Beyond Capex: Future proofing your IT investment for sustainable value delivery

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Introduction

Digitisation (the process of incorporating digital technologies into all aspects of the business) has become necessary for industrial companies to remain competitive. The International Data Corporation estimates that more than half of all technology spending will go towards digital transformations in the next four years (IDC, 2019). Those that don't make progress are likely to find their businesses increasingly under threat from competition by organisations that have a lower cost base, are more agile/responsive and that provide better service to their customers. Digital transformation is a top-down initiative with 23% of CEOs owning or sponsoring their company's digital transformation initiative (Solis, 2019).

In theory, a green-field capital project offers a unique opportunity to leap-frog industry competitors and implement robust and future proof IT systems. A new facility will not have to deal with the legacy IT systems that other companies are trying to get rid of. Within an existing organisation, a smaller "brown-field" capital project can serve as a catalyst for implementing new digital technologies in other parts of the enterprise. Capital projects are inherently concerned with the relatively short-term objective of delivering a new facility on time and within budget. However, the primary goal of the owner team is also to deliver business value. When considering that the new facility will operate for many years, how can the project team deliver a facility that is future proof?

In this article, I explore Smart Manufacturing and Industry 4.0, and the way in which these trends are impacting manufacturing. I also demonstrate that for a new business to be future proofed against digital disruption, it needs to develop the necessary digital capabilities from the outset. This needs to take into consideration the total value chain, from raw materials to production, and ultimately to meeting customer needs. This is a vast and complex subject and this article can only serve as an introduction.

Constraints during capital project execution

There are several reasons why the capital project environment is not conducive to developing the necessary digital capabilities for a new business. Capital project

organisations (owners, EPC's and sub-contractors) are fully aware of the requirement. However, as recent as 2017, McKinsey & Company identified reluctance by capital project stakeholders to adopt modern digital technologies (Fuchs et al, 2017). Specifically, they were weak adopters of advanced analytics, automation, robotics, information modelling and advanced document management systems.

Companies in sectors from government to manufacturing significantly reduced costs by aggressively pursuing digital transformation initiatives. In general, capital project organisations have previously not had the mandate to lead this type of process. Owner operators are left to bring in consultants or draw on other corporate resources where these exist. Often this is late in the project.

Typical capital project methodologies are concerned with delivering a new facility within the constraints of cost, quality and time. Once a capital project is underway, design changes can become very costly. Successful capital projects need to stay focused on efficient execution and need to remain, to a certain degree, isolated from business disruption. Between the time the project is initiated and commissioning of the facility, there will be several major innovations in IT. The project environment follows a waterfall methodology that is very different to the rapid cadence required by agile methodologies needed by an operating business that wants to contain costs, while at the same time retaining and growing market share.

Industry 4.0 and Digital Transformation

Manufacturing is being transformed around the world by digitising the way that products are conceptualised, designed, made, consumed and serviced. Digital technologies are also impacting the operations, processes and energy footprint of factories and supply chains (Ezell et al, 2018).

The concept has evolved with slightly different emphasis in different countries, but is usually referred to as 'Industry 4.0' or 'Smart Manufacturing'. Industry 4.0 originated in Germany and refers to the convergence of digital and manufacturing technologies. Smart Manufacturing refers to "fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs." (NIST, 2018).

Digitisation refers to the application of fast evolving information and communications technology to every facet of the manufacturing value chain. The cumulative result of digitisation programmes across industry is changing the nature of global competition. This process takes place before, during and after the capital project. The challenge is to align the project deliverables to take advantage of these trends.

There are several emerging technologies that underpin Industry 4.0 and Smart Manufacturing. Boston Consulting Group (BCG, 2019) has identified nine technologies that are having the greatest disruptive impact on industrial production, as illustrated in Figure 1.

