



# CAMBRIDGE SERVICE ALLIANCE

## Annual Review Year 10

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# Cambridge Service Alliance industrial partners



**Caterpillar Inc.** For more than 85 years, Caterpillar Inc. has been making sustainable progress possible and driving positive change on every continent. Caterpillar is the world's leading manufacturer of construction and mining equipment, diesel and natural gas engines, industrial gas turbines and diesel-electric locomotives. The company is also a leading services provider; Caterpillar Job Site Solutions offers complete solutions to customers that are designed to improve the jobsite performance and increase sustainability.



**CEMEX.** A global building materials company, CEMEX provides high-quality products and reliable service to customers and communities in more than 50 countries throughout the world, and maintains trade relationships in 100 nations. It works hard to develop and deliver the best solutions in cement, ready-mix, and aggregates, transforming ideas into reality. It is focused on creating sustainable value by providing industry-leading products and solutions to satisfy the construction needs of its customers around the world. It strives to make the future better for its customers, shareholders and communities by becoming the world's most efficient and innovative building materials company.



**HCL.** Founded in 1976 as one of India's original IT garage start-ups, HCL is a pioneer of modern computing with many firsts to its credit, including the introduction of the 8-bit microprocessor-based computer in 1978 well before its global peers. Today, the HCL enterprise has a presence across varied sectors that include technology, healthcare and talent management solutions and comprises three companies - HCL Infosystems, HCL Technologies and HCL Healthcare. The enterprise generates annual revenues of over US \$ 8.9 billion with more than 143,000 employees from 140 nationalities operating across 44 countries.



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# WELCOME



The Cambridge Service Alliance is 10! It's been quite a decade, one in which we thought we had got used to living with constant change. But we had not expected to be celebrating our tenth birthday digitally, amidst a global pandemic.

However, it is in some ways apposite. Digital transformation has been at the heart of Cambridge Service Alliance research for at least half of its life and if COVID-19 has taught us one thing, it is the overwhelming need for businesses to fully embrace digitalisation. The lessons of the pandemic have been stark: those firms that had already invested in their digital infrastructure were much better able to support a sudden, mass shift to remote working. Similarly, the consumer-facing businesses that thrived are those with a strong digital grip on their supply chains and digital platforms which deliver a fantastic customer experience.

Digitalisation has also entered the national consciousness in new, unexpected - and not always welcome - ways. Zoom and Teams are now part of the fabric of our lives, both socially and professionally. In spite of some of their well-documented downsides, they have been an invaluable innovation. We've also seen examples of less successful attempts to apply digital solutions to a problem, such as the UK government's ill-fated exam-grading algorithm.

## **The future of digitally-enabled businesses**

Before the pandemic, we had agreed our four core research themes. They remain as relevant now as they were then, if not more so.

- ▶ How firms can formulate a successful digital transformation strategy.
- ▶ How digital twins and platforms can create new business models and revenue streams.
- ▶ How to apply and benefit from emerging technologies.
- ▶ How technology can help us better understand customer behaviour and improve the customer experience.

In this *Review*, for example, you can read about Dr Chander Velu's practical, cross-functional approach to driving digital transformation through business model innovation (page 4). This will be increasingly necessary as firms have to adapt to new realities - and opportunities. For incumbent B2B firms that have struggled to emulate the success of the platform-driven consumer giants, Dr Erika Pärn thinks that digital twins could be the way forward (page 8). Understanding business models are also central to Dr Zakaria Dakhli's analysis of what's stopping the construction industry from switching to offsite manufacturing (page 11).

Dr Veronica Martinez has been applying a new technology (Bluetooth Low Energy enterprise tag) to the problem of getting people back to work safely (page 13) and Dr Mohamed Zaki has been working with a team of Danish researchers to apply machine learning to techniques to a quality control problem. Zaki has also been working a framework to help organisations take a strategic approach to collecting customer data (page 17) and Dr Yasmin Fathy proposes an innovative approach to improving our post-COVID workplaces - techniques which could also be used to gain valuable customer insights (page 21).

