SKILLSFUTURE JOBS-SKILLS INSIGHTS

A Practical Approach for Small and Medium Enterprises to Adopt i4.0 and Upskill the Workforce (Manufacturing Sector)

Publication by

SKILLSfuture **SG**

In partnership with

rexroth
A Bosch Company

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Introduction

Singapore's "Manufacturing 2030" plan aims to grow manufacturing value-addedness by

50%

from 2020 to 2030[1]

For the manufacturing sector to achieve this goal, companies need to adopt Industry 4.0 (i4.0) to increase the sector productivity.[2] However, companies need practical ways to integrate advanced technologies into manufacturing.
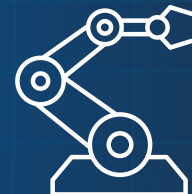
Examples of Advanced Technologies
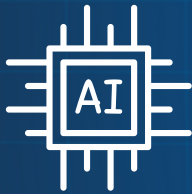
Artificial Intelligence

The Internet of Things (IoT)

Robotics and Automation

Benefits of Adopting i4.0

Enhanced Manufacturing Capabilities

Sustainable and Competitive Advantages

Improved Operational Proccess

Flexibility and Innovation Capabilities
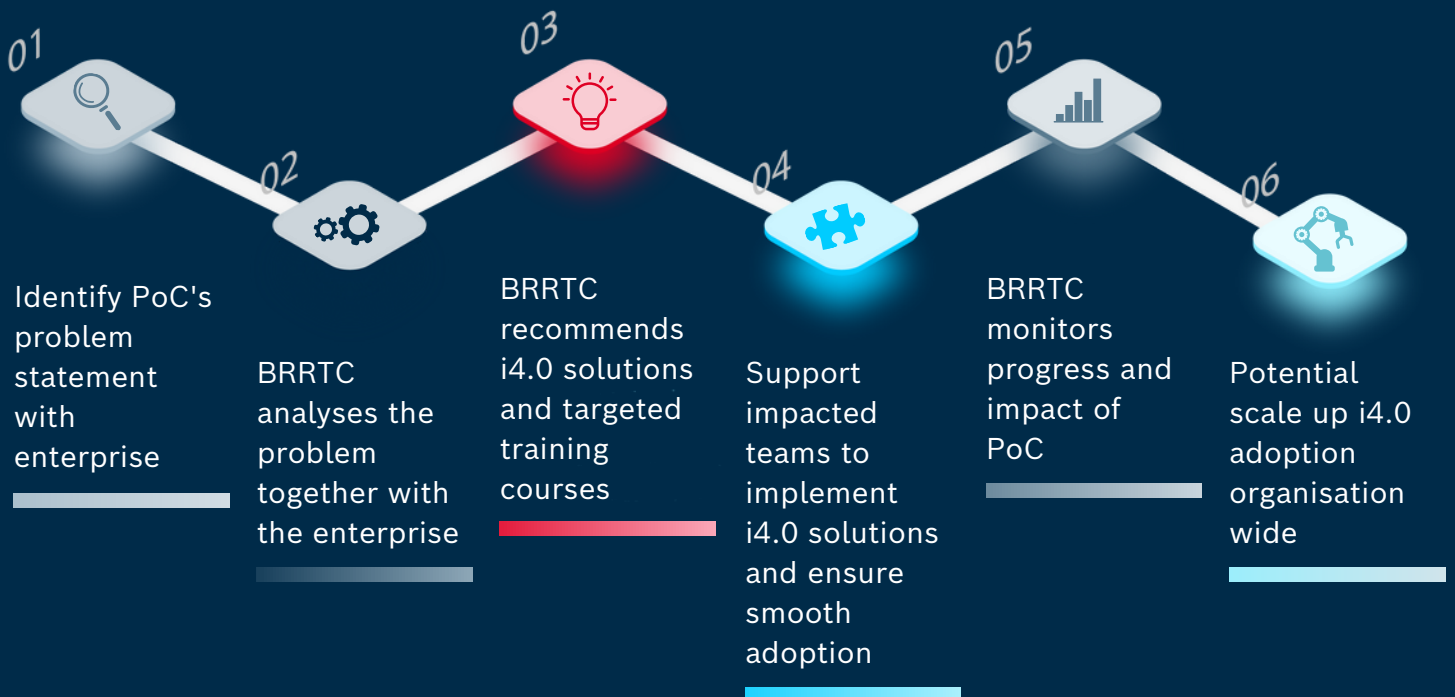
Maximised Output and Minimised Resource