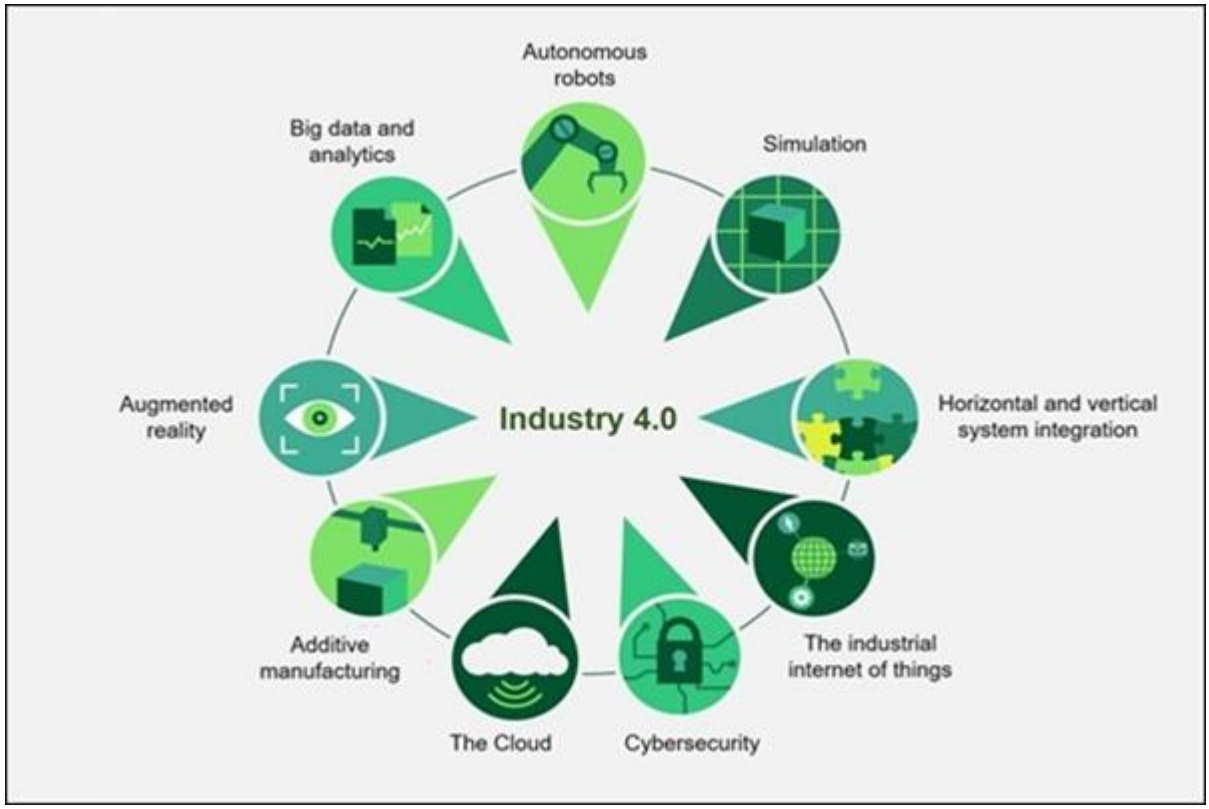

Figure 1: Nine disruptive technologies that are transforming industrial production (BCG, 2019)

The problem during a capital project is to identify exactly how these disruptive technologies could impact on the future business. While this responsibility is in the owner team, developing the detailed requirements could prove difficult until the plant is commissioned and fully operational. However, it is possible to ensure that, at minimum, the necessary infrastructure, platforms and skills are in place for continued digitisation to take place post commissioning.

We'll consider two of the nine disruptive technologies in Figure 1 in more detail, namely 'The Cloud' and the 'Internet of Things'.

The Cloud and Internet of Things

The biggest shift in business systems since the 1970's has taken place over the past five years with a proliferation of data that is available for analysis in the cloud.

The source of much of this data is a result of many low-cost intelligent devices/sensors throughout the value chain. This is commonly referred to as the 'Internet of Things' (IoT). In the industrial context we normally refer to the IIoT or the 'Industrial Internet of Things'. IIoT devices are autonomous, industry grade computing devices that are connected to the internet. The IIoT compliments and extends the traditional SCADA (supervisory control and data acquisition) systems found in a typical factory. Unlike SCADA, IIoT data is processed and analysed using internet services. IIoT data is also

accessible by business partners given the right permissions. Cloud computing allows for significant processing power to process and analyse this data. Prior to 2010, the computing hardware and software to do this was simply not an option for the average company.

The application of IIoT on the factory floor is estimated to increase productivity in traditional factories by as much as 25% (Gerbert et al, 2015). Yet, many capital projects develop their operating cost models without taking this into account.