We hope that you enjoy this *Review*. Do get in touch if you would like to know more about any of the topics covered in it, or, indeed, how you can join the Cambridge Service Alliance.

Professor Andy Neely  
Director, Cambridge Service Alliance

Dr Mohamed Zaki  
Deputy Director, Cambridge Service Alliance

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# Making business model innovation happen: the Business Model Cohesiveness Scorecard



Digital transformation is failing to live up to its hype, at least as far as productivity gains are concerned. If, as research, suggests a lack of business model innovation is the main culprit, we need a way of making it happen. Dr Chander Velu thinks a balanced scorecard approach could be the answer.

Over the last decade, as huge advances have been made in digitalisation, productivity growth has slowed in all the major economies. Counter-intuitively, it is those sectors that are most intensive users of information and communication technologies that appear to have made the largest contribution to the slowdown.

How can we account for this paradox? Some blame the 2008 financial crisis, but the decline predates the crash. Others think that it is a dispersion problem: large companies *are* actually very productive but are let down by a long tail of inefficient SMEs. Is it that the developed world simply doesn't have the

skills to benefit from a digital economy? Or perhaps it's a measurement problem? The tech giants like Google have different business models, often predicated on free services which conventional ways of measuring productivity don't always cope with.



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**Read more:** This article is based on “Business Model Cohesiveness Scorecard: Implications of Digitization for Business Model Innovation” by Chander Velu in *Handbook of Digital Innovation*, edited by Satish Nambisan, et al (Edward Elgar, 2020)

## Are business models to blame?

Or could the problem be a lack of business model innovation – particularly amongst incumbent firms? There is a precedent here. In the last industrial revolution when electric motors replaced steam-driven machinery, factories carried on doing what they had always done – just swapping electricity for steam. It took 30 years and a complete change of business model to bring about the long-anticipated surge in productivity.

The same thing may be happening today, with the big global firms that have dominated our industrial landscape for years, organised around outdated technologies.

If that’s the problem, how do we solve it? Firstly, we need to understand what we mean by a business model. If a business strategy determines a firm’s products and services, a business model is effectively its ‘go-to-market logic’. It is a highly complex, cross-functional system encompassing those activities that are part of the business model, how those activities are interlinked and who has the right to make decisions about them.

To understand it requires ‘big picture’ systems thinking. However, most large, pre-digital firms are organised by function. In this context, no one ‘owns’ the business model. It is often seen as a ‘given’, something that each function needs to optimise but no one questions.

## Avoiding the ‘piecemeal syndrome’

One of the dangers of such organisational silos is that it may make sense for one part of a firm to adopt a new technology to make a particular

process more efficient. But, if the system is not looked at in its entirety, this can be problematic and create conflicts with other processes.

To help us think about the complexities of business model innovation, we have invented the following scenario. If a part in a washing machine stops working, it can take weeks to order a new one from the manufacturer, who has to hold a large number of spares in stock. In a future enabled by IoT, 3D printing and distributed ledger technologies, when the washing machine detects a fault, it could contact the manufacturer who shares its intellectual property with a local firm that prints the part and replaces it.

This is an example of a whole-system innovation that could result in more agile customer service, greater efficiency for the manufacturer and less waste thanks to a better repair service. However, if only parts of the process are adopted piecemeal - for example, if the manufacturer used 3D printing to make new parts and hold them in stock - then the benefits of business model innovation would not be fully realised.

## Looking beyond profitability

Another inhibitor of business model innovation is that many firms rely on profitability as their principal indicator of success. Further, most accounting systems tend to look at the profitability of different parts of the business independently, without taking into account the value they might be generating elsewhere in the organisation or ecosystem.

Focusing solely on profitability (at either the firm or business unit level), makes it difficult to identify and measure all the

interactions within the firm and across the whole value chain that comprise the business model. Yet studies have shown that being able to manage those linkages is a major source of competitive advantage.