1 10-year plan for Singapore manufacturing to grow 50% by 2030: Chan Chun Sing, The Straits Times, 25 Jan 2021.
2 Hussein Magdy Elhusseiny and Jose Cripsim. (2022). SMEs, Barriers and Opportunities on Adopting Industry 4.0: A review. Procedia Computer Science, Vol 196, pg.864-871.

Challenges faced by Small and Medium Enterprises (SMEs) when adopting i4.0

1 Implementation costs

2 Lack of technological know-hows

3 Lack of skilled employees

To examine what workforce capabilities are required for i4.0, this publication spotlights (a) skills needs as exemplified by three industry Proof-of-Concept (POC) projects to adopt new technology in preventive maintenance, process management and inventory management; (b) highly transferrable sustainability skills and critical core skills for the manufacturing sector. It ends with a call to action on the courses and programmes available to help companies and workers upskill in these areas. The three industry POC projects are conducted by Bosch Rexroth Regional Training Centre (BRRTC), one of SSG's SkillsFuture Queen Bees.[3] These projects prove that it is feasible of SMEs to adopt i4.0 solutions to achieve business outcomes and reskill the workforce.

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Identify PoC's problem statement with enterprise

BRRTC analyses the problem together with the enterprise

BRRTC recommends i4.0 solutions and targeted training courses

Support impacted teams to implement i4.0 solutions and ensure smooth adoption

BRRTC monitors progress and impact of PoC

Potential scale up i4.0 adoption organisation wide

BRRTC's process of working with enterprises during PoCs.

3 SkillsFuture Queen Bees (SFQB) are private organisations that champion the SkillsFuture Movement in their respective industries. There are currently more than 30 SkillsFuture Queen Bee companies. There are two types of SFQBs. The first type is SFQB-Value Chain, where SFQBs partner SkillsFuture Singapore (SSG) to offer customised jobs and skills solutions. The second type is SFQB-Market Leader (BRRTC is under this model), where SFQBs partner SSG to develop and/or deliver training programmes for skills in demand.

PoC 1: Reduce Downtime through Predictive Maintenance

Company: Kim Hock Corporation Pte Ltd
Business: Metal and wood waste recycling
Objective: Digitalise and improve the maintenance of wood shredder machine operations to reduce downtime

Graphic illustration of a wood-shredding machine. ©Evgeny
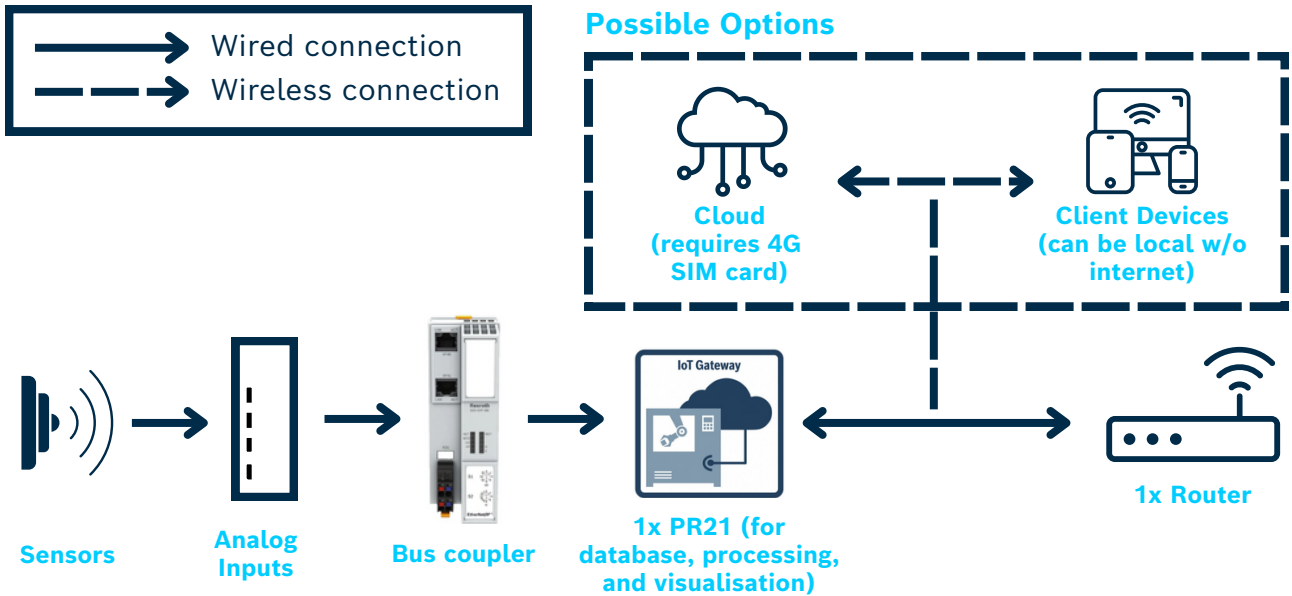
BRRTC i4.0 Solution

