How Digital Transformation and IoT Can Contribute to the UN Sustainable Development Goals

An Industrial Internet Consortium and IoT Alliance Australia Joint White Paper

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THE GENESIS

In Simon Sinek's book *Start With Why*[2], he explains the *Golden Circle* (Why-How-What) which is essential to inspire people to take action and necessary to achieve the *United Nations' Sustainable Development Goals* (UN SDGs) by leveraging digital transformation in organizations.

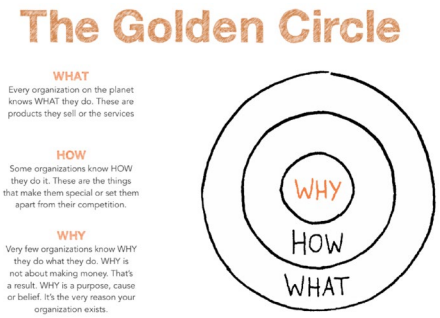

Figure 1: The Golen Circle

This paper uses a modified version of the Golden Circle, changing the original sequence to Why-What-How to approximate how organizations currently operate and thereby increase the chances of achieving the relevant UN SDG.

WHY?

In the World Economic Forum's (WEF) 2018 report on the *Internet of Things Guidelines for Sustainability*[3], researchers clearly show how existing IoT projects support UN SDGs, even though in most cases this was not the organization's objective in executing the project.

IoT only represents one technology in the digital technology stack and is combined in business solutions with other digital technologies, like mobile, cloud, drones, robotics and artificial intelligence (AI), all to support digital transformation. One use case could involve getting sensor data streams into an integrated data management and analytics platform for the purpose of predictive maintenance and displaying the relevant information in an augmented reality (AR) application on a smart phone. Therefore, the WEF study results can be applied to digital transformation, which is enabled by IoT.

Figure 2: Internet of Things Guidelines for Sustainability

The climate change discussion over the last 12-to-18 months clearly demonstrates the relevance of this topic in societies worldwide as big investors like Blackrock shift their portfolios towards sustainability and social impact. Blackrock's *Letter to the CEO*[4] by CEO Larry Fink is a highly recommended piece of thought leadership.

[2] Simon Sinek, Start with Why: How Great Leaders Inspire Everyone to Take Action, Penguin LCC US, 2011
[3] https://www.weforum.org/whitepapers/internet-of-things-guidelines-for-sustainability/
[4] https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter

With high street and main street joining forces, not aligning digital transformation initiatives with UN SDGs can be a high-risk for any organization. This is evident from current trends such as consumers voting with their wallets and switching to product and service alternatives that consider environmental and social impact along the cradle-to-grave life cycle.

WHAT?

Organizational activities are driven by business strategy and its execution in the form of initiatives that transform the operating model. Digital technologies play a key role in many transformation activities. What we need to achieve is to link UN SDGs to digital transformation initiatives of an organization. While UN SDGs are clearly defined, digital transformation lacks a clear and accepted definition; this paper provides a potential definition below.

WHAT ARE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS?

UN SDGs are 17 interconnected goals to achieve a better and more sustainable future for all.[5] They were unanimously adopted by all UN Member States in 2015 to end poverty, protect the planet and ensure all people enjoy peace and prosperity by 2030.

Figure 3: UN Sustainable Development Goals

WHAT IS DIGITAL TRANSFORMATION?

Although there is no single agreed digital transformation definition, there is common understanding that it relates to business change, related outcomes and effects enabled by digital technologies (e.g., IoT). Essentially, digital transformation is adapting to change using digital technologies. This likewise draws attention to adaptive digital capabilities.[6] We can define a Digital Transformation Maturity Model by considering what IoT and other digital technologies can enable from a business transformation perspective.

[5] https://sustainabledevelopment.un.org/

[6] Korhonen, JJ and Gill, AQ, "Digital Capability Dissected" (2018). *ACIS 2018 Proceedings*. 27.

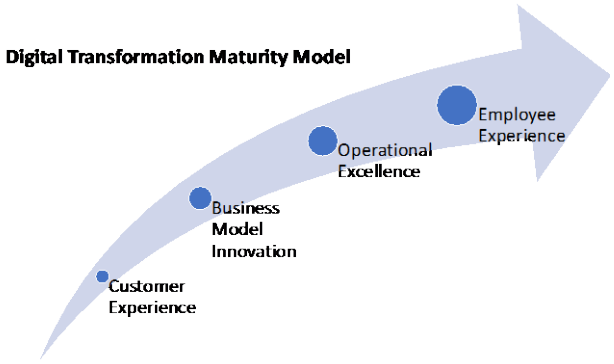

Figure 4: Digital Transformation Maturity Model

Customer experience entails using digital technologies to improve the experience of customers in buying and using existing products and services. This is not limited to online experiences, but includes the brick-and-mortar shopping world. Information regarding availability of goods in stores can be provided using sensor technology (e.g., smart shelves). The maturity model can start with the customer experience, as customer demand drives everything else, including business model innovation.

