SMART
INDUSTRY
READINESS
INDEX

MANUFACTURING TRANSFORMATION
INSIGHTS REPORT 2019

EDB
singapore

Singapore Economic Development Board (EDB), a government agency under the Ministry of Trade and Industry, is responsible for strategies that enhance Singapore's position as a global centre for business, innovation, and talent. We undertake investment promotion and industry development, and work with international businesses, both foreign and local, by providing information, connection to partners and access to government incentives for their investments. Our mission is to create sustainable economic growth, with vibrant business and good job opportunities for Singapore.

For more information, please visit www.edb.gov.sg.

BACKGROUND

The Smart Industry Readiness Index (SIRI) Assessments

To help manufacturers take the first step in their Industry 4.0 transformation, we launched the Smart Industry Readiness Index (SIRI) in November 2017. Created by the Singapore Economic Development Board (EDB) in partnership with a network of leading technology companies, consultancy firms, as well as industry and academic experts, SIRI comprises a suite of frameworks and tools to help manufacturers – regardless of size and industry – start, scale, and sustain their manufacturing transformation. SIRI covers the three core elements of Industry 4.0 – Process, Technology, and Organisation. To date, more than 200 official SIRI Assessments have been completed for companies in Singapore and aboard.

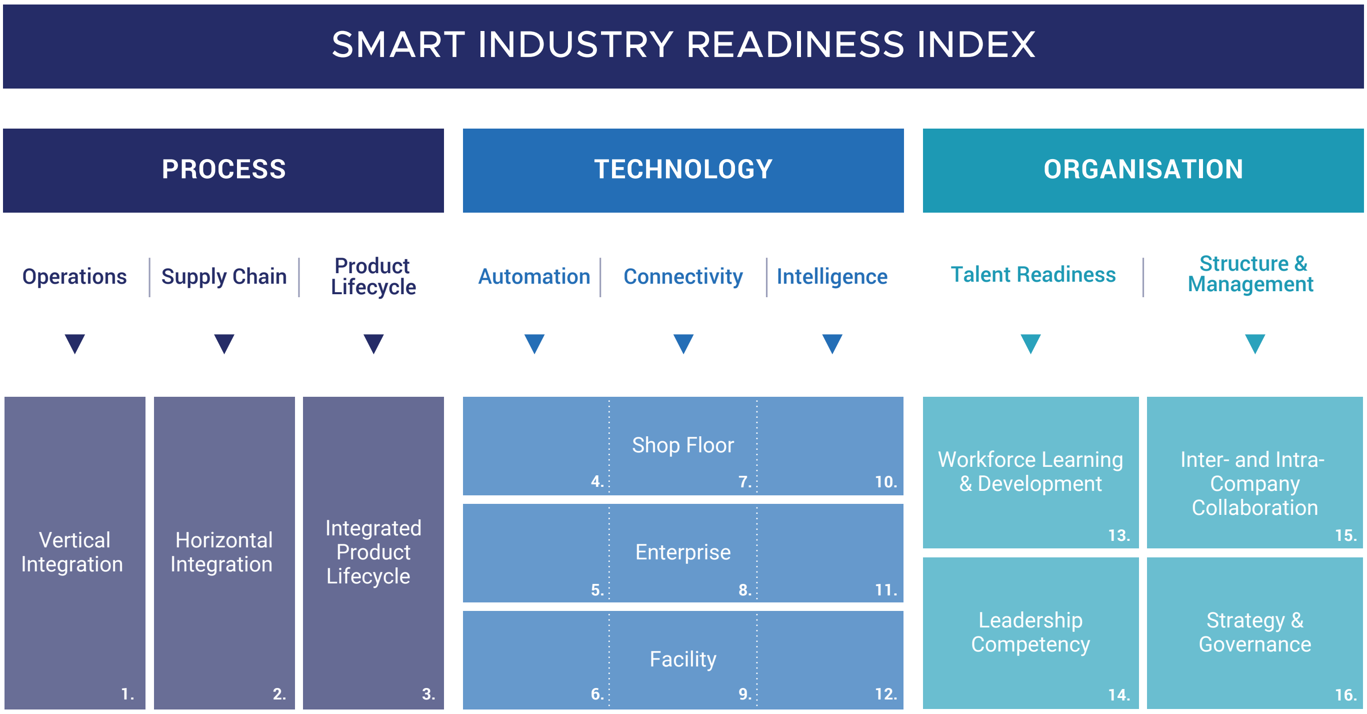

Figure 1 The Smart Industry Readiness Index (SIRI) framework

ABOUT THE REPORT

Two years after the launch of SIRI, we have arrived at the next phase: sharing insights to illuminate the current state of manufacturing transformation. The ***Manufacturing Transformation Insights Report 2019*** analyses data collected from the SIRI Assessments of 200 Singapore-based manufacturing facilities. They span 12 manufacturing industries, ranging from small, family-owned Singaporean enterprises to large, multinational corporations (MNCs) whose parent companies originate from 14 different countries across Europe, North America and Asia Pacific.

While we focused our report on Singapore-based facilities, the international profile and diversity of industries covered by the data make the report's findings relevant for the global manufacturing community as well.

As such, this report seeks to provide all stakeholders within the industrial sector with:

1. **A data-backed snapshot of the current state of industrial transformation across multiple manufacturing industries;**
2. **Observations relating to the three building blocks of Industry 4.0 – Process, Technology, and Organisation; and**
3. **A benchmark for manufacturers to assess and compare their Industry 4.0 maturity levels against those of their peers in the same industry.**

We hope that the insights will prove useful to manufacturers, governments, trade associations, and other stakeholders in ideating and developing new solutions and interventions that will accelerate global industrial transformation towards the digital era.

Overview of Data Set

33%
SMALL AND MEDIUM ENTERPRISES

12
MANUFACTURING INDUSTRIES

14
COUNTRIES

2018 -2019
ASSESSMENT PERIOD

*All figures are in Singapore dollars

Figure 2 Overview of data set used in the SIRI Manufacturing Transformation Insights Report 2019

THE 12 MANUFACTURING INDUSTRIES

Aerospace

The Aerospace sector comprises companies that manufacture, assemble, repair, and/or service equipment, parts, and products for civil aircraft, military aircraft, and spacecraft. Products include but are not limited to engines, fan blades, and remanufactured parts.

Chemicals

The Chemicals sector comprises companies that produce specialty and other chemicals. Products include but are not limited to plastics, synthetic fibres, additives, adhesives, sealants, specialty paints, pigments, coatings, and fragrances.

Electronics

The Electronics sector comprises companies that manufacture electronic components, equipment, and consumer electronics products. Products include but are not limited to connection devices, electron tubes, electronic capacitors, resistors, and printed circuit boards.

Energy

The Energy sector comprises companies that engage in refining and cracking of crude oil as well as the production of petrochemical primary products. Products include but are not limited to petroleum naphtha, gasoline, diesel, liquefied petroleum gas, olefins, and fuel oils.

Food & Beverage

The Food & Beverage (F&B) sector comprises companies that process, produce, and package food and beverage products. Products include but are not limited to baked goods, canned products, and dehydrated food items.

General Manufacturing

The General Manufacturing sector comprises companies that manufacture broad-based consumer and commercial products that are not classified under other industries. Products include but are not limited to bicycles, clothes, packaging boxes, and shoes.

Logistics

The Logistics sector comprises companies that provide freight transportation, courier, warehousing and other logistical services. Services include but are not limited to storage, distribution, freight forwarding, and end-to-end goods delivery.

Marine & Offshore Engineering

The Marine & Offshore Engineering sector comprises companies that manufacture machinery and equipment for exploration and extraction of crude oil and natural gas. Products include land drilling rigs, offshore platforms, and Floating Production Storage & Offloading (FPSO) conversion units.

Medical Technology

The Medical Technology sector comprises companies that manufacture healthcare equipment and devices. Products include but are not limited to medical instruments, drug delivery systems, cardiovascular and orthopedic devices, and diagnostic equipment.

Pharmaceuticals

The Pharmaceuticals sector comprises companies engaged in the research, development, and production of pharmaceuticals. Products include but are not limited to active pharmaceutical ingredients, medicines, and veterinary drugs.

Precision Engineering

The Precision Engineering sector comprises companies engaged in the production of complex machinery and systems as well as precision modules and components, serving a wide variety of industries such as electronics, aerospace, and medical technology. Products include but are not limited to laser systems and machine tools.

Semiconductors

The Semiconductors sector comprises companies engaged in the design and fabrication of semiconductors and related products. Products include but are not limited to integrated circuits and electronic discrete components such as diodes and transistors.

Adapted from The Global Industry Classification Standard (https://www.msci.com/gics)

FINDINGS

1 Manufacturing industries exhibit varying transformation profiles.

Many in the industry today lack awareness about the state of transformation across different manufacturing sectors, and how the sectors compare against one another. To shed some light, we analysed and compared the 12 manufacturing industries' transformation profiles, utilising two key parameters: SIRI Maturity and SIRI Variance.

SIRI Maturity[1] is a ranking measure of how an industry or company has performed in the SIRI Assessment across all 16 dimensions, relative to the other industries or companies. A higher ranking indicates that the industry or company is more likely to be further down the road in its industrial transformation journey.

SIRI Variance is a measure of how much the companies' SIRI scores deviate from the mean within an industry. The lower the SIRI Variance, the more uniform the pace of industrial transformation in the sector.

Taken together, SIRI Maturity and SIRI Variance provide a frame to help us visualise and make sense of the 12 manufacturing industries' transformation profiles. Here, we want to make an important disclaimer that a low positional ranking on either parameter does not necessarily suggest a fundamental or systemic problem with an industry's current state of transformation. This is because the pace and uniformity of transformation is highly sector-specific and often heavily influenced by factors like the nature/volume of products, complexity of manufacturing processes, competitive dynamics within the industry, and macroeconomic trends like overall business conditions and industry operating environment. Nonetheless, the ***SIRI Maturity x Variance Map*** offers a useful starting point for anyone keen to have a general understanding of the varying transformation profiles across manufacturing sectors.

To help interpret the ***SIRI Maturity x Variance Map***, we have classified the 12 manufacturing industries into four main ***Archetypes of Transformation***, each named after a type of natural habitat.

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[1] The SIRI Maturity of an industry is calculated using the ***SIRI Maturity Ranking Methodology***, which is described as follows:

I. In each SIRI dimension, the 12 industries are ranked against each other, from 1 (highest) to 12 (lowest).

II. Each industry's rankings across all 16 SIRI dimensions are aggregated to obtain a cumulative ranking value. The smaller the cumulative ranking value, the better that industry has fared compared to others.

III. Using the cumulative ranking value, industries are ranked from 1 (lowest SIRI Maturity) to 12 (highest SIRI Maturity).

The ***SIRI Maturity Ranking Methodology*** applies at both the industry and company level. This methodology was adopted because the bands in different SIRI dimensions represent varied states and are not equivalent, hence using a pure aggregation of SIRI bands across all 16 SIRI dimensions would not be meaningful in evaluating performance. For instance, a Band 1 in Vertical Integration is not equivalent to a Band 1 in Shop Floor Automation.