Re-imagine the future of manufacturing

As mentioned, a capital project is ultimately responsible for delivering business value to the owner. The external environment will likely change significantly over the years during which the facility operates.

In the USA and China (in particular), Industry 4.0 is strongly associated with new 'smart products', internet 'platforms' and the new business models that are based on them (Kagermann et al, 2016). **Smart products** are products that are equipped with sensors that measure and feedback customer usage information to the manufacturer. This enables proactive servicing/maintenance and facilitates data driven new product development. The motor industry is already adopting this approach – certain model motor vehicles already report usage data to service centres allowing targeted preventative maintenance strategies, as well as alerting owners to overdue maintenance. **Platforms** refer to central hubs through which companies transact. The trading hubs typically own very few assets. The best-known consumer examples are Amazon, Uber and Airbnb. Despite the lack of ownership of any significant capital assets, these organisations can be major market disruptors.

In other regions, the emphasis might be slightly different. For example, in Germany "Industrie 4.0" also refers to the integration of digital factories with intelligent supply chains. Having the lowest cost of production is no guarantee of success. In the future business competitiveness will also depend on the strength of the entire industrial supply chain (of which your company will only be a small part).

Future manufacturing is likely to also be characterised by a continued move away from making products to delivering products as a service. This trend is called 'servitisation' and offers manufacturers a way in which to differentiate their offering from what would otherwise become a commodity (such as electricity, chemicals, etc.) These value-added services will also require new organisational capabilities.

This growing need for more customised services will require agile, responsive end-to-end operations. Not all companies are at the same maturity level in this regard. Maturity levels range from basic computerisation through to adaptability, as shown in Figure 2 (Shuh et al, 2017), which illustrates the typical stages in a digitalisation development path.

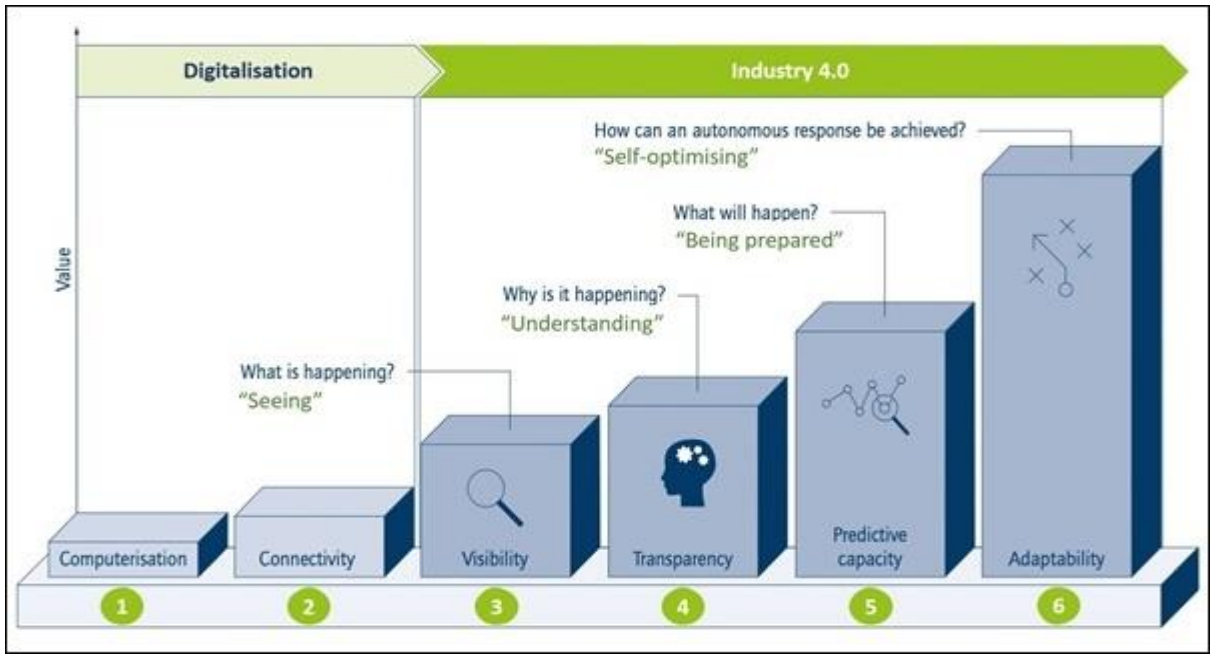

Figure 2: Typical maturity levels in a digitalisation process (Shuh et al, 2017)

Owing to the many dependencies it is of course not realistic for a new industrial scale business to start up at level 6. More likely, a new facility will be commissioned at level 3. What is important for the capital project team is to ensure the operation is equipped with the resources, capabilities and systems to evolve quickly through step 4 to 6 as the plant ramps up to full production.