Business model innovation changes the way an organization currently operates. This could mean moving from products to services, creating new digital products or changing channels to the market. The IoT Business Model Builder in the Industrial Internet Consortium's (IIC) *Business Strategy and Innovation Framework* can be used to shape business model innovation. Selling flight hours instead of jet engines is an IoT-enabled innovation that engine manufacturers like General Electric and Rolls-Royce have embraced. Once the new business model is defined, the business operations of the organization can be optimized using digital solutions.

Operational excellence entails optimizing the operating model using digital technologies. This is what Jeanne Ross from Massachusetts Institute of Technology (MIT) calls *digitization*. Many, especially asset-intensive, industries use the word *automation*. For example, IoT helps with the automation of business processes, using intelligent assets like autonomous mining trucks. After the processes are reengineered and optimized, the final step is to improve the employee experience. In the end, people create the customer experience. Sadly, this is often overlooked in a drive to "optimize the hell out of operations with automation and lean approaches".

Employee experience explores the work environment while attempting to make it more productive, safe and enjoyable. However, different industries have different priorities in this respect. In manufacturing, productivity tops the list; in mining safety is the priority; while in creative industries a more enjoyable working environment is the focus. Vital sign sensors can be built into safety vests or smart helmets in factories to monitor employee health in real-time.

In the white paper *Realizing the Internet of Things: A Framework for Collective Action*[7] five pillars for the successful introduction of IoT are described and as IoT is a digital technology, those pillars are likewise key to the success of the digital transformation of an organization.

1. *Architecture and standards:* Reference architecture enables the development of standards, by disclosing the areas of a technology landscape or organization where standards add value by influencing the technology vendors to distance themselves from proprietary solutions. Reference architectures also provide best practices in the form of blueprints to accelerate and deescalate digital solution implementation risk.

2. *Security and privacy:* Sensors and IoT devices provide an additional attack surface for end-to-end business solutions and data collected from sensors may be linked back to an individual person and needs to be protected accordingly.

3. *Shared value creation:* Value from investment in digital technologies, like IoT, may only occur in the long-run and benefits may be realised by other organizations and individuals that did not make the technology investment. A shared business case in a value network is key to incentivise investments in digital technologies.

4. *Organizational development:* Personnel will require new skills to use digital technologies, but also to operate in an organization that may change significantly due to the impact of technology on the business model and operations.

5. *Ecosystem governance:* Digital solutions require the input and participation of multiple organizations in a value network. They form an ecosystem and how to steer that ecosystem towards a common goal requires a governance structure. Industry associations like the Industrial Internet Consortium (IIC) and the WEF have a key role to play.

Those pillars are critical success factors for the successful implementation of digital transformation and hence key for achieving the UN Sustainable Development Goals an organization has decided to pursue.

WHAT IS THE CONNECTION BETWEEN UN SDGS AND DIGITAL TRANSFORMATION?

UN SDGs can be used to shape the business strategy and goals of an organization. Depending on an organization's answer to the question "What is our digital vision and how do we want to achieve it?", some UN SDGs are relevant to the digital transformation of an organization. What is not apparent is how UN SDGs fit into the strategic planning process, which is addressed next.

[7] Merritt J. and Sarma S., "Realizing the Internet of Things: A Framework for Collective Action" (2019), World Economic Forum in collaboration with the Massachusetts Institute of Technology

How?

Strategic Planning in the Digital Age

The Object Management Group's Business Motivation Model (BMM)[8] and the Balanced Score Card (BSC)[9] are two tools often used in strategy planning and execution and are certainly relevant to digital transformation. The BMM contains vision, goals and objectives, while the BSC categorises objectives and links them to the strategic initiatives. These tools can likewise be used to link UN SDGs to the business strategy as illustrated below.