Archetypes of Transformation

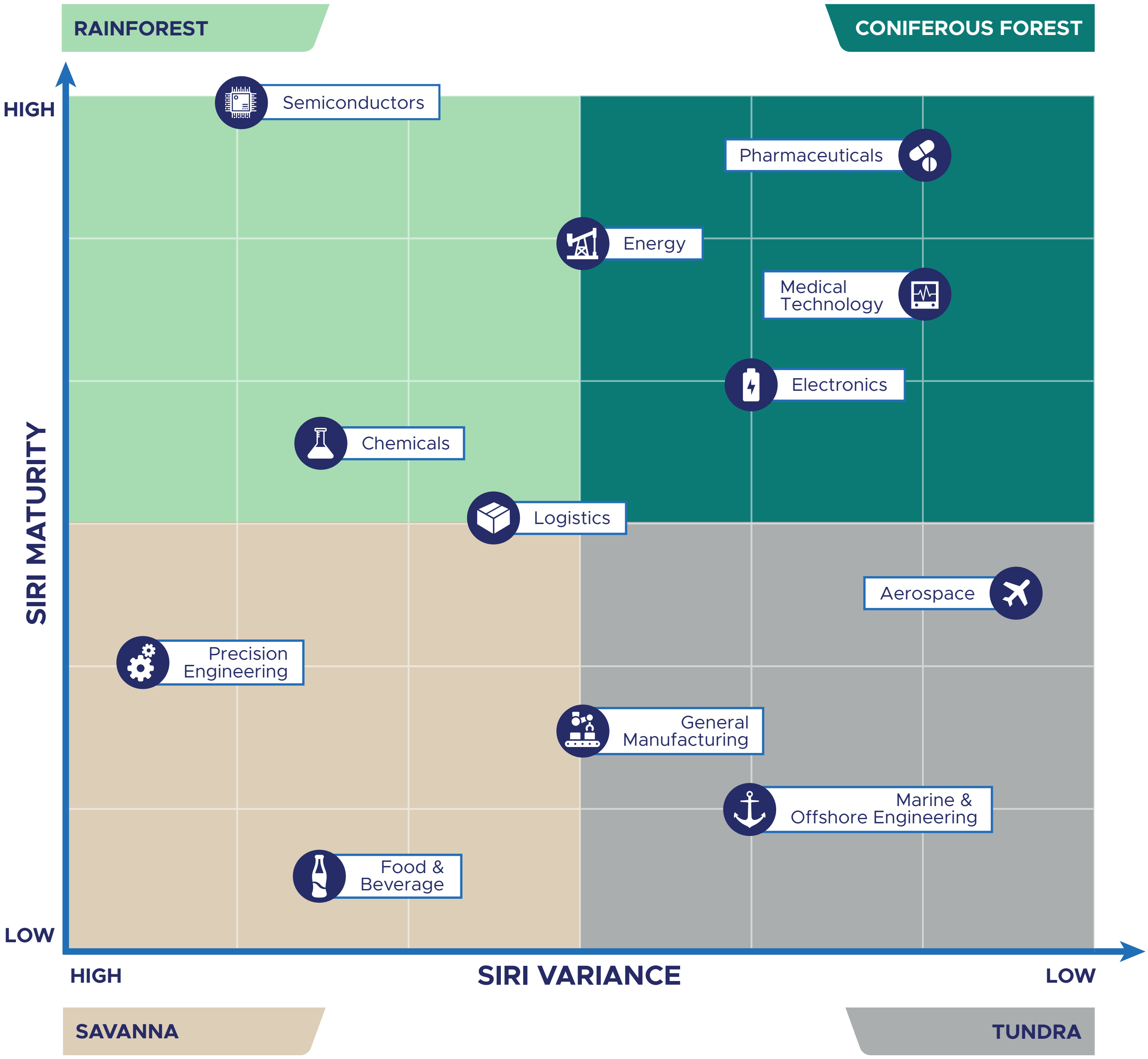

Figure 3 The four Archetypes of Transformation

Coniferous Forest

A coniferous forest is associated with rows of uniform-looking pine trees growing tall and strong. This habitat is used to illustrate the key characteristic of industries in this archetype: they rank high in SIRI Maturity and low in SIRI Variance.

Companies within these sectors are generally further along in their Industry 4.0 journeys and are largely similar in their pace of transformation. Of course, an industry may fall into the ***Coniferous Forest Archetype*** due to a deliberate effort to transform, but there are also other reasons why some sectors may inherently tend toward the ***Coniferous Forest Archetype***. Such industries typically manufacture products that are technologically intensive and highly regulated; this generally favours sectors that mostly consist of MNCs with resources to pursue higher standards in manufacturing processes, technology adoption, and organisational development. Having a small group of large companies in turn facilitates more coordinated knowledge sharing amongst key players to address common problem statements, which can further accelerate transformation across the sector.

To support these industries that are continuously forging ahead, governments should ensure that the sectors' physical and social infrastructure enables and does not constrain development. For instance, it would be critical to groom a highly skilled workforce to help these industries achieve their Industry 4.0 ambitions. In turn, companies within the ***Coniferous Forest Archetype*** can serve as role models, thought leaders, and inspirations for others to embark on their own industrial transformation.

Case Study

BMAC

Knowledge sharing within an industry

The Platform

The Biopharmaceutical Manufacturers' Advisory Committee (BMAC) is a public-private platform in Singapore that comprises representatives from the pharmaceuticals, biologics, and nutritional sectors, as well as local government agencies.

What they did right

As an industry-led initiative, BMAC has created an open and trusted environment where leaders of Singapore's biopharmaceutical sector can come together to discuss emerging industry trends, opportunities, and challenges. Over time, this has created a culture of collaboration and today, member companies feel comfortable approaching one another for help and support as they adopt and source for new Industry 4.0 solutions.

Leveraging SIRI as a common framework, BMAC companies banded together to consolidate their SIRI scores, as well as identify common problem statements and priority areas that they could work on collectively. This not only allowed the group to gain deeper insights into industry challenges, but also facilitated their discussions with vendors to develop meaningful solutions that would benefit all BMAC members. Ultimately this has provided a timely push to accelerate the transformation of the broader biopharmaceutical sector.

Tundra

The next archetype is represented by the tundra, a habitat with strong winds, low temperatures, and limited rainfall. With its harsh climate, the tundra illustrates the key characteristics of industries in this archetype: they rank low in SIRI Maturity and SIRI Variance.

Just as wildlife in the tundra battle formidable conditions to survive, certain industries in the ***Tundra Archetype*** face greater challenges in industrial transformation because the nature of their products and manufacturing processes limit the ease and feasibility of deploying certain Industry 4.0 improvements.

Evidence can be found in sectors like Aerospace and Marine & Offshore Engineering. Their products are highly customised and manufactured in small quantities, which may limit opportunities for commercially viable improvements in areas such as automation and digitisation. To illustrate the disparity, Boeing and Airbus delivered a total of 1,606 aircraft in 2018[2,3] and Keppel delivers an average of five to twenty oil rigs each year[4]; in contrast, Energizer manufactures more than six billion battery cells annually[5] with lower product variability. Moreover, certain high-value activities in ***Tundra Archetype*** sectors may not be so easily subjected to the traditional types of Industry 4.0 improvements found in other industries. One example is maintenance, repair and & overhaul, a major segment of Singapore's aerospace industry that is highly bespoke and heavily reliant on skilled manpower.

For these reasons, it is more challenging for some ***Tundra Archetype*** industries to embark on any form of large-scale manufacturing transformation, in contrast to sectors characterised by simpler products, smaller product variabilities, and higher volumes. Fortunately, opportunities for transformation still exist in the Process and Organisation building blocks. Governments and trade associations can partner companies in these sectors to explore initiatives such as redesigning manufacturing process, enhancing workforce training programs, and fostering closer partnerships with key suppliers and customers.

Rainforest

The third archetype is based on the rainforest, a habitat with year-round rainfall, ample sunlight, and comfortable temperatures, all of which facilitate the growth of lush vegetation. Yet, despite such favourable conditions, some plants falter. The ***Rainforest Archetype*** thus describes industries that rank highly in both SIRI Maturity and SIRI Variance, indicating that while most firms in the sector are ahead in their Industry 4.0 journeys, a small group has not kept pace.

One reason for this high variance could simply be that some firms are slow to adopt the latest processes and technologies. In other instances, it could be due to differing levels of Industry 4.0 maturity across a sector's value chain. Such is the case in the Semiconductor industry; while it has the highest SIRI Maturity among the 12 manufacturing sectors, it also has the second highest SIRI Variance. This is because the front-end wafer fabrication plants are very progressive, but the back-end assembly & testing players undertake vastly different activities that may not require the technological and process sophistication needed by their upstream counterparts.

For industries in the ***Rainforest Archetype***, it is important for governments and trade associations to identify the sources contributing to the high variance. Depending on whether it is caused by a few anomalous manufacturers or differences in business expectations across sub-clusters of companies, governments should customise the necessary interventions accordingly.

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[2] "Boeing: Commercial." Boeing, www.boeing.com/commercial/

[3] "Orders and Deliveries." Airbus, www.airbus.com/aircraft/market/orders-deliveries.html

[4] "Performance Review: Operating & Financial Review." Kepcorp.com, Keppel Corporation, 2019, www.kepcorp.com/annualreport2018/pdf/keppel-corporation-limited-performance-review.pdf

[5] "Year 2000 Energizer Holdings, Inc. Annual Report." Annualreports.com, Energizer Holdings Inc., 2000, www.annualreports.com/HostedData/AnnualReportArchive/e/NYSE_ENR_2000.pdf

Savanna

The last archetype is represented by the savanna, a semi-arid habitat scattered with shrubs and isolated trees. The ***Savanna Archetype*** thus describes industries that rank low in SIRI Maturity but exhibit high SIRI Variance. While most companies within these industries are in the earlier stages of industrial transformation, a small number of players have forged ahead, like the occasional large trees that rise above the grasslands.

Unlike industries in the ***Coniferous Forest Archetype***, industries in the ***Savanna Archetype*** are usually home to large bases of companies that heavily skew towards small- and medium-sized enterprises, as exemplified by the F&B and Precision Engineering sectors. This gives rise to very diverse attitudes, resources, and constraints when it comes to transformation, with only a few larger or more forward-looking players able to pull ahead of the rest.

While many companies in this archetype remain passive towards transformation, those that have decided to be more proactive can start by drawing lessons from early movers and emulating their best practices. To encourage more businesses to actively pursue transformation, governments and trade associations can consider replicating effective initiatives from sectors in the ***Coniferous Forest Archetype***, such as fostering platforms for industry knowledge sharing or profiling, promoting, and celebrating the success stories of more forward-looking firms.

Case Study

COHERENT

Uncovering opportunities for transformation using SIRI

The Company

Headquartered in California, Coherent is among the top three manufacturers of industrial laser systems and components globally. In 2011, Coherent established its manufacturing presence in Asia with the setup of a factory and regional headquarters in Singapore.

What they did right

With intentions to upgrade its Singapore manufacturing site, Coherent completed the SIRI Assessment in 2018 as a starting point for its transformation plan. The assessment enabled Coherent to uncover new opportunities that were not previously considered. Building on the assessment results, the company then engaged a consultant to develop a comprehensive transformation roadmap. The planned improvements, which Coherent targets to complete by 2020, include enhancements to connectivity and integration across the company's various systems as well as developing new skills roadmaps to train its employees.

> **"The SIRI Assessment helped us better understand the current state of our facility and how it compared to the rest of the industry. Through it, we realised that there was a lot of room for us to improve and opportunities we could work on. This knowledge guided the development of our Lean-Digitalisation Transformation roadmap."**
>
> – Mr Goh Hin Tiang,
> General Manager,
> Coherent Singapore

2 The leading companies consistently outperform the rest across all 16 SIRI dimensions.

Three groups of companies

To give readers a sense of what it means for a facility to be best-in-class, average or elementary, the 200 surveyed companies have been ranked[6] according to their SIRI Maturity and classified into three main groups:

- A **Top Performers**, representing the top 10 per cent of companies;
- B **Broad Middle**, representing the middle 80 per cent of companies; and
- C **Bottom Performers**, representing the bottom 10 per cent of companies.