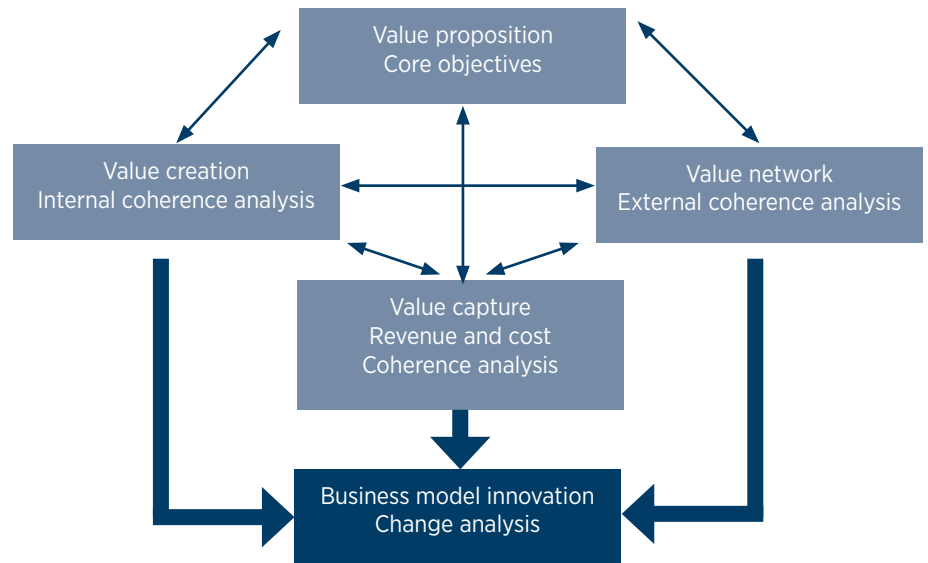
In order to help senior managers identify and evaluate these linkages and hence spot opportunities for innovation, we suggest adopting a scorecard approach alongside conventional profitability assessments.

## Developing the Business Model Cohesiveness Scorecard (BMCS)

The ‘balanced scorecard’ is a well-established method of augmenting financial reporting with other key measures such as how the business is creating value for its customers, what internal processes does it have for satisfying customer and shareholder needs and how is it developing its people, systems and culture to achieve growth. More recently, the approach has been extended to emphasise the alignment needed to capture synergies across the business through mechanisms such as having a clear business strategy.

While this more nuanced approach is a significant improvement on financial reporting, it still does not give managers the information they need to understand and manage the evolution of the business model.

The BMCS uses systems dynamics thinking to model the behaviour of the system as whole, rather than in a piecemeal fashion. It aims to measure the alignment between the different components of the business model, from four perspectives:



*Business Model Cohesive Scorecard Framework*

1. Physical flow: are the raw materials and finished products and services delivered at the right time and in the right place?
2. Information flow: is the information for decision-making delivered to the right people or systems at the right time?
3. Decision rights: do the right people or systems have the authority to take decisions?
4. Incentives system: are people appropriately incentivised to make timely and joined-up decisions?

By asking these questions of all the elements in the business model, it is possible to see if the firm is delivering on its customer value propositions while making a satisfactory return. In doing so, BCMS complements traditional financial reporting by enabling business model innovation while evaluating financial viability.

### Evaluating business model's impact, internally and externally

How does this work in practice? If we return to our example of the washing machine manufacturer and assume that it has acquired the capability to print a spare part when a machine's IoT device orders one, we need a structured way to evaluate the pros and cons of changes to the business model. The first step is to examine its potential impact on the firm's coherence internally across all functions (product design, procurement, manufacture, sales, distribution, customer service, HR and IT) and then externally to include ecosystem partners such as the logistics firms, repair specialists and retail stores.

