operational disruption. Providing a significant increase in productivity to 98%, the benefits of the new system configuration have also enabled Laithwaites Wine to handle a substantial increase in throughput, reduce excessive manual handling and relocate the remaining manual processes into the area below the mezzanine floor and away from busy trucking routes, providing increased safety for their employees.

Source: https://zenoot.com/articles/case-study-automation-investment-helps-laithwaites-significantly-increase-productivity/

Video: https://youtu.be/7IIAZVB3KPU

Case Study : Westheimer Brewery, Automated end of life processes

Westheimer Brewery is a traditional brewer based in Germany. Westheimer wanted to reduce the

physical strain on employees that can be caused by end-of-line work. They state that the brewery's previous, older palletizing machinery would frequently break down, meaning that modernisation was required. The company implemented the following:

- Kawasaki CP500L robot and Cubic-S safety hardware/software installed
- Robot loads empty bottles onto pallet en route to filling station, and filled bottles onto a pallet for distribution
- Tool changing station allows system to adapt to product changes

The new palletizing system is flexible and adaptable to new or different products. The high degree of flexibility is also a great advantage when it comes to external orders. Westheimer Brewery works in a one-shift operation, and special orders - such as organic beer - are added at regular intervals. They also support other breweries from their large network and numerous craft beer labels and start-ups that have shaped the beer market in recent years. Having a flexible automated system allows Westheimer to more easily keep up with beer industry trends.

Case Study: Irwin's Bakery Northern Ireland – Use of robotics & automation

Founded in 1912 in Portadown, Irwin's (W.D. Irwin & Sons) is a third-generation family business and Northern Ireland's largest independent plant bakery. They supply a wide range of bread and baked goods to major retailers across the UK, Ireland and several international markets. With over a century of trading under their belt, Irwin's recognized the need to innovate to keep ahead in a competitive market. Recently, they've sought to combine their traditional craft bakery skills with modern, state-of-the-art automation technologies. In this case study, the business was focusing on the reduction of waste, the improvement of quality and the delivery of increased flexibility. The business worked with the Northern Ireland Technology Centre from Queens University. The business looked at the use of robotics and how they could be implemented within Irwins. The challenge was to introduce robotics into a traditional manufacturing process. The staff responded well to the project and undertook training to understand how to best implement the process and continue to improve. The project delivered across the four key measures:

- Improved efficiency
- Reduced waste
- Improved quality
- Improved flexibility.

Irwin's noted that the project was not necessarily easy to deliver and that there were a significant number of challenges to address, but the overall impact of the project was worth the effort and patience needed to deliver it.

Video: https://youtu.be/BR2p6JpOrDs

Case Study: NC Engineering – Using robotics to increase efficiency

NC Engineering is a manufacturer of industrial and agricultural equipment based in Hamiltonsbawn, Armagh. They sell this advanced equipment globally. Using advanced digital technology, the company automated the control of their tools and introduced a robotic welding system into their manufacturing processes. These steps have increased business efficiency and competitiveness, in addition to attracting international customers. The company was having difficulty in recruiting skilled staff and started to investigate automation to augment the staff they already had. Initially the robots were viewed as a threat to existing staff, but this fear was quickly dispelled, with the robots undertaking the monotonous, repetitive tasks and freeing the skilled staff to deal with the more complex and challenging aspects of production.

The company states that the project was not easy to deliver, but that the effort was worthwhile, improving labour productivity, business output and upskilling of existing jobs.

Video: https://www.youtube.com/watch?v=sG1u9TJrxi8&feature=emb_logo

Data Handling

Ed Miniat

Ed Miniat is a $150 million producer of cooked meats and edible oils for leading food suppliers and restaurants nationwide. Miniat operates two facilities in the Chicago area. A software programme 'Whistle' from Coolearth is running live in the main facility, where meats are processed, cooked, and packaged. Miniat selected Whistle for its real-time data collection, integration to an ERP system, and catch weight functionality. Miniat has benefited by streamlining highly complex business processes. The programme collects variable weights of individual raw meat containers, putting this data into the ERP. Whistle allows Miniat to directly scan GS1-128 labels, dramatically reducing data entry. Formerly burdened by 12 to 24 hour information latency times, Miniat now enjoys real-time visibility of all inbound, outbound, and manufacturing-related activities. Whistle's effortless catch weighting allows Miniat to conduct a high volume of complex sub-lot transactions that proved too difficult to manage in Infor ERP. Overall, the combination of Whistle and Infor ERP has allowed Miniat to significantly reduce standing inventory and increase inventory turns.