The SIRI scores of the Top Performers were consistently higher than those of the Broad Middle and the Bottom Performers across all 16 SIRI dimensions. This validates the importance of adopting a holistic approach towards industrial transformation, which is to devote attention and resources to progressively develop all three building blocks of Industry 4.0 — Process, Technology, and Organisation — in a stepwise fashion.

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[6] The same ***SIRI Maturity Ranking Methodology*** described in Footnote 1 was applied at the company level.

Performance of 200 Companies (2018-2019)

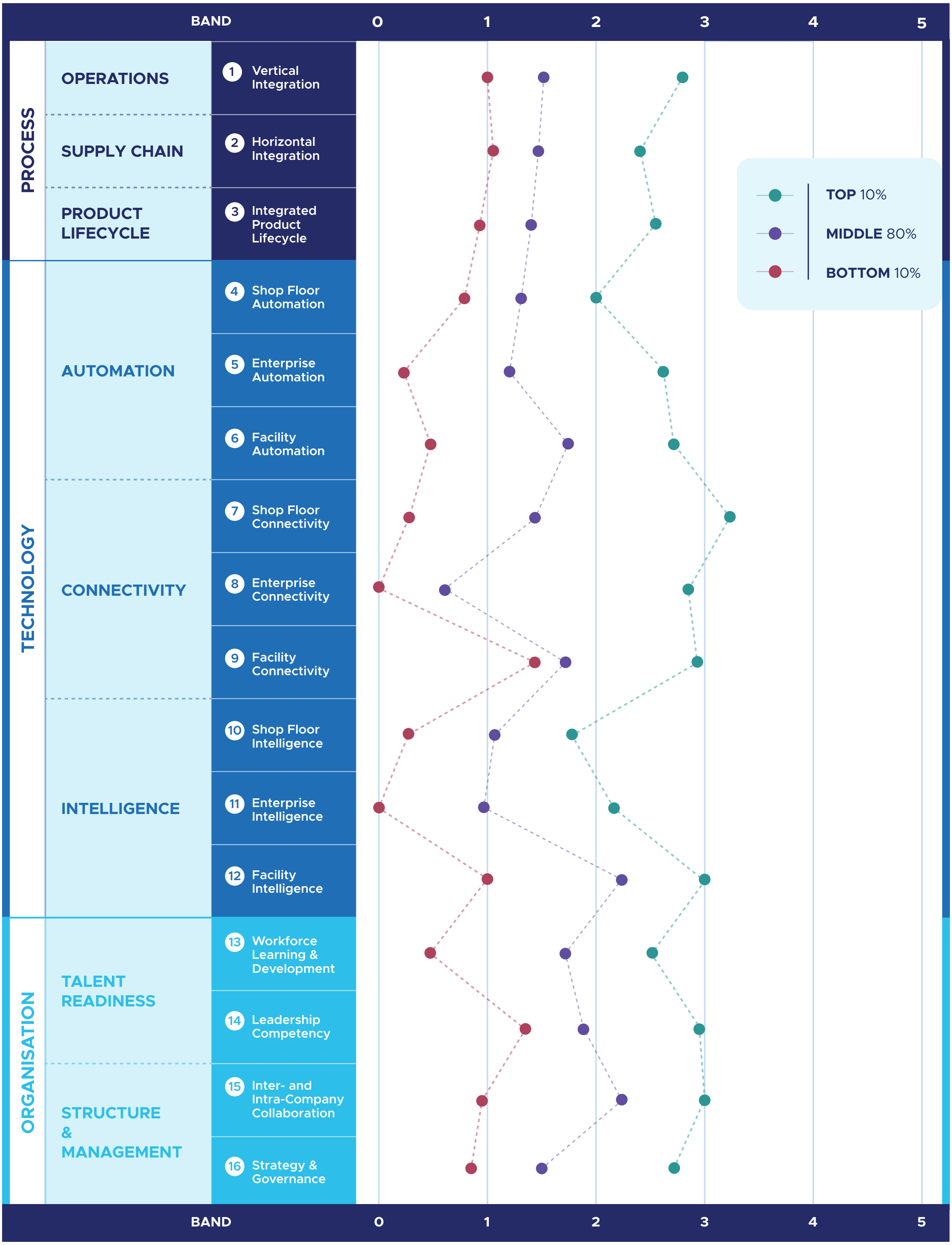


Figure 4 Performance of 200 companies across the 16 SIRI dimensions (2018 - 2019)

3 Process Building Block: The Broad Middle and Bottom Performers are working to digitise their processes, while the Top Performers are working to integrate their digitised processes.

Process Building Block

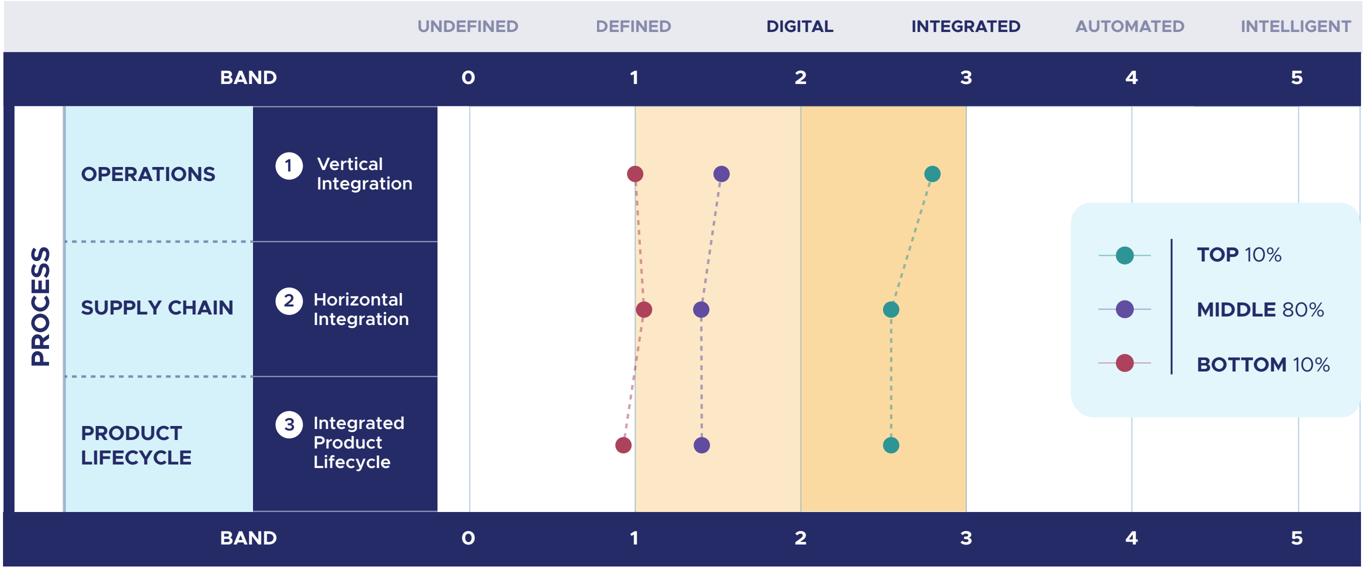


Figure 5 Performance of 200 companies in the Process Building Block

Across the three dimensions within the Process Building Block, the Broad Middle and Bottom Performers are mostly at a stage where their operations, supply chain, and product lifecycle processes are generally defined and ready for digitisation. As seen in the graph above, the average SIRI scores of the Broad Middle and Bottom Performers falls between a Band 1 (Defined) and Band 2 (Digital) across the three Process dimensions (Vertical Integration, Horizontal Integration, and Integrated Product Lifecycle). In comparison, the Top Performers' average SIRI score for each of the three dimensions sits between a Band 2 (Digital) and Band 3 (Integrated), demonstrating that these companies have largely completed the digitisation of their processes and are taking the next steps towards integrating them.

Case Study

PEOPLE BEE HOON

Process design as a key enabler of technology deployment

The Company

A small, family-owned enterprise founded in 1943, People Bee Hoon manufactures a variety of rice vermicelli products for Southeast Asian, US, and European markets.

What they did right

In 2017, People Bee Hoon started planning for the expansion of its existing facility in order to triple production capacity from 25,000 packets a day to 75,000 packets a day. The company understood that having a well-designed manufacturing process would be critical for brownfield expansion. As such, it consulted industry veterans and visited other food manufacturing facilities to learn how to design an integrated and efficient manufacturing process that could reduce manual labour and facilitate deployment of new shop floor automation technologies. People Bee Hoon now anticipates being able to improve product quality and increase production volume while maintaining existing workforce size.

> **"The SIRI Assessment provided me with an overall snapshot of my factory and informed my thinking about how my company should approach digital transformation. The journey to design a better process to manufacture vermicelli has been a very educational and enriching one for my employees and me."**
>
> — Mr Desmond Goh,
> General Manager,
> People Bee Hoon Factory

4 Technology Building Block: The biggest gaps between the Top Performers and the Broad Middle and Bottom Performers are in Connectivity.