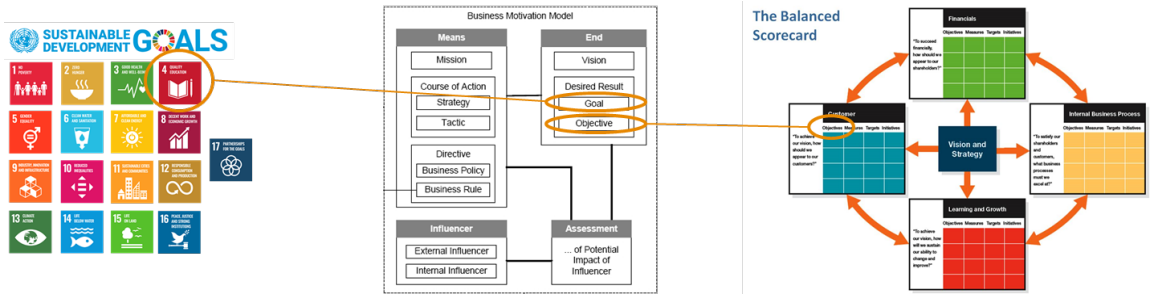

Figure 5: Business Motivation Model and The Balanced Scorecard

UN SDG and Business Strategy Models

A specific UN SDG maps to a goal in the BMM that is linked to a set of objectives. An objective in the BMM can be mapped to an objective in the BSC. The next step is linking the objective in the BSC to an organization's supporting digital transformation projects so that UN SDGs relevant to an organization can be directly traced to its project portfolio. The BSC provides this mechanism as it links objectives to initiatives and initiatives are the main building block of a digital transformation project portfolio.

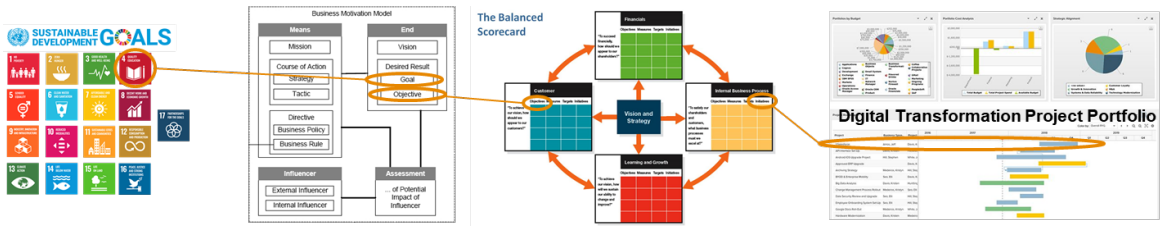

Figure 6: Digital Transformation Project Portfolio

[8] Business Motivation Model, Object Management Group, https://www.omg.org/spec/BMM/About-BMM/

[9] Norton, David P. and Kaplan Robert S., "The Balanced Scorecard: Translating Strategy into Action", Harvard Business Press (1996)

UN SDG and Digital Transformation Initiatives

While we now have a way to link UN SDGs to an organization's strategic planning process, we now need to create the link to the operating model of an organization, coming up next.

Model Driven Enterprise for Digital Transparency

Digital transformation initiatives change the business operating model and technology landscape in a way that supports the achievement of UN SDGs. An organization's current and future business operating models along with its technology landscape can be documented using Enterprise Architecture Models (EAMs). The MIT Centre for Information Systems Research (CISR)[10] defines *enterprise architecture* as an enabler for business strategy execution. Strategy execution occurs through digital transformation projects that use solution architecture designs to describe the future state of the part of the organization or value network that is transformed.