Internally, the effects could be both positive (better customer service and opportunities for product innovation,

for example) and negative: challenges for IT in supporting a new, standalone machine which may take longer to get the part to the customer. Similarly, there are pros and cons for ecosystem partners. Providing a bespoke service for customers needs to be traded off against the complexity of managing, for example, the logistics of delivery when the logistics firm might not know when the part is going to be ready.

### Understanding how value is captured

Having assessed the possible impacts of the new business model on the firm and its ecosystem, the next step is to look at how it would generate revenues while delivering the value proposition to the customer.

In our example, the greater flexibility for product design could increase revenues but the increased delivery times could negate the benefits to the customer and decrease revenues.

For the manufacturer, holding less inventory could lower costs but the uncertainty and complexity of printing on-demand could increase them.

Combining an analysis of revenues and costs with the rate at which assets are turned over to make a profit (resource velocity) will indicate the likely impact of margins and profit.

Applying this value lens in conjunction with an analysis of the aspects of business models discussed earlier (physical and information flows, decision rights and incentive systems) is likely to highlight some of the problems with the proposed business model and catalyse discussions for improvements, such as moving the printing nearer to the customer, in partnership with the retailer or a repair firm.

The benefit of the BMCS is that it gives the management team a mechanism for discussing the cohesiveness of a complex system and a method for evaluating its effectiveness. It is important to stress that it is not designed to be a one-off exercise but a method of supporting continuous dialogue about coordinated, cross-functional changes to the business model. This will be critical both to identifying new opportunities for business model innovation and also for implementing them across the whole business and ecosystem.



	Value Creation	Value Network
Revenue/Value Proposition	▲ increased flexibility increased time to delivery ▼	
Cost	▼ reduced inventory ▲ uncertainty from printing on demand	▲ due to uncertainty from printing on demand
Resource Velocity	▼▲ Could increase or decrease depending on the net effect of flexibility and time to deliver for the customer	
Margins/Profit	▲ Potentially increased margins/profits depending on the trade-off between revenue and costs and resource velocity	▼ Potentially decreased margins/profits from higher costs depending on impact of revenue and resource velocity

Revenue and cost coherence analysis

## Putting the scorecard into practice

Our suggestion is to use interviews and workshops with senior management to create qualitative reports which would drive the changes needed to embed systems thinking across the organisation. In time, the quantitative elements of the analysis could be automated using data from various management systems: manufacturing support, enterprise resource planning, customer relationship management and accounting. In order to derive maximum value from the approach, it should be extended across the ecosystem, perhaps managed through a formal committee structure combined with appropriately defined data-sharing.

None of this is easy. But if firms are to take a more strategic – and effective – approach to business model innovation, they need a way both to cut through the complexity and to ensure that the process is owned by and embedded in the whole organisation. We believe the BMCS can help them achieve this and, in doing so, make an important contribution to solving the productivity paradox.



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## CSA WHITE PAPER

### Driving business model innovation: how ready is your digital thread?

A new white paper from the Cambridge Service Alliance and HCL Technologies considers how the development of a digital thread is vital for business model transformation.

But the authors also recognise that designing and implementing a digital thread is not straightforward. These days, it's the cultural and organisational issues that are more challenging than the technical. To help firms overcome these barriers, Cambridge Service Alliance researchers and HCL have developed a structured approach that will help firms assess whether they have the knowledge and capabilities they need to succeed.

**Read** the white paper: [www.cambridgeservicealliance.eng.cam.ac.uk/news/drivingbusinessmodeltransformation](http://www.cambridgeservicealliance.eng.cam.ac.uk/news/drivingbusinessmodeltransformation)







# Digital twins: driving business model innovation

For B2B firms struggling to reap the rewards of digitalisation, could digital twins be the way forward? Dr Erika Pärn explores the relationship between this emerging technology and business model innovation.



For many engineering and manufacturing firms, digital transformation remains elusive as they struggle to emulate the success of platform-based consumer businesses such as Uber, AirBnB and Facebook. While new technologies are undoubtedly delivering important efficiency gains, full-on digital revolution has proved more difficult to achieve in the B2B world.