Technology Building Block

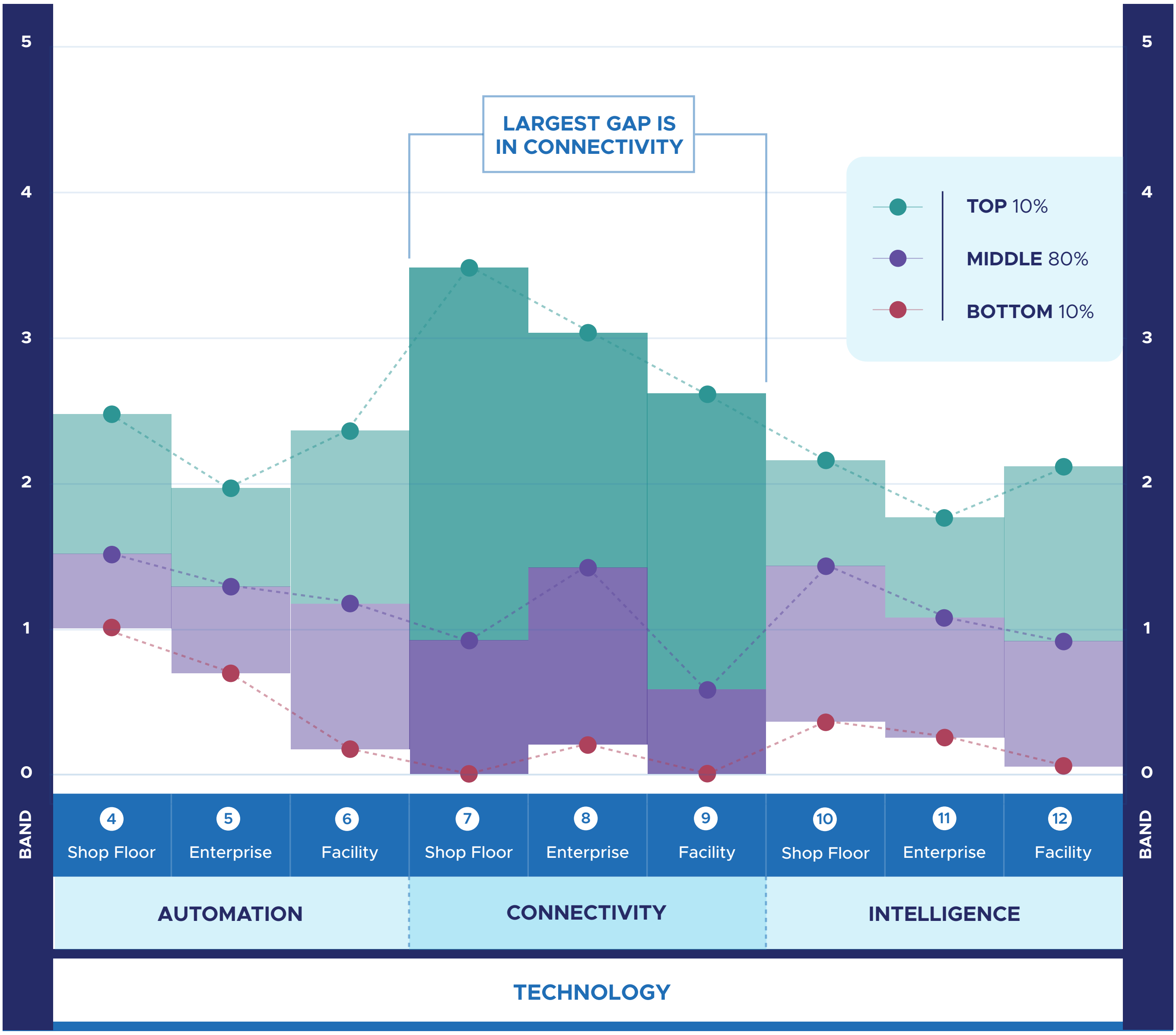


Figure 6 Performance of 200 companies in the Technology Building Block

In the Technology Building Block that comprises the Automation, Connectivity and Intelligence Pillars, the biggest gaps separating the Top Performers from the Broad Middle and the Bottom Performers are in the three dimensions within the Connectivity Pillar.

A common school of thought is that automation forms the basis for industrial transformation. However, in this digital age where data is the new oil, connectivity has become even more critical. A highly connected factory, where all assets (machines, products, materials, labour, and peripherals) are linked via a common network, will not only enable more extensive and effective machine-to-machine and human-to-machine communications, but also enable firms to better leverage data to generate new insights and facilitate more real-time decision making. Establishing a comprehensive Industrial Internet-of-Things (IIoT) architecture will accelerate a firm's ability to achieve enhanced collaboration and synchronisation throughout the manufacturing site, thereby generating long-term advantages. To truly extract value from Industry 4.0, manufacturers should therefore consider allocating more resources to further augment connectivity across shop floors, enterprises and facilities.

Interestingly, while the Top Performers fare exceedingly well in the Connectivity Pillar, they only perform slightly better in the Intelligence Pillar as compared to the Broad Middle and the Bottom Performers. The benefits of high levels of connectivity will be limited if companies do not know what to do with the data. Intelligence across the shop floor, enterprise, and facility will be the next frontier for companies, particularly the Top Performers, to unlock the true potential of Industry 4.0.

Case Study

CHEVRON ORONITE

Connectivity as a cornerstone for long-term transformation

The Company

Chevron Oronite, the California-based subsidiary of energy giant Chevron, operates a lubricant additives plant in Singapore, which is not only its largest in Asia but also one of its pioneer facilities in digital transformation.

What they did right

With a strong focus on long-term planning and IIoT, Chevron Oronite has recently completed the installation of a plant-wide wireless infrastructure — ranging from process equipment and field instruments to mobile devices for staff — to enhance the overall connectivity of its Singapore facility. To date, close to 1,000 wireless sensors and devices have been installed across the plant.

Chevron Oronite has begun to reap the benefits of this initiative. With the wireless sensors, field operators can extract key information from different instruments and systems while in the control room, hence reducing time in the field. Worker efficiency has surged, saving the manufacturer thousands of man-hours a year. Asset efficiency has also improved significantly; Chevron Oronite remotely monitors the performance of assets, and uses the data collected to build predictive models for anticipating equipment failure.

> **"We are invested [in building] our foundation in data and asset connectivity and interoperability to enable more innovative projects that we believe can bring much more value to our operations in the future"**
>
> — Mr Goh Koon Eng,
> General Manager Asia Pacific, Manufacturing and Supply, Chevron Oronite

Case Study

AMGEN

Unlocking the value of data through enhancing connectivity

The Company

US biotechnology firm Amgen is a world-leading manufacturer of biologics medicine. Its Next-Generation Biomanufacturing facility in Singapore is the company's first manufacturing facility in Asia, and the first to use latest innovations and multiple technologies to achieve greater speed, productivity, and flexibility in commercial-scale manufacturing.

What they did right

Hundreds of millions of data points are currently generated through the development and execution of biopharmaceutical processes. The volume and complexity of biomanufacturing data is also expected to grow exponentially in the coming years. Therefore, a key part of Amgen Singapore Manufacturing's Industry 4.0 strategy is to build a robust digital infrastructure to enable optimal and real-time use of big data for analytics and other applications.

For example, the company has implemented a structured data integration and analytics platform combined with predictive modelling and visualisation to enable centralised process monitoring across its entire manufacturing network. With this, the company is able to carry out activities like analysing historical information across products and sites to predict overall performance, quality, and the likelihood of successfully manufacturing additional batches without extending production schedules.

To date, this system has reduced manpower requirements for process monitoring by 67 per cent and nearly halved the volume of process monitoring documentation, saving the company 1,200 man-hours. This has allowed the biotechnology pioneer to continue delivering optimal business performance and productivity improvements to ensure uninterrupted supply of medicines to its patients.

> **“In the biomanufacturing industry, connectivity on the shop floor is generally high and as a result, a lot of data is being collected. The key is to integrate all the data and the systems, like our manufacturing execution system, enterprise resource planning, [and] raw materials system, into a single enterprise data lake. This will allow for greater accessibility and aggregation of data that can then drive innovation and deliver impact.”**
>
> — Mr James Weidner,
> Executive Director of Process Development,
> Amgen Singapore

5 Organisation Building Block: While Leadership Competency is an important starting point for any company's industrial transformation, strong Inter- and Intra-Company Collaboration is critical to scale and sustain it.

Figure 7 Performance of 200 companies in the Organisation Building Block

At first glance, the Leadership Competency SIRI scores of the Top Performers, Broad Middle and Bottom Performers are not too dissimilar. However, it is clear that the Bottom Performers could do better in Inter- and Intra-Company Collaboration.

A well-informed management team is a necessary starting point on any company's manufacturing transformation journey. Within corporate leadership ranks, awareness of Industry 4.0 has grown significantly over the years, and executives from all 200 manufacturers covered in this report have some familiarity with the latest Industry 4.0 trends and technologies. Now, it is time for leaders to translate this knowledge into action. This could be done through establishing digital transformation as a key organisational mandate, empowering teams to work on small digital transformation projects for quick wins, or simply facilitating the proliferation of these new ideas and concepts to the rest of the company.

It takes a village to raise a child, and the same principle applies in transforming a manufacturing plant. Industrial transformation is not something that can be achieved in a day, nor by a single individual. The ability for any company to transform at scale is largely dependent on whether all key stakeholders — employees, customers, and suppliers — are energised, empowered, and committed to the transformation cause. As corporate leaders in the manufacturing sector mull over the next steps for transformation, enhancing Inter- and Intra-Company Collaboration or Workforce Learning & Development would be important initiatives to consider.

Case Study

INFINEON

A deliberate approach to engage the whole organisation in the transformation journey

The Company

German semiconductor company Infineon Technologies is a world leader in semiconductor solutions. The company manufactures microelectronics that link the digital and the real world, with semiconductors that enable smart mobility, efficient energy management, and the secure capture and transfer of data.

What they did right

In 2017, Infineon announced a five-year transformation roadmap for its global test innovation and back-end manufacturing site in Singapore. The company is a firm believer that the entire organisation, across all rank and file, needs to be engaged in the transformation process. It has thus invested heavily into organisational readiness, change management, people development, and community building.

For instance, Change Ambassadors have been appointed to facilitate two-way communication of new initiatives and promote feedback between shop floor staff and management. The company also holds regular internal and external roadshows to expose employees to the benefits of its smart factory projects and educate its supplier community about the latest developments in Industry 4.0. In addition, Infineon has partnered with Institutes of Higher Learning to design and implement comprehensive learning roadmaps so that employees at all levels – operators, technicians, engineers, and managers – are equipped with the soft and technical skills critical for Industry 4.0.

> **“It is essential to ensure that the organisational element is not neglected, but rather given equal or even greater attention, in any major transformation. At Infineon, we are very deliberate and proactive in engaging our entire workforce to obtain their buy-in for the transformation initiatives and prepare them for the digital working life. That is the only way for transformation to scale.”**
>
> — Dr Laurent Filipozzi,
> VP and Site Head of Plant Singapore,
> Infineon Technologies Asia Pacific

EPILOGUE

The ***Manufacturing Transformation Insights Report 2019***, based on findings from the first 200 official SIRI Assessments, illustrates how SIRI is a robust tool which can enable a data-driven approach towards understanding the state of industrial transformation, both in Singapore and around the world.

At the back of this report, information on how each manufacturing industry performed across the 16 SIRI dimensions is captured in its respective Industry Performance Card. We are confident that the ***Industry Performance Cards***, ***Archetypes of Transformation*** and ***Insights*** from this report will collectively serve as a useful guide for corporations and governments alike, as they develop solutions and interventions to support and accelerate digital transformation.

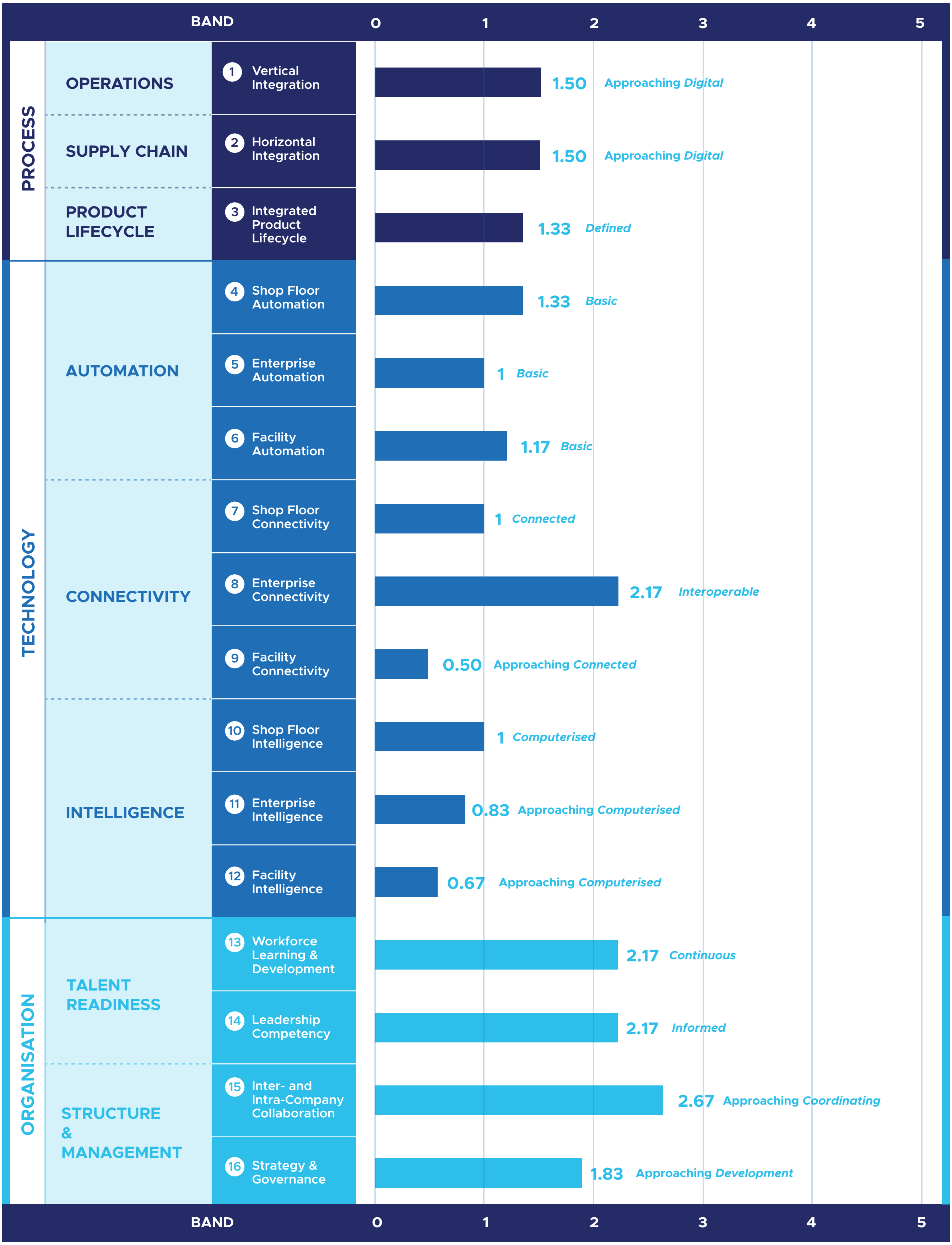
We hope that the report can also function as a powerful platform to educate and energise the manufacturing community, ultimately inspiring more companies to also kickstart their Industry 4.0 journeys.