Digitisation through the Project Stages

Project phases and stages

The OTC Stage-Gate Model for a typical industrial scale capital project, showing the recommended phases and stages of development, is represented in Figure 3.

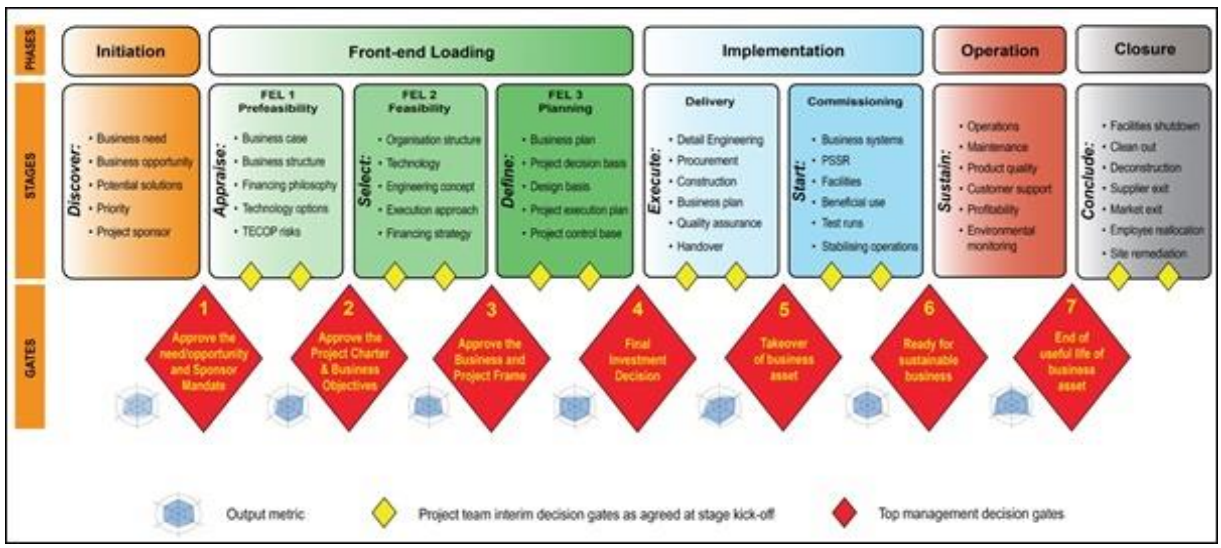

Figure 3: Phases and Stages of development of a typical capital project

Arguably the most important time to charter the digital future of the new facility is when the business is conceptualised, i.e. in the 'Initiation' phase at the start of the project.

The initiation phase starts with the identification of a new business opportunity. This is the ideal time to consider the impact of smart manufacturing and Industry 4.0. During the project execution phases, certain design philosophies will need to be incorporated into the plant, the control and automation systems and the business systems, as well as in the staffing structures and skills. It becomes increasingly difficult as the project proceeds to retrofit these later.

During initiation there also needs to be some consideration of customer outcomes and not just defining the product specification. It is important to engage with prospective customers to ensure that at the end of the project the venture will deliver the right product/service. I've spent five years working on one industrial scale capital project where attention to customer outcomes and not just the product specification would have made a significant difference to the business success. Six years after commissioning it turned out (after significant losses were incurred) that we were able to make a better and far more profitable product for an adjacent market using mostly the same equipment.

During the early business development/conceptualisation stage, it is a good idea to study examples of digital factories within your industry. It is also a good idea at this stage to engage experienced consultants from the industry who can educate, inform and facilitate this process.

Having accepted the inevitability of Industry 4.0, the business leaders/entrepreneur should also decide whether to commit to establishing a digital culture. Part of this will be to identify the type of skills the business will require to be future proof (Shuh et al, 2017). Bringing these skills into the project as early as possible is a good idea.