Could digital twins be the way forward? As well as connecting the physical with the digital, like B2C platforms they also connect individuals and organisations. As such, they may be the enablers of disruption and business model innovation that the B2B world has been waiting for.



To explore this hypothesis we are working with colleagues at TU Dortmund and the Fraunhofer Institute for Software and Systems Engineering in Dortmund, Germany. Our goal is to develop a framework that will help firms understand both the opportunities digital twins can offer and how well placed they are to capitalise on those opportunities through a digital twin business model taxonomy.

As is the case with other digital technologies, the benefits of digital twins have to date largely been derived from increased efficiencies: improving performance, speeding up processes, predicting and pre-empting maintenance issues, quality control and cutting costs.

The cost savings alone are likely to be impressive. According to Gartner, by 2022 digital twins will be saving consumers and businesses \$1 trillion a year in asset maintenance. Which makes it not surprising that Gartner is also predicting

their widespread adoption, with half of major enterprises expected to be using digital twins by 2023.

Our contention is that if businesses are to derive maximum value from digital twins, they need to think more creatively about how they can support new value propositions. We are starting to see this happening. In 2020, for example, Rolls-Royce partnered with a start-up to create digital twins of its power systems to provide real-time insights that cross customer, supplier and partner boundaries. This is not just about increasing efficiencies – it's platform-based business model thinking.

### **Digital twins and business model innovation in aviation, automotive and construction**

In commercial aviation, digital twins have to date mainly been used to support maintenance and fleet management. However, twins of both aircraft and airport could provide new services such as the connected tracking of luggage or personalised cabin control.

In automotive, Tesla is using the technology to deliver a new kind of service. Every one of its vehicles is in constant touch with the Tesla 'motherhip', continuously transmitting performance data and receiving, in return, software patches and upgrades.

We are likely to see this kind of approach expand so that, for example, drivers' interests and locations are matched with relevant service providers. As you arrive in a new city, for example, you might be told, depending on your profile, what's on at the cinema, where you can go for a swim or find the best sushi.

As autonomous vehicles become more of a reality, we can see a completely new business model in which a car becomes a channel through which to sell other services. In each of these scenarios, it is

a digital twin that connects the customer with the service provider.

Digital twins are also starting to have an impact in the construction sector. Software providers such as Autodesk have platforms based on digital twins which are allowing new business models to emerge particularly around 3D design and construction services. As a result, we are starting to see a proliferation of start-ups offering new web-based tools and services.

However, where the aviation and automotive sectors are making good progress with digital twins, the construction industry faces more obstacles. It takes a relatively long time to build a building, the supply chains are long and include lots of small and micro-businesses that are not in a position to adopt new technologies. Buildings also need to last a long time - decades, if not centuries - making lifecycle maintenance both critical and challenging.

External forces are, however, beginning to drive change, whether it's governments mandating the sector to digitalise, building new hospitals at pace in Wuhan, responding to disasters such as Grenfell Tower or supporting commitments to carbon reduction.

In all three sectors, then, we are starting to see some examples of how digital twins are – or may – drive business model innovation, moving beyond delivering operational efficiencies to providing completely new products or services.

### **Understanding the direction of change**

To help us think about how digital twins can enable business model innovation, we have identified three pathways to change.

#### **1. From dependency to autonomy**

The inexorable drive towards autonomy is emerging in many engineering in

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“... if businesses are to derive maximum value from digital twins, they need to think more creatively about how they can support new value propositions.”

fields from automotive, aviation to manufacturing. One important feature of digital twins is their ability to understand, learn and react autonomously.

Autonomous decision making is seen as the pinnacle of value emanating from digital twins.