Implement predictive maintenance technology by connecting condition monitoring sensors to IOT platform to track key metrics:

Pump pressure
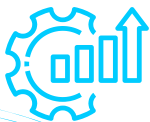
Wood hog vibration and temperature

Weigher information

Solution Architecture
IoT Gateway and Monitoring

Wired connection
Wireless connection

Possible Options

Cloud
(requires 4G SIM card)

Client Devices
(can be local w/o internet)

IoT Gateway

Sensors → Analog Inputs → Bus coupler → 1x PR21 (for database, processing, and visualisation) → 1x Router

Solution architecture to implement predictive maintenance technology at Kim Hock Corporation.

Job Roles upskilled through the POC	New Key Tasks	Examples of Skills needed	Skills Demand Growth [4]	No. of Job Posts in 2022 Requiring this Skill
Plant Engineers and Technicians	▸ Install sensors ▸ Lay electrical wires ▸ Lay data network cables ▸ Set up wireless routers ▸ Set up the dashboard of the IoT platform on mobile devices ▸ Become system administrators of the IoT platform	Internet of Things Application	74%	15,010
		Data Collection and Analysis	70%	9,062
		Predictive Maintenance	68%	2,095

Results

Productivity and cost savings increased, as unplanned downtime decreased

The plant engineers and technicians involved in the PoC can now implement predictive maintenance technology in other machineries

The machines became more reliable and hence products can be shipped to customers on time

4 Skills demand growth refers to the relative increase in demand for a skill from 2019-2022, where skills with high demand growth are more likely to see shortages now and in the near term.

PoC 2: Enhance Process Management by taking steps to digitalise the factory shopfloor

Digital factory shopfloor

Company: Oriental Motor Asia Pacific
Business: Manufacturing of electrical products and accessories, specialising in motors
Objective: Improve the parts replenishment of a Surface Mount Technology (SMT) line process to increase productivity, by implementing a digital factory shopfloor

TESTIMONIAL FROM ORIENTAL MOTOR

"

BRRTC provided us with guidance, technical support, skills and knowledge during the PoC. As a company, we are able to

1. Embark on the proof of concept which demonstrated how a solution or an idea can be implemented;
2. Integrate IoT sensors and devices within the SMT line to retrieve data from devices;
3. Learn about flow-based programming Node-RED and designing a dashboard;
4. Learn how to retrieve data from machine server via Node-RED;
5. Learn and understand the basics of networking, database and web application.

"

Bosch Rexroth's IoT panel within OM APAC's SMT line.