Opportunities for digital advantage across the value chain

In this section, I will identify some practical examples of areas across the business value chain where digitisation can be incorporated. A very simplified representation of a typical manufacturing value chain is given in Figure 4.

The following areas in the value chain are likely to have the greatest short-term impact by digitalisation (Adapted from MGI, 2015).

- **Operational efficiency / digital twin models:** Use a digital twin model to run scenarios to optimise production, e.g. using IIoT together with SCADA data to centrally or remotely optimise operations;
- **Predictive and preventative maintenance:** Through continuous monitoring and using predictive analytics, determine in advance when maintenance will be needed;

- **Intelligent supply chain:** Data driven artificial intelligence-supported demand planning, forecasting and scheduling;
- **Logistics and distribution:** Using IIoT to track materials in transport. Measure real-time inventory levels through the manufacturing process and combining with third party data (e.g. a 3PL or 4PL provider) for logistics optimisation; and
- **Health and safety:** Real time tracking of workers and equipment when they move into dangerous areas or perform dangerous work.

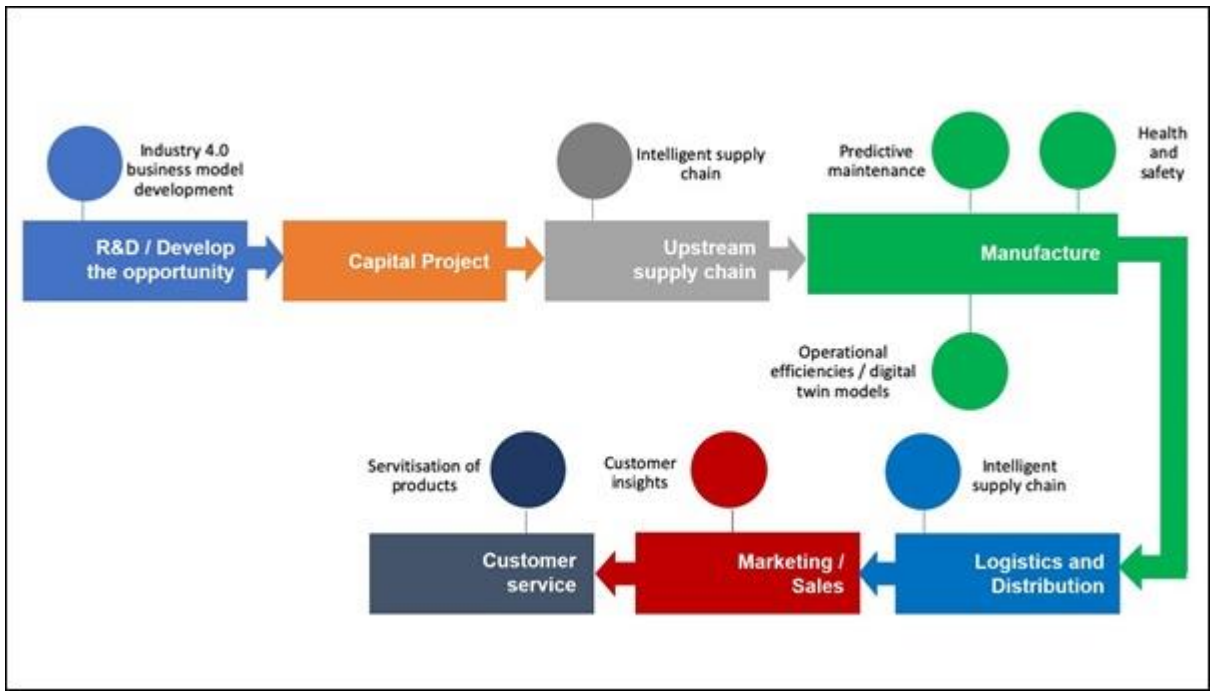

Figure 4: A typical value chain showing areas where digitisation could apply

Embedding digital systems into the new business

Industry 4.0 requires a level of integration across the value chain that sets a new bar in terms of system integration. The business systems need to be horizontally integrated across the value network; and at the same time vertically integrated into the company's internal business processes. When designing a digitally resilient business, it is necessary to engineer the end-to-end digitalisation of the entire value chain (Kagermann et al, 2016).