## 2. From ignorance to insight

By providing continuous insights into the performance of their physical counterparts, digital twins make real-time improvements to services possible. When ambitions are realised to create ‘national digital twins’ of whole countries, covering power, water, transport, communications, weather and demographic data, we will be able to answer a whole set of previously unanswerable questions. Can you, for example, avoid building a hospital car park by managing appointments and public transport flows? Can you reduce energy consumption by 10 per cent per person over a six-month period? What would be the impact of closing a main road to deal with flooding?

## 3. From inaccuracy to fidelity

How accurately the digital twin reflects its real-world counterpart is critical. For a digital twin factory, the level of fidelity needs to be high, not least because data – and the actions that data might trigger – is being passed between machines with no human intervention. In the construction sector, the level of fidelity tends to be much lower because more human intervention is still needed at both the design and construction stage.

Alongside these three key characteristics of digital twins, we observe three key forces that are also driving change within business models: the switch from products to services, the shift in focus from efficiency to agility and the move from digital separation to fusion.

## 1. From products to services

By enabling new business models that can create new value from operations, digital twins will have a critical role to

play in the shift from products to services. What might this look like? In automotive, digital twins will be able to feed back to manufacturers which features are being most used by drivers. In construction, a digital twin allows workers to personalise their office environment by using an app.

## 2. From efficiency to agility

If manufacturing and engineering firms are going to meet the diverse needs of their end-users and downstream supply chain partners, they need to stop focusing on efficiency and start thinking more about agility and customisation. Digital twins can enable this change.

## 3. From separation to fusion

By using digital twins to fuse the virtual world with the real, new business models become possible. In aviation, automotive and construction, as we have seen, the technology has the potential to underpin a revolution in the customer experience through, for example, new in-flight entertainment and the personalisation of the driving or office experience.

## Towards a maturity assessment model

Although our research is still at an early stage, these characterisations of how digital twins can enable business model transformation are helping us develop a framework to understand firms’ digital twin capabilities and where their business model innovation opportunities lie.

They are informing our preliminary analysis of the five key elements of a digital twin-enabled business model, against which we can measure a firm’s activities.

1. The **value architecture** – or how the business model works. Is it, for example, based on machine-to-machine interaction or machine-to-human? Where is the data coming from?

2. **Value finance** – or how the digital

twin makes money. Does it, for example, generate revenues through sales or leasing? Is the pricing fixed or based on outcomes?

3. **Value network** – or how it connects. Is it a standalone platform or part of an ecosystem?

4. **Value proposition** – or what it provides its customers. This is both the services it offers such as customer insight, training, visualisation and what they deliver such as decision support, personalisation or process optimisation.

5. **Value generation** – or how it creates value for its customers. Examples include data analytics, simulations, gamification, improved customer experience or extending the lifespan of an asset.

By breaking down the business model into its constituent parts we get a better understanding of how value is created with a digital twin. This will give us a structured way of evaluating a firm’s opportunities for business model innovation and identifying those that best fit with its unique capabilities.

In today’s world of digital (and pandemic) disruption, business model innovation is increasingly seen as ‘business as usual’ and not a one-off exercise, at least for consumer businesses.

Manufacturing and engineering companies are yet to fully realise the potential of digital twins to transform the way they do business in the after-sale market. A number of obstacles stand in their way: digital twins take an immense amount of computational power to operate, need people with the right skills to develop them and, perhaps most significantly, a huge amount of money to implement them. For those firms that can find a way forward, we think digital twins present an opportunity to irrevocably change the landscape and steal a march on their competitors.



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# What's standing in the way of offsite manufacturing?

## Understanding business models in the construction sector

For decades, the construction sector has been hailing offsite construction as the next big thing but we have yet to see it really taking off. Why is that, when the technologies and processes already exist? Zakaria Dakhli believes it is due to a fundamental incompatibility between business models and it is only when this has been fully understood that the long-awaited transformation can take place.

The construction sector across the world is beset by many seemingly intractable problems. In spite of government efforts to digitalise the sector through initiatives such as the adoption of Building Information Modelling (BIM), building methods have remained largely unchanged for centuries.