We have come a long way since the launch of SIRI almost three years ago. In that time, we have had the privilege to work alongside a vast network of technology players, manufacturers, trade associations, and international organisations. To all who have helped us bring SIRI to where it is today, we thank you.

INDUSTRY PERFORMANCE CARDS

Aerospace

The Aerospace sector comprises companies that manufacture, assemble, repair, and/or service equipment, parts, and products for civil aircraft, military aircraft, and spacecraft. Products include but are not limited to engines, fan blades, and remanufactured parts.



Chemicals

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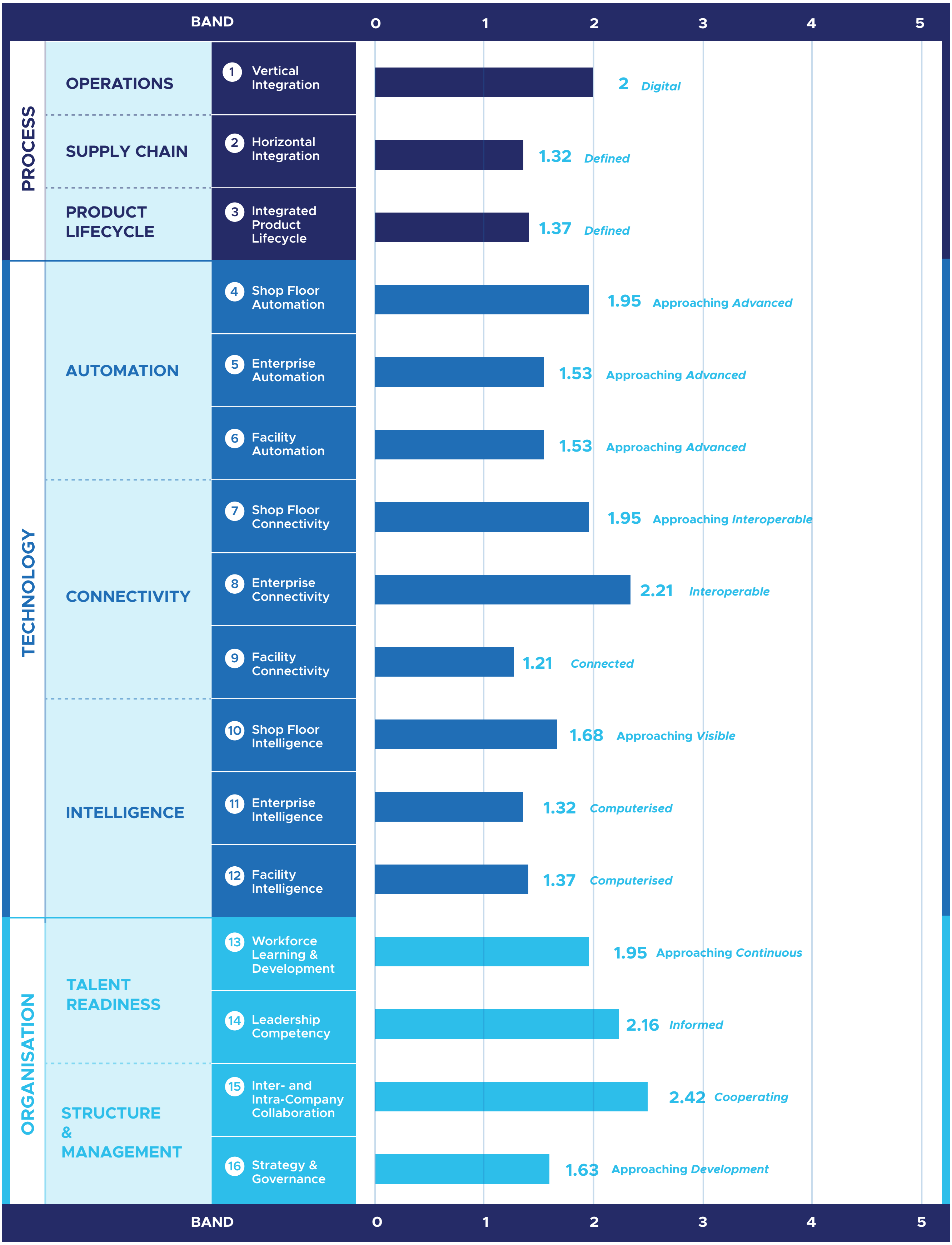

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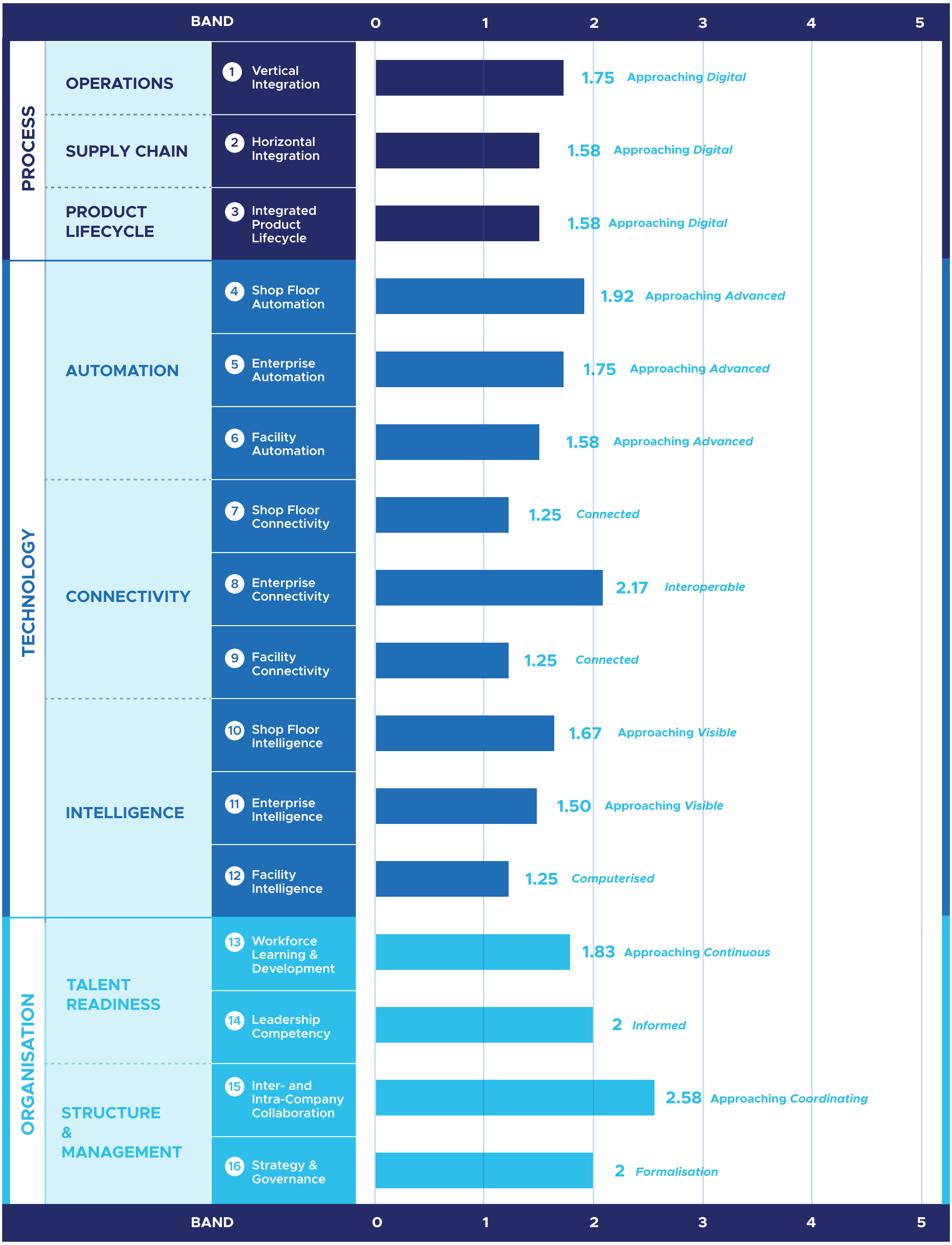