Paper to digital, San Benedetto

Agua Mineral San Benedetto was determined to eliminate paper from its business processes and put in place a zero-paper policy. In three years, the company successfully reduced its annual paper consumption from 120,000 to 40,000 pages. They used scanners, a Microsoft Dynamics AX business environment, and an Esker document process automation technology. The first process to be implemented was order processing - the automatic capture and processing of all non-EDI orders into Microsoft Dynamics AX ERP. In the past, employees at Agua Mineral San Benedetto manually processed orders that were received via fax, email or telephone. These represented 35 percent of its global orders (about 16,000 documents per year). This time-consuming process, coupled with the multiple order reception channels, generated significant bottlenecks that resulted in delays, errors and an increased risk of lost documents. Thanks to Esker's Order Processing automation solution, which automates every phase of sales order processing, San Benedetto's order management process now involves four steps:

1) Automatic order data capture; 2) Electronic validation; 3) Order creation; and 4) Archiving in the ERP system. The company lists a range of benefits from this component of the process:

- Significant reduction in time spent managing the sales cycle
- Better overall management thanks to complete process visibility
- Cost savings due to the elimination of fax machines, fax lines, printers, 46 physical sales order files, and consumables
- Improved customer service with optimized human resources (archived files indexed for quick retrieval when a customer calls)
- Environmental savings: 2 trees, 205 kg of CO2 emissions and 2,000 liters of water per year

Source: https://cloud.esker.com/fm/dc/case_studies/us/090-Esker_DeliveryWare_Case_Study_SanBenedetto-US.pdf

Factory Floor & Production Systems

Amplicon helping a food manufacturer implement real time monitoring and control system to increase efficiency of automated production processes in factory floor

This case study is presented by Amplicon – the organisation which is selling the product, but they outline some work with a UK based food manufacturer specialising in canned foods and soft drinks which supplies large volumes of own branded goods to some of the top supermarkets in the UK. The client needed a system to monitor and control production processes on the factory floor in real-time. One of the major requirements was for a system that would report the exact number of canned products manufactured in a given time which would allow for the more efficient management of resources and raw materials. In addition, due to the vast amount of heat generated by their production automation machines on the factory floor, they also required a system that would monitor and control the temperature on the entire floor to ensure the production machines were not overheating and increasing the production downtime and maintenance cost. This system also provided an optimal temperature for the working environment for the production staff.

Following the evaluation of the customer specification, the Amplicon measurement and control specialists recommended two independent process automation systems. One system was used to count and display, in real-time, the exact number of canned products manufactured and the other to monitor and control the temperature on the factory floor to ensure smoother operation of the production automation machines.

The VPD-130 industrial touch HMI device with the tM-P4A4 module was used to count and display in real-time the accurate amount of canned product manufactured. The VPD-130 comes with built-in functionality to monitor and display data in real-time.

The WISE-7118Z control unit was deployed to monitor and control 6 thermocouple sensors positioned around the factory floor. With the WISE-7118Z 6 digital outputs and IF-THEN-ELSE control logic features, six cooling fans can be switched on/off to cool the entire factory floor when the temperature exceeds the

specified level. The functionality offered by the WISE-7118Z was a perfect fit for the client requirements

Source: https://www.amplicon.com/projects/production-monitoring-control-factory-automation/

Sensor Technology

Use of sensors in global drinks manufacturer (Cotts)

Fluid level sensors have been vital in reducing downtime for the UK site of a global drinks manufacturer. At the Nelson facility of Cott Beverages – one of the world's largest producers of beverages on behalf of retailers, brand owners and distributors – ensuring maximum uptime is a key priority. It's an issue that particularly applies to each of the site's five filling lines for still and carbonated drinks, as well as the two aseptic bottling lines housed in a separate plant on a neighboring site. On a typical multi-bottle filler, one litre and 500ml carbonated soft drinks like colas are bottled at around 19,000 units per hour, which allows a 40 millisecond fill-time per unit.

The syrup is mixed with water, carbonated, and then fed under pressure to the filling bowl, a ring-shaped header tank above the filling nozzles. Controlling the level of liquid in the filling bowl is critical to the process as it determines the accuracy of fill. Margins can be squeezed by a run of poor fill. In addition, identifying which conventional level sensor is faulty, replacing it, testing, calibrating and cleaning, can take around four hours of downtime, equating to the filling of about 80,000 bottles.

The installation of LFP Inox fluid level probes from SICK UK has, the company says, delivered a replacement solution with far-reaching benefits for the whole Lancashire-based plant. The hygienic level sensors with IO-Link offered the improvements in performance and data output required. Cott Beverages then worked with the SICK technical team to determine the correct specification.

Connection to the three sensors is made via IO-Link and a single gateway integrating all three to the Profibus network. This provides digital access to diagnostic data in each – allowing monitoring of the operating status of an individual sensor – and an alarm can be triggered before any failure.

In the event of a fault developing with one of the sensors, the alarm and operator instructions on the filler's human-machine interface (HMI) control panel facilitate the switching out of the faulty device.

An average level of the two remaining sensors is maintained until an assessment can be made during routine maintenance downtime. The SICK LFP microwave sensors also have their own LED and digital readout, so faults can be detected either on the HMI or on the filler bowl itself. A two-metre long probe is kept in the back-up spares to fit each application on the plant. In addition, the LFP's self-teach can simplify setup. The unit can be fitted at the press of a button.

Trials have demonstrated that a sensor replacement could be completed during the one-hour Clean In Place (CIP) phase between production runs; a quarter of the time it took with the previous level sensing technology, says SICK.

Source: https://processengineering.co.uk/article/2022490/case-study-sensors-boost-beverage-company-s-efficiency

For more information on this report please contact:

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