BRRTC i4.0 Solution

Create a system to monitor and visualise the status of a SMT line process

Start/Stop by the operator before/after part replenishment for each Mounter > Timing and Counter (via ctrlX)

2x Wireless Push Buttons

2x Receivers

WiFi AP

Obtain each light signal via a relay to provide machine status (1 x mounter, 1 x tower light)

2x 3-tier Tower lights

6x Relays

Wireless I/O module

Web-based visualisation on client devices/ big screen

Tapping signal from solenoid valve on the pusher conveyor (before Unloader) to get Throughput
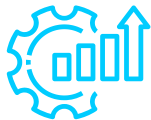
Pneumatic solenoid valve

Relay

ctrlX (IoT Gateway used to process and visualise)

System architecture of data collected for the productivity study.

Results

Monitor the line process status in real-time, without the need for additional manpower to gather and upload data, thereby increasing productivity

Exploring new i4.0 solutions to tackle waste management

Optimise inventory levels, FIFO control, and reduction of lead time

Replicate the same solution for the rest of the SMT lines

Job Roles upskilled through the POC	New Key Tasks	Examples of Skills needed	Skills Demand Growth	No. of Job Posts in 2022 Requiring this Skill
Manufacturing Engineer	▶ Integrate IoT sensors and devices ▶ Design and optimise processes that incorporate IoT technology	Robotic and Automation	72%	7,196
		Programming and Coding	70%	170,583
		Big Data Analytics	68%	129,558
		Process Control	53%	17,332
Production Lead	▶ Analyse vast amount of data generated by the manufacturing process ▶ Use IoT platform to provide real time visualization of data related to the manufacturing process for improved efficiency	Data Collection and Analysis	70%	9,062
		Data Visualisation	65%	13,859
Data Analyst (potential/ new role)	▶ Analyse vast amount of data generated by the manufacturing process ▶ Use data science to produce actionable insights	Cloud Computing Application	81%	24,161
		Artificial Intelligence Application	80%	38,897
		Internet of Things Application	74%	15,010
		Data Visualisation	65%	13,859
		Data and Statistical Analysis	55%	8,940
Maintenance Technician	▶ Perform predictive maintenance	Internet of Things Application	74%	15,010
		Programming and Coding	70%	170,583
		Predictive Maintenance	68%	2,095
		Big Data Analytics	64%	129,558
		Preventive Maintenance Management	43%	27,510

PoC 3: Increase Productivity and Manage Inventory through Real-time Monitoring

Equipment Management

Company: Tritan AMS (Advanced Manufacturing Solutions)
Business: Providing advanced manufacturing solutions such as Additive Manufacturing and Automation, with strong expertise in Precision Tooling, Machine Tools Trading and Sheet Metal Fabrication.
Objective: Reduce failed prints. Value-add to the industrial 3D printers that they sell.
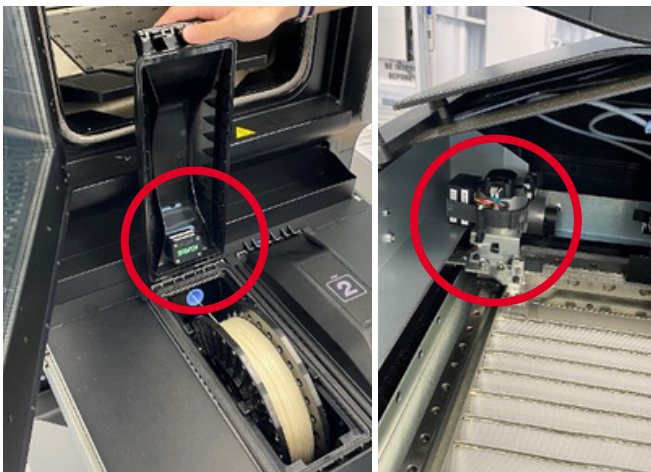
Wireless sensor within the material chamber and on the axis motor.

BRRTC i4.0 Solution

Build IoT platform to monitor material type, material utilisation, and temperature within the 3D printers

Install wireless sensors to monitor the humidity in the material chamber of the 3D printers

Connect sensors to IoT platform with alerts to maintain optimal material chamber humidity, which in turn reduce job rejects

Next steps of i4.0 adoption

To replicate the same for their sheet metal fabrication and further increase their productivity through automation using robotics.

To use Autonomous Mobile Robots / Guided Vehicles to transport sheet metals.

An overview of seven 3D industrial printers in a dashboard for operators.