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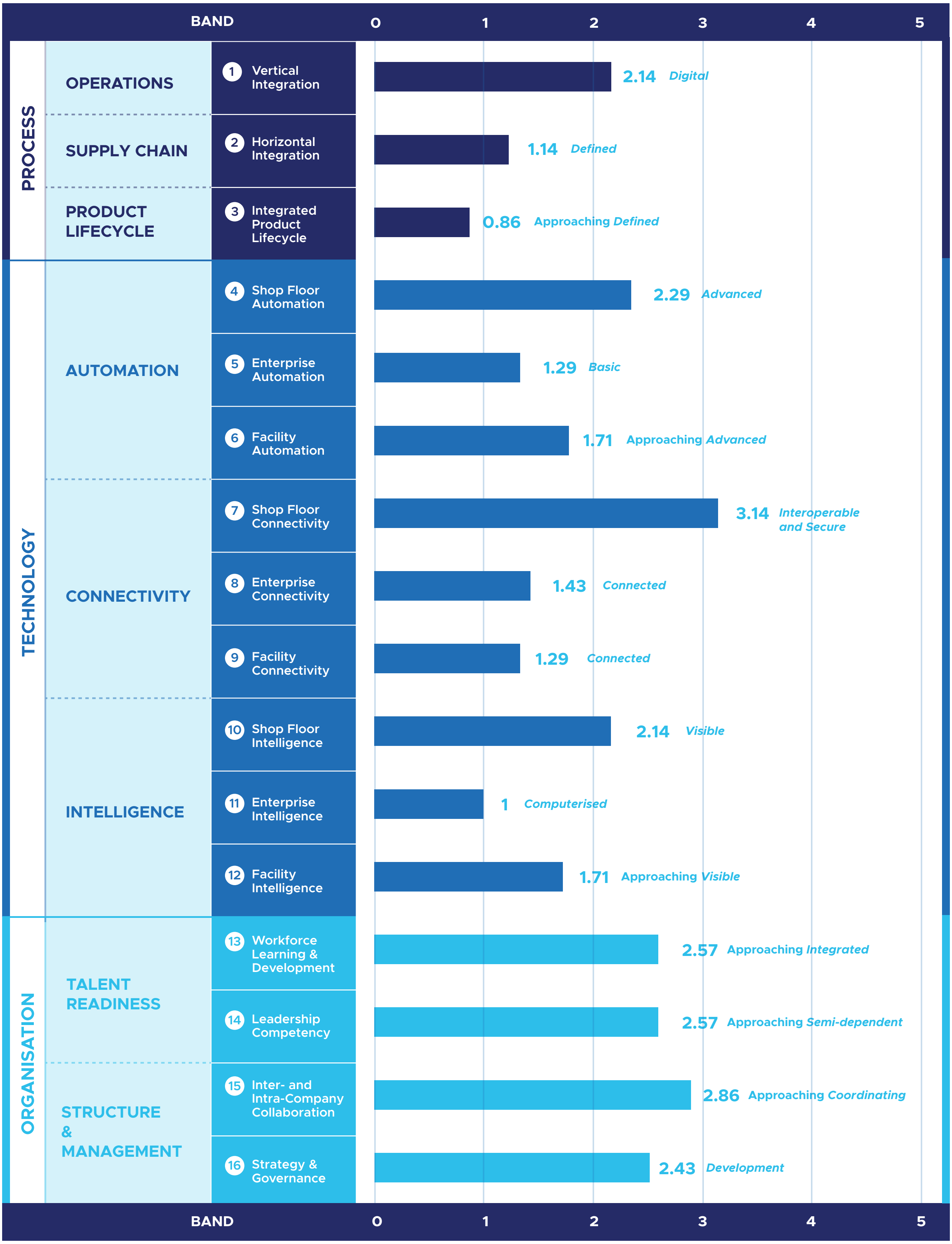
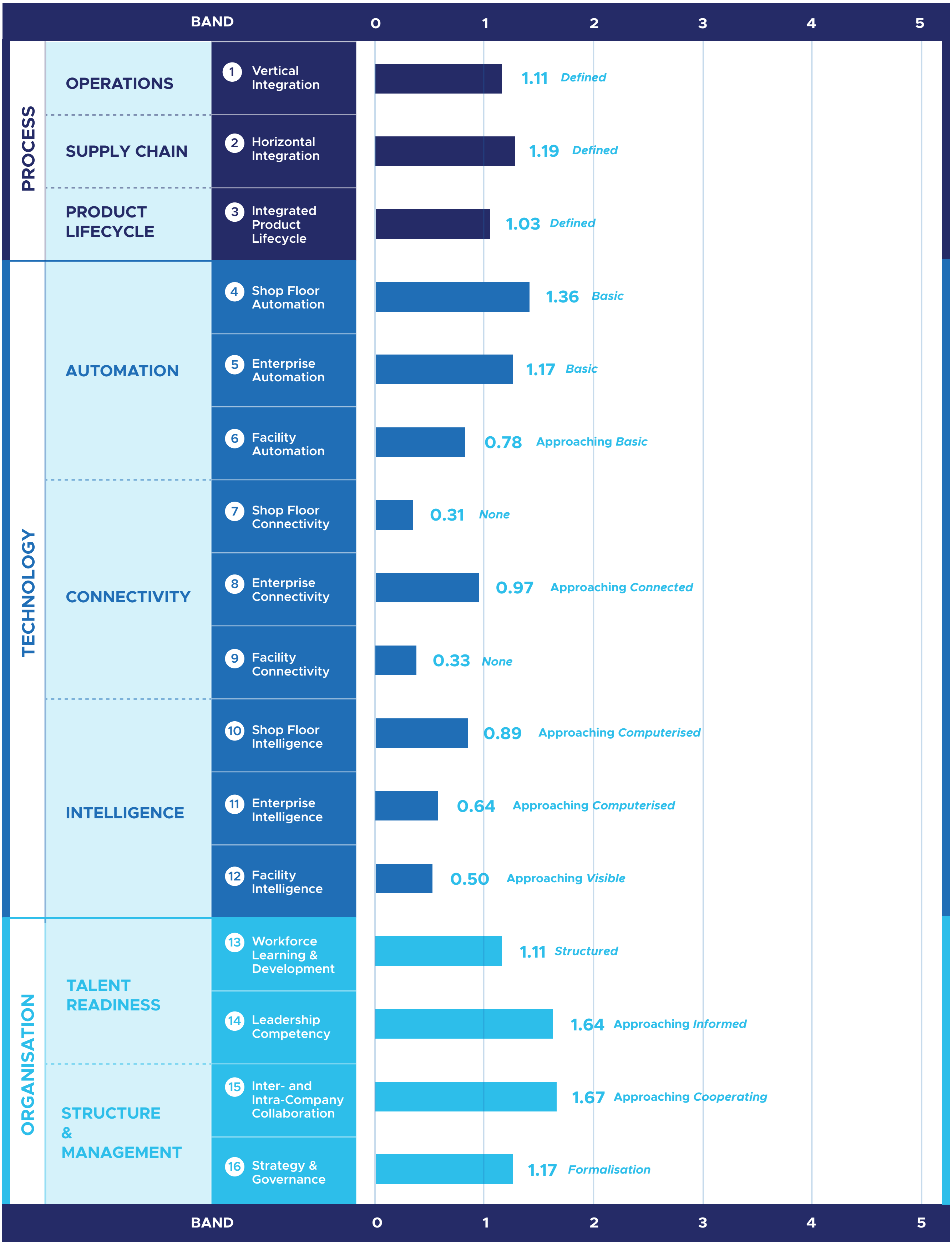
The Energy sector comprises companies that engage in refining and cracking of crude oil as well as the production of petrochemical primary products. Products include but are not limited to petroleum naphtha, gasoline, diesel, liquefied petroleum gas, olefins, and fuel oils.



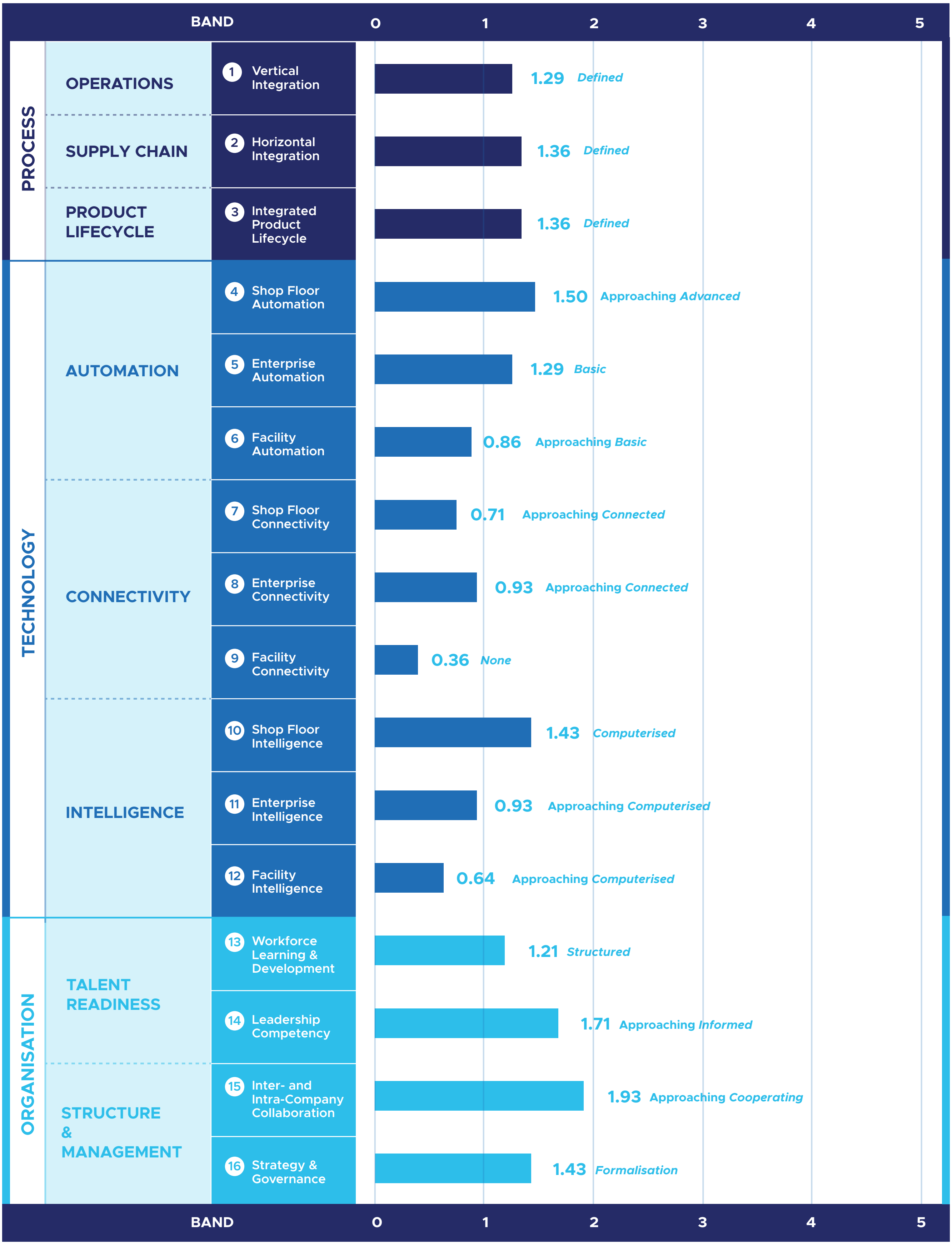
Food & Beverage

The Food & Beverage (F&B) sector comprises companies that process, produce, and package food and beverage products. Products include but are not limited to baked goods, canned products, and dehydrated food items.