In practical terms, this could mean that operational data from machines on the factory floor, warehouse management systems, logistics and transport systems is combined with data from adjacent (upstream and downstream) operations to provide real-time intelligence. In some cases, the upstream and downstream data will belong to organisations outside the factory boundary.

This also means that traditional business systems such as supply chain management (SCM), enterprise resource planning (ERP) & customer relationship management

(CRM) need to be connected to the plant as well as the systems of business partners and customers in a way that information becomes visible along the entire value chain. Every system, technology and platform therefore need to be carefully selected during the capital project to enable this integration.

Incorporating digitalisation in the design philosophies

At the outset it is important that the digital strategy is incorporated into the design philosophies for the plant. During the project the EPC and sub-contractors need to be aware of these requirements and take them into account when specifying equipment. When the project is handed over, these philosophies will become baked into the operation and hard to change, making it important to get right up front.

The following are some considerations that should be considered when developing the design philosophies:

- **Create the connected enterprise:** Design a robust and scalable IT infrastructure that is suited for the large data volumes anticipated in future. Decide how you will secure the networks and mitigate against cyber-threats. Decide how you will manage cloud aspects such as data sovereignty, security, flexibility, reliability and scalability;
- **Standardise on core technologies:** Develop a standard for your core platforms (operating systems, databases, intranets, cloud servers and middleware). Develop standards for desktop computers, mobile devices and edge computing devices;
- **Next generation control, automation and business system design:** Develop a unified enterprise architecture that will incorporate control and automation systems together with business systems. Select control and automation systems like PLC's, DCS and SCADA that are cloud/IIoT ready and that conform to your architecture standards. Address data storage, automated data analysis (including AI), contextualised information delivery and visualisation/reporting. Decide how you will simplify and standardise task specific user interfaces to provide a common workflow and real-time capability across the business;
- **Decouple systems for maximum agility:** Decide on whether you will implement an integrated system from a single vendor or whether you will utilise best-in-class applications. Decide on whether you will develop any in-house software applications or use only "off the shelf" software. Decide which specialised/unique software applications are necessary to provide you with a competitive advantage. Decide how you will incorporate open industry standards allowing for substitution in future. Decide how the business systems are to be implemented at enterprise, business and business unit level – i.e. implement as separate systems, or in a common, integrated system;
- **Ensure you have the appropriate experience, skills and expertise:** Decide how you will select suitable vendors to be your strategic partners. Decide on which capabilities you will need to build in-house, and which can be outsourced. Pay

attention to attracting and retaining digital skills in the organisation. Decide how the OT (operational technology) and IT (information technology) functions will be structured to work to a common set of objectives; and

- **Design for 'planned obsolescence':** Decide how you will manage evolving open-source software within your systems. Decide how you will manage upgrades and planned obsolescence of technologies. Decide how to avoid proprietary solutions that results in vendor lock-in.

The fast-moving technological landscape will be difficult to exploit with in-house skills only. It is important to decide on your IT outsourcing strategy early on for the following reasons:

- **Specialist skills:** Outsourced specialised partners are more likely to have access to specialised information and communication technologies (ICT) skills and are exposed to industry best practices;
- **Career opportunities:** Career development of IT professionals within your organisation may be restricted – an outsourced partner may provide the necessary opportunities;
- **Business focus:** By outsourcing specialised IT functions, you can focus more on your business; and
- **Advisory function:** A well-managed outsourcing relationship should result in you having access to a trusted advisor to the business.

However, a certain level of in-house expertise will also be required. This might mean retaining in-house business analysis and development capabilities.

Closing Remarks

It has only been possible in this article to scratch the surface on the topic of digitisation, smart manufacturing and Industry 4.0. However, it should be evident that digital needs to be incorporated early on into all aspects of projects having a long-term strategic outlook.

Industry 4.0 and smart manufacturing are relatively new concepts and it is still early days. There are many obstacles towards realising the full potential of these technologies, not least of which are legacy systems and entrenched practices in existing companies. Other obstacles include lack of awareness, internal expertise, informed leadership and skills.

A project can only practically deliver a sub-set of the overall business requirement. At some point an operator will take over the facility and become responsible for continuing to innovate along the digital path. One major responsibility of the owner team is to

ensure that this new business is adequately structured and empowered with the skills and technologies to be able to adapt and thrive in this environment.

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