Job Roles upskilled through the POC	New Key Tasks	Examples of Skills needed	Skills Demand Growth	No. of Job Posts in 2022 Requiring this Skill
Plant Engineers and Technicians	▶ Configure the IT setting of the IoT platform ▶ Use Node-RED programming ▶ Build the control panel with electrical wiring to house the platform ▶ Operate Autonomous Mobile Robots / Guided Vehicles	Condition Monitoring	78%	990
		Robotic and Automation Technology Application	72%	7,196
		Data Collection and Analysis	70%	9,062
		Programming and Coding	70%	170,583
		Robotic and Automation System Maintenance	69%	895
		Predictive Maintenance	68%	2,095

Results

Reduce wastage due to job rejects

Forecast materials order

Timely customer service support

Sell an enhanced version of industrial 3D printers with predictive maintenance technology

Green and Critical Core Skills

Alongside i4.0 and digital skills, manufacturing companies increasingly need a workforce that can respond to the increasing number of binding sustainability requirements, and that can work well across disciplinary boundaries, to manage the convergence of hardware and software. SSG and partners have highlighted the importance of green skills and Critical Core Skills (CCS)[5] in various reports, including the Skills Demand for the Future Economy (SDFE) 2022 report and the January 2023 Jobs-Skills Quarterly Insights with IES.

Examples of Green Skills needed	Skills Demand Growth	No. of Job Posts in 2022 Requiring this Skill
Renewable Energy System Management and Integration	169%	1,246
Sustainable Manufacturing	157%	1,174
Energy Management and Audit	98%	7,881
Sustainable Engineering	93%	3,354
Environmental Sustainability Management	73%	36

**Top five Critical Core Skills for Engineers and Technicians:**

▶ **Communication**
▶ **Collaboration**
▶ **Problem Solving**
▶ **Creative Thinking**
▶ **Self Management**

To find out more about green skills for engineers and technicians, you can download the Job-Skills Quarterly Insights on the left. To find out more about i4.0 implementation, you can download the Skills Demand for the Future Economy 2022 on the right.

https://go.gov.sg/jsi-2023q1

Jobs-Skills Quarterly Insights

https://go.gov.sg/sdfe
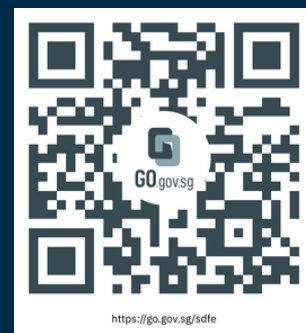
Skills Demand for the Future Economy 2022

5 Critical Core Skills are a unique set of 16 core skills identified by Singapore employers as the most critical to thrive in the future economy.

Call to Action

Courses to upskill the workforce to support i4.0 adoption, including those that offer application approaches:

https://go.gov.sg/sep2023-sfjsi-brrt
c-courses

Courses to upskill in the area of Critical Core skills:

https://go.gov.sg/mysf-ccs-courses

Other SkillsFuture Initiatives	Training Provider
Jobs-Skills Integrator [6] (JSIT) in the Precision Engineering sector: JSIT-PE	JSIT-PE (Nanyang Polytechnic)

https://go.gov.sg/sep2023-sfjsi-brrt
c-feedback

You are an important stakeholder and your invaluable feedback will help us develop more useful insights for you in the future. We ask that you spare 5 minutes to let us know how this report has helped you via this link.

6   JSITs are intermediaries who will work with industry, training and employment facilitation partners to optimise training provision and job matching services for companies and individuals. They will help to aggregate manpower and skills demand, actively supply of trainings, and help match skilled workers to jobs.

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Companies

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Oriental Motor Asia Pacific Pte Ltd

Tritan AMS Pte Ltd

References

In collaboration with partners, SkillsFuture Singapore employs data and industry validation to curate insights for individuals and enterprises to make informed decisions on jobs and skills matters.

ITM Combined Press Release, 18 Oct 2022, New Growth Strategies to Drive Advanced Manufacturing Across Five Sectors in Singapore (https://www.assemblymag.com/articles/97679-industry-40-technology-and-manual-assembly)