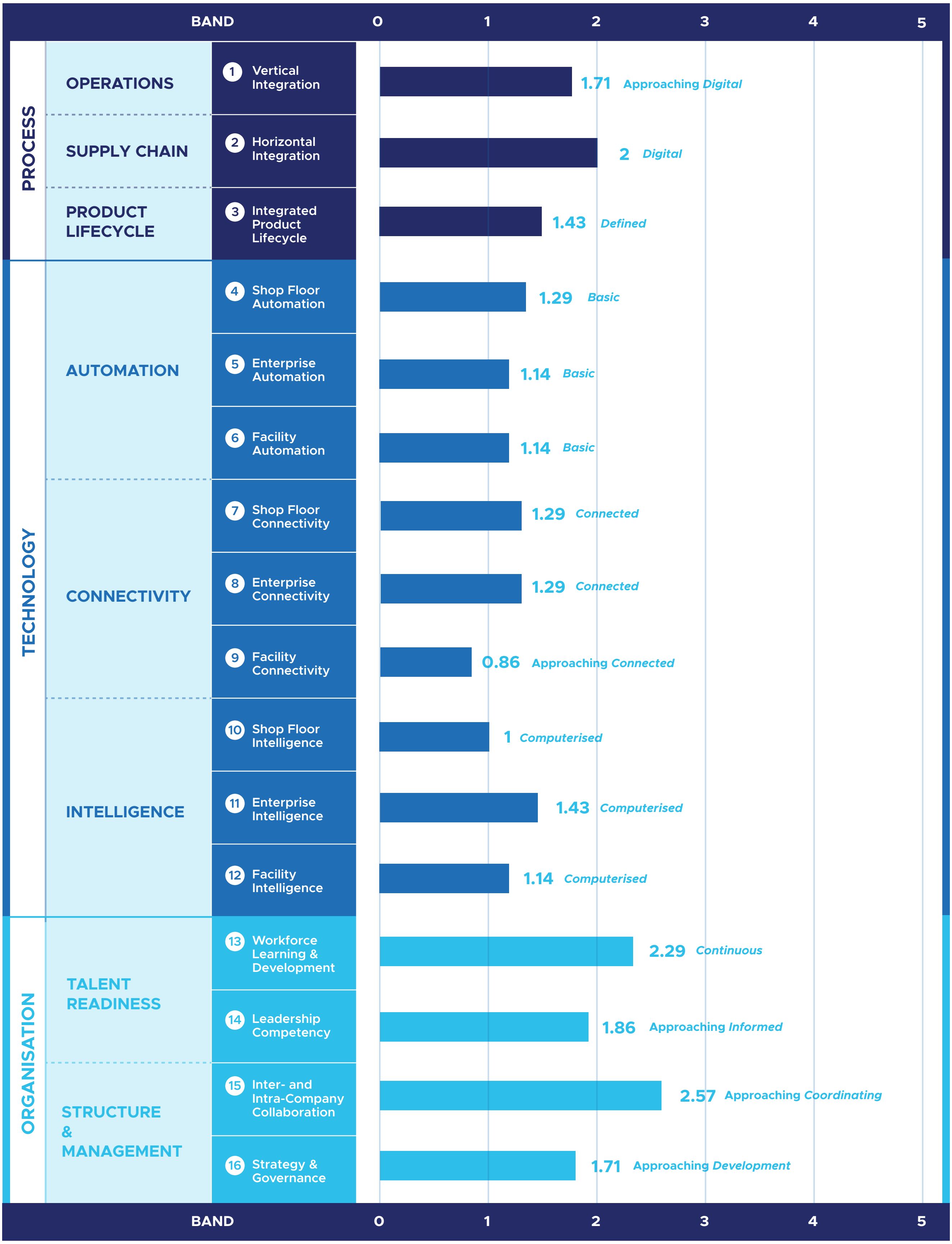
General Manufacturing

The General Manufacturing sector comprises companies that manufacture broad-based consumer and commercial products that are not classified under other industries. Products include but are not limited to bicycles, clothes, packaging boxes, and shoes.



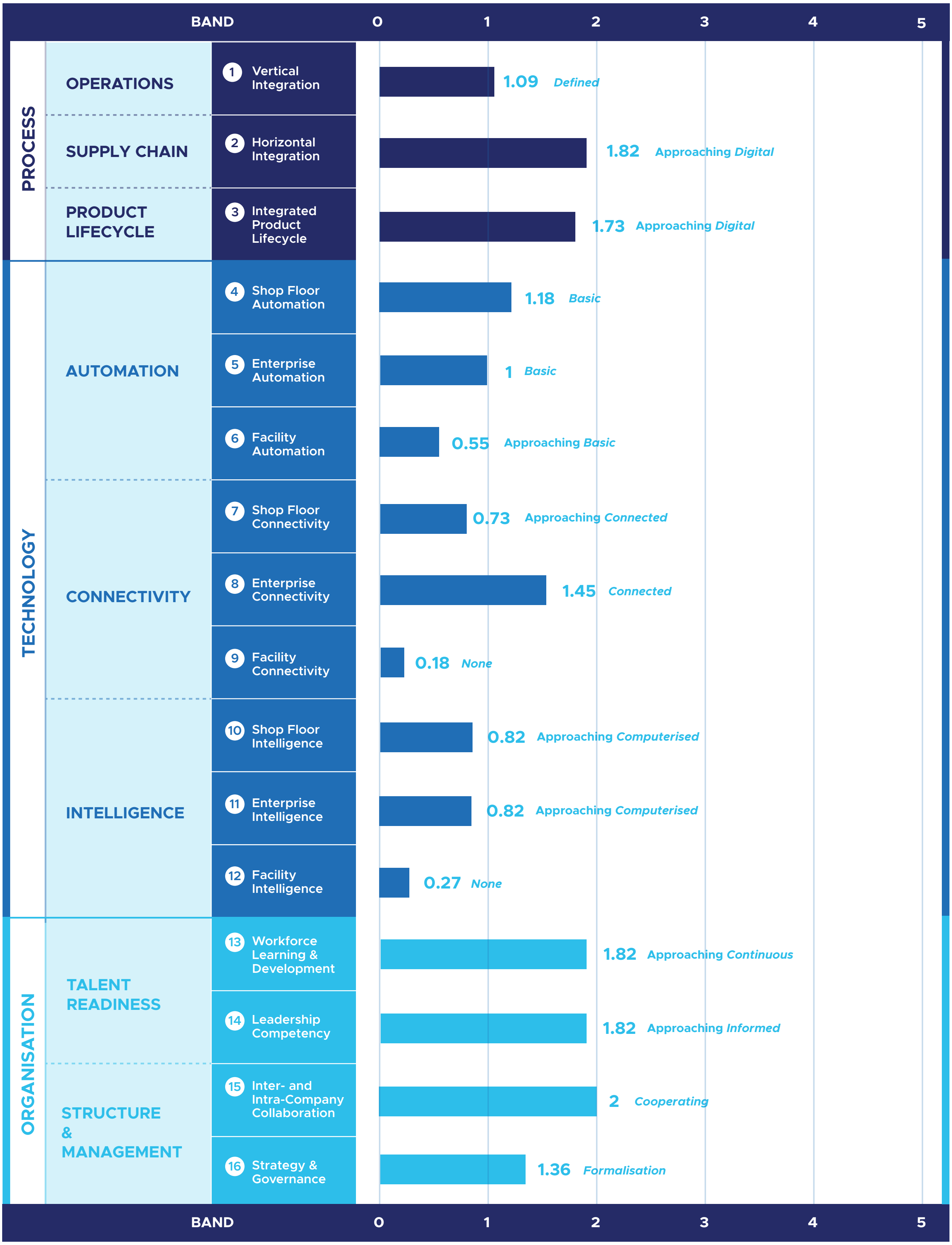
Logistics

The Logistics sector comprises companies that provide freight transportation, courier, warehousing and other logistical services. Services include but are not limited to storage, distribution, freight forwarding, and end-to-end goods delivery.



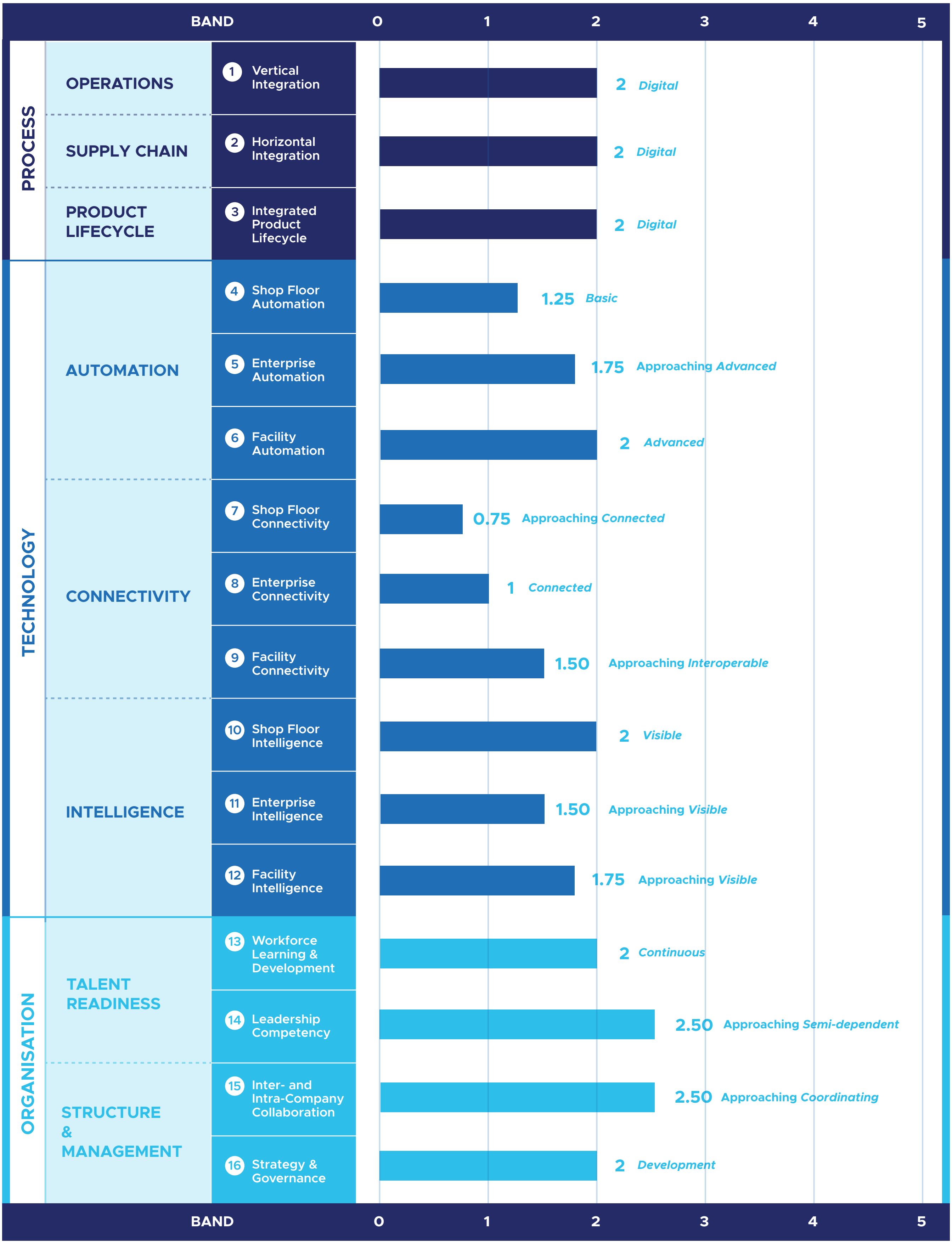
Marine and Offshore Engineering

The Marine & Offshore Engineering sector comprises companies that manufacture machinery and equipment for exploration and extraction of crude oil and natural gas. Products include land drilling rigs, offshore platforms, and Floating Production Storage & Offloading (FPSO) conversion units.