Leaders in the sector recognise the gulf between their working practices and those of manufacturers, with their optimised supply chains and use of machine learning and automation to drive efficiency and productivity. Surely, by adopting these ways of working to manufacture buildings offsite, it would be possible for the construction industry to do exactly the same. So why isn't it happening?

Dakhli points to the difference in business models between the two sectors as a key barrier to take up. The construction industry is project-based and the manufacturing sector is production-based. What does that mean in practice?

In construction, every project is different. You are starting from scratch each time, to a new specification, in a new location, with a different set of contractors. Supply chain management and storage logistics are not considered to be a core capability. Problems are often not anticipated and their solutions improvised. Manufacturers, by contrast, are mass-producing products with limited variation in a stable factory environment with an arsenal of tools at their disposal to improve their production processes, manage their inventory and optimise their supply chains.

### Understanding the value chain

The complexity of the value chain in construction poses further challenges. At each stage of the process there is a different client (depending on whether you are the architect, the engineer, the main contractor or one of the many subcontractors) each with a different notion of value. When the project is finished, the client who pays for the building is often not the client who operates it.

This means that the end-product often fails to meet the needs of the end-user because they were not the purchasing client and therefore not involved in making key spending decisions.

According to Dakhli, the main source of waste in construction is the way projects are designed and managed. They are sequential with each stage being handed on to the next specialist. The consequences are lots of re-work, fragmented communication, latent stress and a culture of blame between supply chain partners.