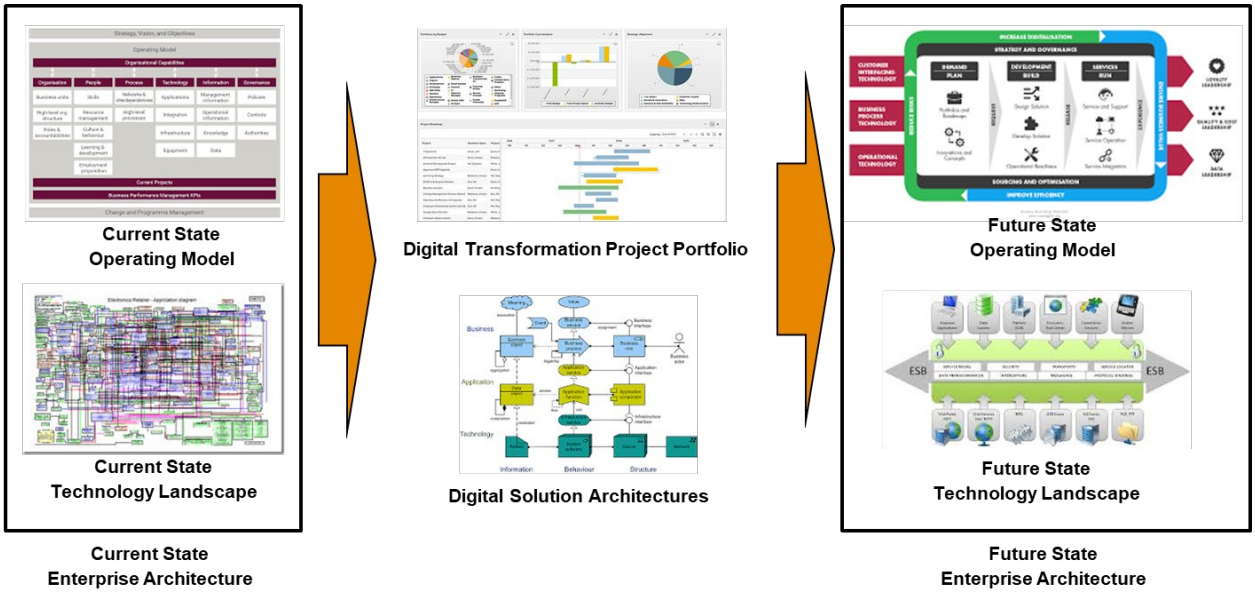

Figure 7: Current and Future Enterprise Architecture States

EAMs can describe the whole organization consistently and create transparency by documenting the different parts of an enterprise and the relationships between them. Using the right tools to model the enterprise and solution architectures in the organization's current and future state facilitates identification of dependencies and relationships. Questions that can then be answered include:

- If I switch off this server, what business processes are affected?
- If I re-engineer this process, what IT systems are affected?

[10] https://cisr.mit.edu/content/classic-topics-enterprise-architecture

- If this project does not succeed, what UN SDGs are affected?

The outcome of using a standardised and integrated modelling tool landscape is a consistent and current EAM.

The *enterprise model* covers strategy, business operations and technology landscape. Its power lies in the transparency generated which aids understanding how the organization operates and also provides the ability to run "what-if" scenarios.

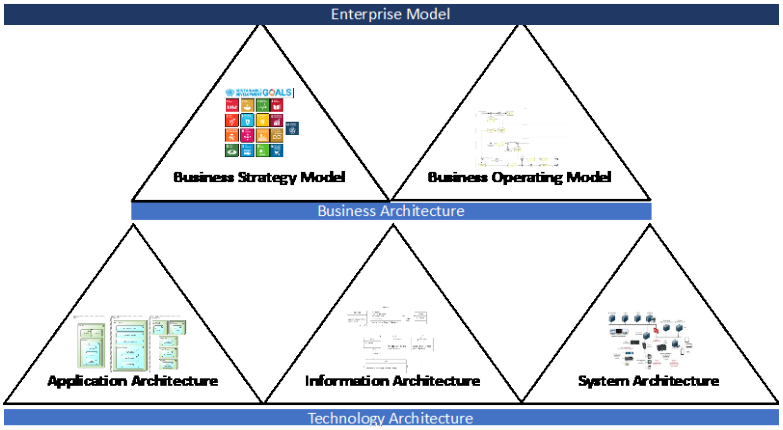

Figure 8: Enterprise Model

This enterprise model is a virtual representation of the real world. A model-driven enterprise connects the enterprise model to the real world of business and technology operations as a new approach of managing an organization. Business and technology operations have two aspects: the actual execution and the monitoring of business activities. The monitoring is necessary to compare the enterprise model with what is happening in real world operations. Gartner describes the combination of modelling, monitoring and execution as the "Digital Twin of the Organization".[11]

[11]https://www.gartner.com/en/documents/3901491/create-a-digital-twin-of-your-organization-to-optimize-y

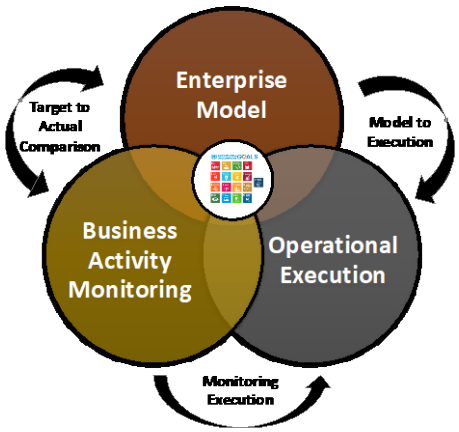

Figure 9: Model-Driven Enterprise

UN SDGs are defined in the enterprise model, achieved through operational execution, measured via business activity monitoring and compared to the target values in the enterprise model. With sensor technology and IoT, business operations can be monitored in near real-time and hence target UN SDG achievement can be tracked in a timely fashion.