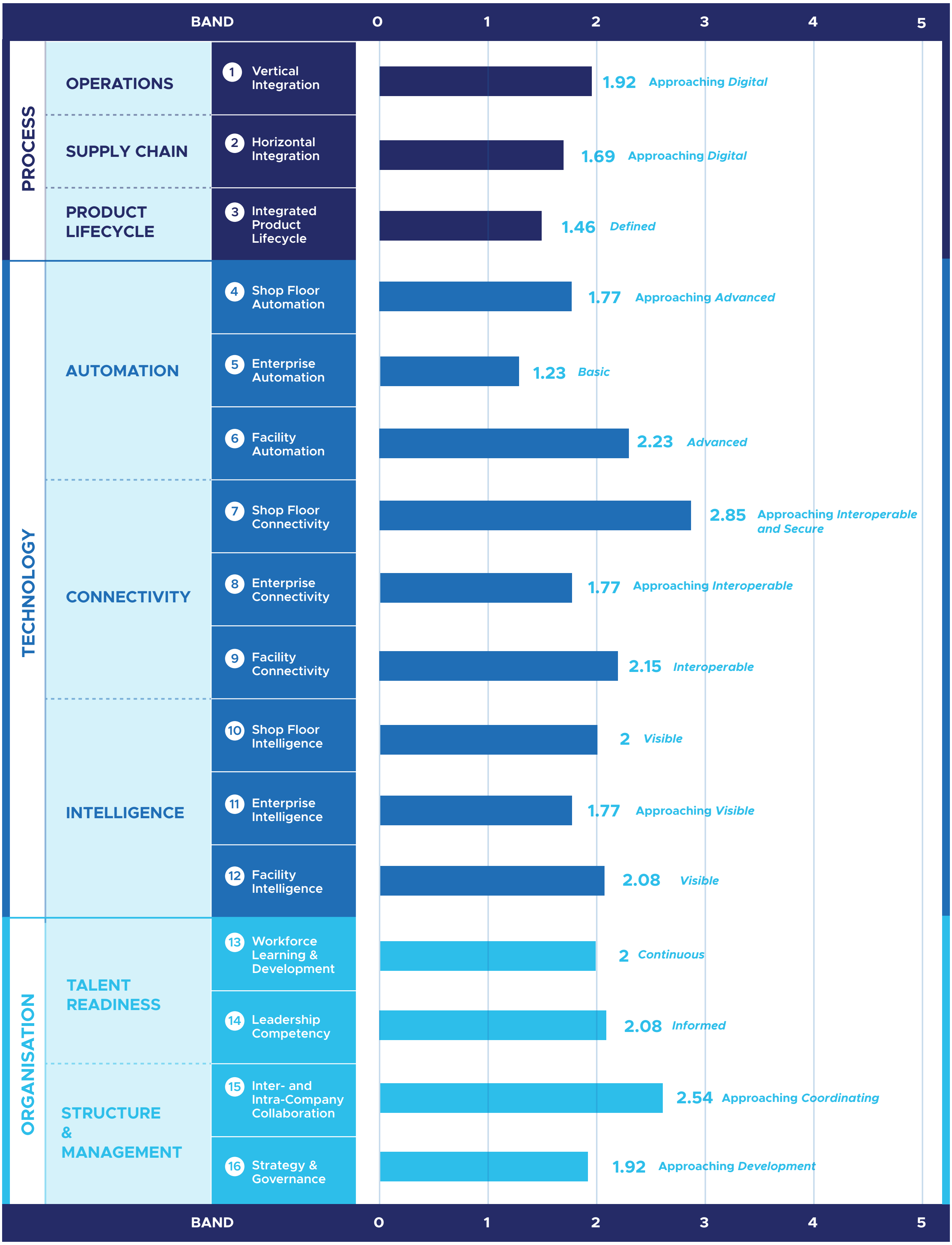
Medical Technology

The Medical Technology sector comprises companies that manufacture healthcare equipment and devices. Products include but are not limited to medical instruments, drug delivery systems, cardiovascular and orthopedic devices, and diagnostic equipment.



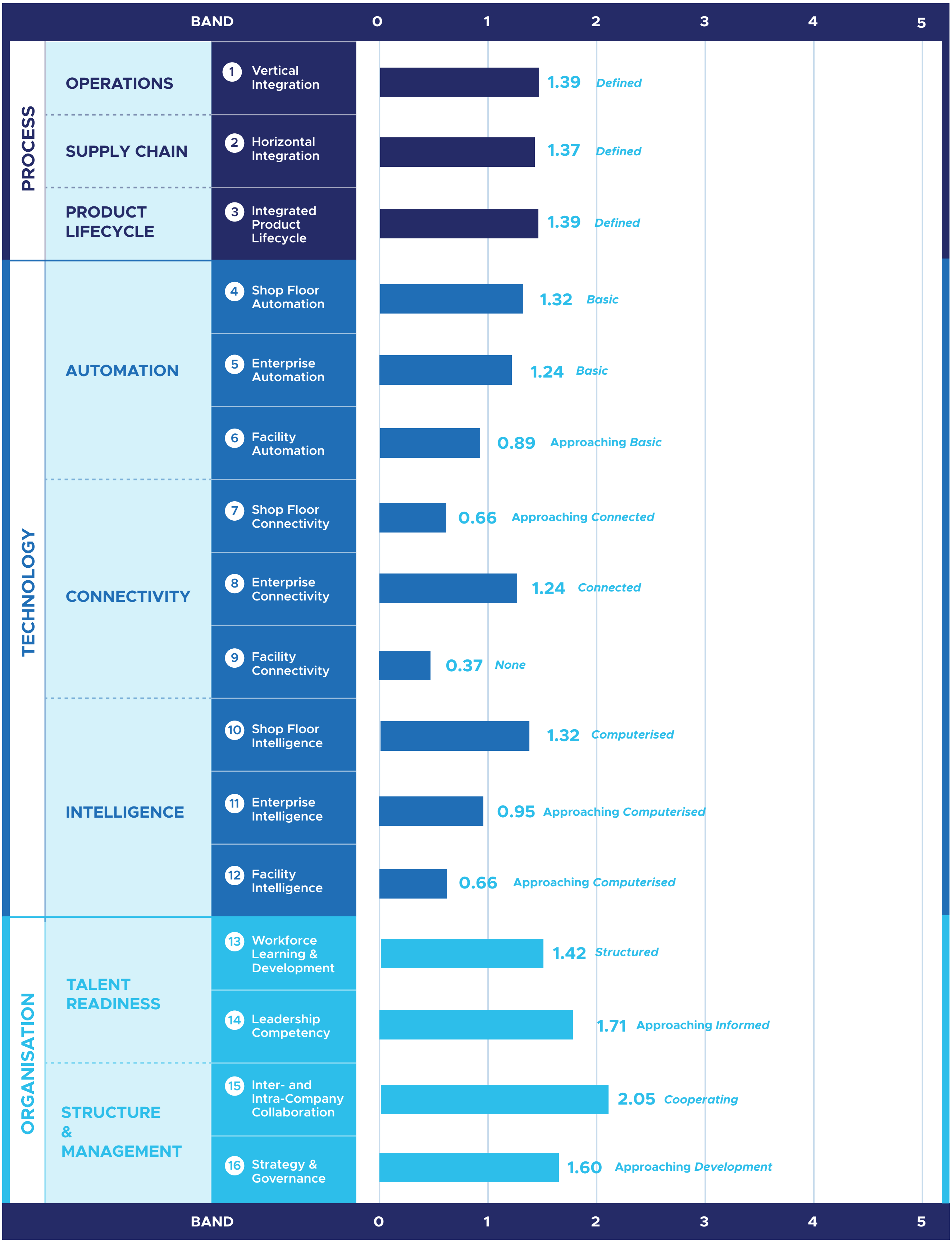
Pharmaceuticals

The Pharmaceuticals sector comprises companies engaged in the research, development, and production of pharmaceuticals. Products include but are not limited to active pharmaceutical ingredients, medicines, and veterinary drugs.



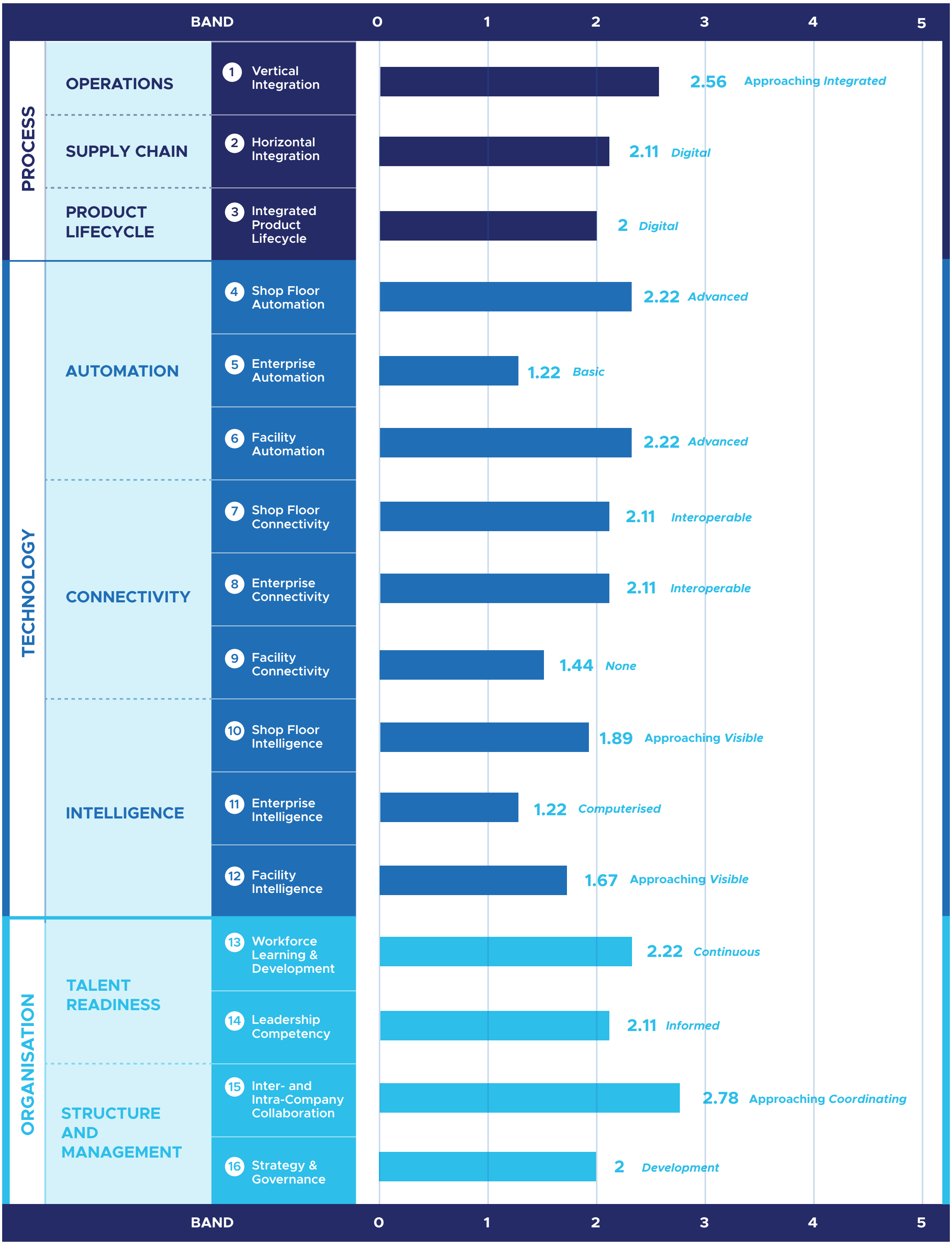
Precision Engineering

The Precision Engineering sector comprises companies engaged in the production of complex machinery and systems as well as precision modules and components, serving a wide variety of industries such as electronics, aerospace, and medical technology. Products include but are not limited to laser systems and machine tools.



Semiconductors

The Semiconductors Sector is comprised of companies engaged in the design and fabrication of semiconductors and related products. Products include but are not limited to integrated circuits (“IC”) and electronic discrete components such as diodes and transistors.



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6. People Bee Hoon Factory Pte. Ltd.

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