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Smart manufacturing and its implications for Singapore's SMEs

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By THOMAS MENKHOFF & GOPALAKRISHNAN SURIANARAYANAN

While Covid-19 and the climate catastrophe continue to make headlines, local small and medium-sized enterprises (SMEs) are quietly setting the gears of Smart Manufacturing in motion with a strategic focus on digitising and automating production processes powered by "Industry 4.0" (I4.0) ready business models.

A shared view among several interviewees we talked to recently in the context of an ongoing study on the impact of I4.0 on the business models of local manufacturers is that Industrial Internet-of-Things (IIoT), machine learning, visual computing, automation and digital twining are deemed of great importance for the long-term competitiveness of Singapore's manufacturing ecosystem on the global stage.

I4.0 encompasses adopting opportunities from end-to-end digitalisation with connected computers and increasingly autonomous automation systems equipped with intelligent machine learning algorithms that control robotics with minimal human input.

As the traditional manufacturing model is being increasingly replaced by advanced, high-value manufacturing technologies such as IIoT, cloud computing, and real-time data processing and insights, adopting the right enabling technologies in a phased manner with proper planning on the basis of a winning business model is critical for sustained I4.0 success.

Our research interviews with key decision-makers across Singapore's I4.0 ecosystem (comprising government agencies, universities, suppliers/providers of technology and business associations) helped to identify 5 key drivers - government's technology push with funding and training support; labour dependence; productivity and efficiency issues; pressure to innovate business models due to increased competition; and impact of Covid-19.

The 4 main barriers are ROI (return on investment) concerns, capability and mindset issues, and ecosystem limitations for adopting and implementing I4.0 approaches in local SMEs.

Particular emphasis was put on examining the impact of I4.0 on the business models of several local manufacturing SMEs (medical technology; engineering equipment; machine vision and imaging) by utilising A. Osterwalder's Business Model Canvas (BMC) framework and its "building blocks" such as customer value proposition, revenue streams, profit formula and key resources.

The results suggest that business model innovation - that is, the development of a novel and differentiated value creating and value capturing, strategic operating model - is critical for leveraging the numerous opportunities that I4.0 solutions provide.

Business model innovation often leads to a fundamental shift in how a firm delivers value to its customers, whether by revamping its value proposition and optimising the underlying operating model or by enhancing technological process capabilities in form of I4.0 enabling technologies such as big data analytics in combination with visual computing.

A classic example is Swiss tool manufacturer Hilti, which shifted from selling high-quality tools to selling tool fleet management services to construction companies in the 2000s.

Customers get to choose from a wide selection of tools ("Tools on Demand"), and then pay a fixed monthly rate for a defined period of time. Hilti tracks, repairs, replaces, and upgrades tools at no additional cost.

Visual computing

A key enabling technology for I4.0 is visual computing with its subdivisions of augmented reality (AR) that combines reality with digital content and vision analytics.

Companies can apply visual computing techniques to visualise and examine the massive amounts of data such as images, video and 3D sequences, and sensor data about an asset's condition, collected by cyber-physical systems installed in the firm's manufacturing cells (manufacturing cells are sets of machines that are grouped by the products or parts that they produce) to tackle predictive maintenance-related issues and to recommend actions to take.

AR software is a key I4.0 enabling technology that derives actionable production and/ or maintenance-related information from smart cameras and sensors.

German steel giant ThyssenKrupp (TAG), for example, is using high-precision AR tools to help on-site staff in some of its large industrial facilities to identify critical technical components affected by technical problems and to reduce downtime.

By pointing the camera of a tablet at the machine, defective parts are marked in one colour. Simultaneously, the AR application helps the worker by displaying the faulty part that needs to be replaced as well as repair instructions on the screen.

Another AR application field is elevator maintenance. AR-powered tools enable TAG technicians to visualise immediate and future issues with its elevators and fix them before they occur. AR is increasingly used for training purposes, for example, with regard to digitalised visual workflows that provide a top-level view of all the steps involved in a particular industrial production task or machine-related process by enabling the user to see his/her own hand overlapped with the hand of a master craftsman.

Many German carmakers use AR for welding training and stud welding to build prototypes.

The SMEs surveyed had benefited quite significantly from the ongoing Smart Factory ecosystem expansion led by the Agency for Science, Technology and Research, and were moderately advanced on their I4.0 transformation journey.

They pursued a smart, incremental I4.0 adoption strategy via a phased and bite-sized module implementation approach. Industry 4.0 technologies like IIoT, AI, robotics, data and image analytics as well as Big Data were preferred technology choices.

A lean manufacturing approach with data-driven decision making in combination with a High-Mix-Low-Volume (HMLV) strategy was the preferred Smart Manufacturing route adopted by the SMEs.

Leveraging BMC building blocks

The manufacturers we talked to excellently leveraged several BMC building blocks such as "Key Partners", "Key Activities", "Key Resources", "Cost Structure" and "Customer Relationships" (with "Value Proposition" and "Customer Segments" as medium impact areas).

"Channels" and "Revenue Streams" turned out to be low-impact areas, suggesting that more can be done to reach out to (new) customer segments and to come up with new service offerings, including ways to generate cash from (new) customer segments as well as more creative pricing mechanisms such as pay-per-use.

Challenges ahead include heavy emphasis on bottom-line metrics, precision engineering skills upgrading and greater use of business model and supply chain innovations such as Product-Service systems (PSS), on-demand provision of customised services, real-time shipment and inventory visibility and tracking as well as prescriptive artificial intelligence.

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