There are a couple of partial model-driven enterprise solutions available with a focus on *monitoring execution* and *target to actual comparison*. To deliver products or services to a customer one enterprise is insufficient and a supply chain or value network is needed. With all the different modelling tools, operational systems and monitoring solutions from different vendors, interoperability is the main challenge in achieving a model-driven enterprise let alone a model-driven value network that supports the achievement of UN SDGs.

To address this challenge the *MIT Auto-ID Lab* (IoT birthplace) and the *University of Technology Sydney DigiSAS Lab* have initiated an industry-driven research collaboration on the model-driven enterprise starting with data exchange formats for models and other relevant information.

WHERE?

Here we show three real-world examples of how UN SDGs were unintentionally achieved by organizations. This demonstrates that many organizations implicitly support UN SDGs and hence miss an opportunity to improve their reputation and brand. All the case studies do not implement a model-driven enterprise, but the main intent behind sharing the examples below is to illustrate how IoT and digital transformation can be used to achieve UN SDGs. To honour organizational confidentiality the names of the organization cannot be disclosed.

1. *Global Mining Operator*: Mine sites are dangerous working environments and most organizations in the industry have a strategic goal of *zero harm*. Worker fatigue affects the safety of mine operations. Fatigue has many contributing factors and predicting it is difficult. Hence, guidelines are provided to the employees and preventative fatigue management programs are implemented. Available health data, including real-time sensor data in personal

protective equipment can be correlated using machine learning to allow for near real-time prediction of fatigue risk. This is aligned with *UN SDG #3: Good Health and Well-Being*.

2. *Industrial Equipment Hire Company*: Amongst other assets, industrial clients hire diesel generators from an industrial equipment hire company for use in regular operations or whenever the electricity grid has an issue. Diesel generators have a large carbon footprint. Through sensor data and AI, generator fuel consumption can be minimized. Also based on consumption, carbon offset credits can be purchased to enable their clients to hire a *carbon-neutral diesel generator*. This supports *UN SDG #13: Climate Action*.

3. *Container Terminal Operations*: Container terminals are traditionally dangerous working environments where people die. There is limited visibility around the corners inside the container stacks. Straddles are 65-ton vehicles that bring containers from point A to point B. Just imagine a straddle colliding with a forklift. An Australian operator equipped the container terminal with sensors and removed the straddle driver thereby converting them to autonomous straddles. IoT sensor data, combined with data analytics allowed the Australian operator to reduce its injury rate by over 95% within one year of introducing these digital technologies which supported *UN SDG #3: Good Health and Well-Being*.

4. Smart Farming[12]: Sugar cane farming requires intensive work from farmers. Because of aging farmers and a younger generation avoiding manual work, farming faces a serious problem: a lack of workers. To solve this problem, an agriculture company in Thailand, with six sugar mills, four ethanol generation plants and around 5,000 contract sugar cane farmers, devised a smart farming solution, using GPS, sensors and autonomous tractors. This example illustrates typical challenges of adoption of IoT technologies in developing countries. The company needs to use expensive radio frequency, because IoT networking technology is not yet available in Thailand. Market adoption of smart farming solutions are difficult, due to the required investment, the difficulty of farmers understanding the benefits of the solution and not having the necessary skills to operate the solution. Solving those issues for IoT adoption in developing countries could contribute to solving the problem of a decreasing work force. This Smart Farming Solution supports *UN SDG #9: Industry, Innovation, and Infrastructure*.

CALL FOR ACTION

This paper illustrated how digital transformation can support relevant UN SDG, by including them in the strategic planning and execution of digital transformation activities. The model-driven enterprise concept can link to business operations and the technology landscape, making the progress towards UN SDGs measurable and transparent. We recommend including the model-driven enterprise in your digital vision and strategy and implement it one digital transformation project at a time, starting with a proof of concept to show the value to the business.

[12] Lee, J. (2018) EECi demand articulation and strategy development, STIPI, mimeo. Bangkok, Thailand

AUTHORS AND LEGAL NOTICE

This document is a work product of the Industrial Internet Consortium *Digital Transformation Working Group*, co-chaired by Jim Morrish (TransformaInsights), Dirk Slama (Bosch) and Bassam Zarkout (IGnPower).