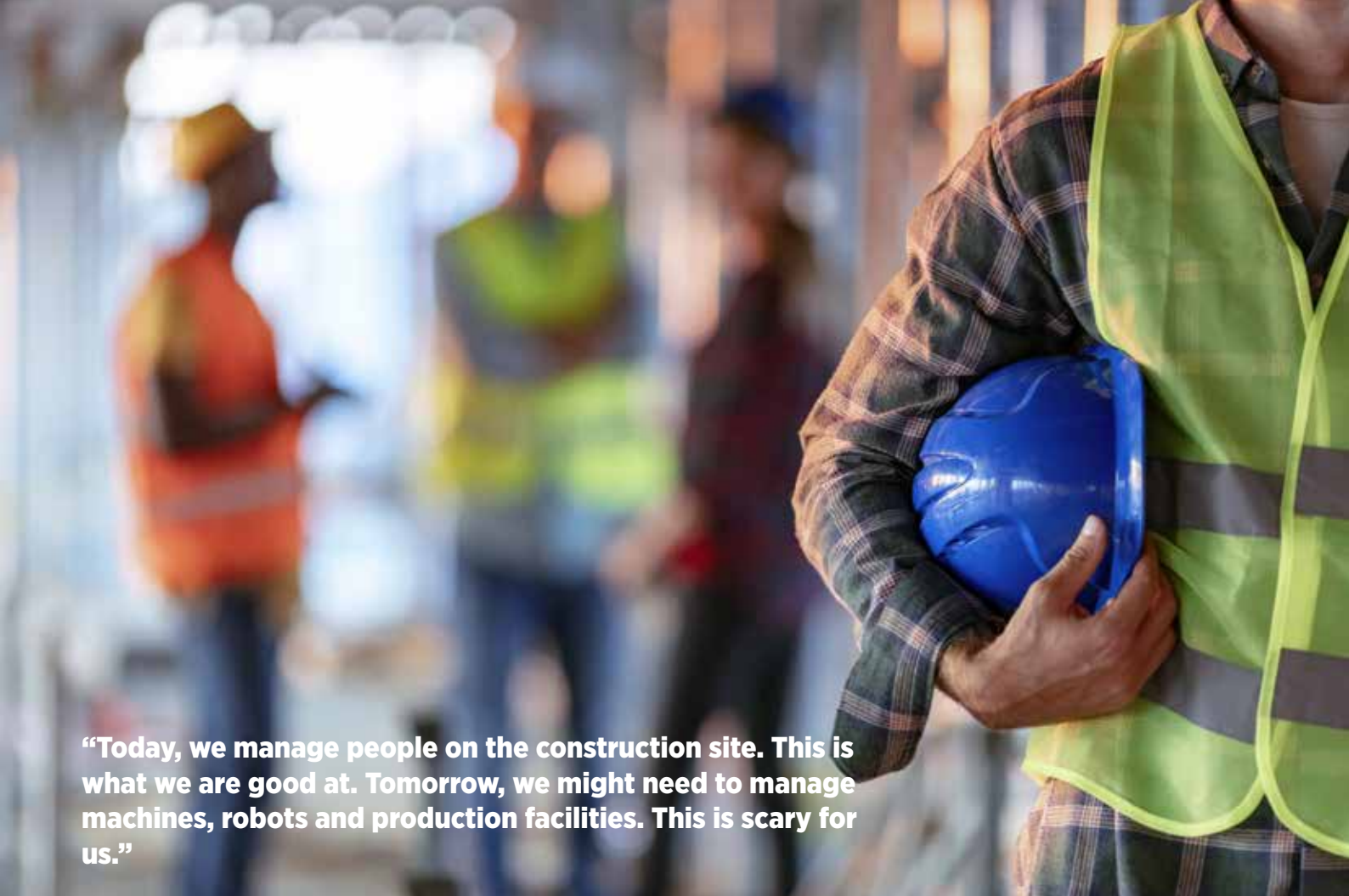
### Offsite manufacturing

Surely, offsite manufacturing is at least one of the answers to this problem? It creates a controlled, information-intensive environment in which material, process waste and cost can be minimised and construction cycle time, safety and environmental performance improved.

### From project to product-based business model: the economics

However, the economics of the construction industry result in a business model which make this difficult. Manufacturing in sectors other than construction is driven by customer needs and relies on accurate demand forecasting. For large and complex assets, 'engineer-to-order' (ETO) production may only take place once an order has been received and is customised to the client's needs. This is similar to a construction project in which there are many bespoke elements - but it is different because the manufacturer has much greater control over its costs and hence profitability.

Switching to offsite manufacturing requires major investment on the part of the construction firms. But without a steady demand, they are unlikely to take that risk. Their current project-based business model in which contractors come together as required is predicated on flexibility, in which labour is the safety net and



**“Today, we manage people on the construction site. This is what we are good at. Tomorrow, we might need to manage machines, robots and production facilities. This is scary for us.”**

investment in fixed assets is perceived as too risky. It is also the case that the sector lacks the skills to switch.

One manager we spoke to said: “Today, we manage people on the construction site. This is what we are good at. Tomorrow, we might need to manage machines, robots and production facilities. This is scary for us.”

Dakhli believes that it is only by developing a better understanding of the

different ways of working in construction and manufacturing – and the economic forces that are driving them – that the barriers to establishing a successful offsite manufacturing capability for the construction sector will be overcome.



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WHITE PAPER

**Generate revenue from digital platforms by managing the customer experience**

According to customer service guru, Shep Hyken: “Customers are smarter than ever because they’re experiencing great service from certain brands, and those rock-star brands are setting the bar higher for everyone else.”

But firms are finding that in spite of increasing their investment in the different realms of the customer experience they are unable to reap the potential rewards.

In this white paper, the authors explore this ‘customer experience paradox’ and how firms can use digital platforms to overcome it.

**Read** the paper here: [www.cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/digitalplatforms](http://www.cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/digitalplatforms)



# Getting people back to work, safely

As people across the UK gradually return to offices, a widely available, low-cost technology can help business protect their employees and ensure a COVID-safe workplace. Underpinned by an easy-to-implement digital infrastructure, the Test, Tag and Trace approach is already in use in a major bank in Canada, a large multinational pharmaceutical company in Europe, and leading meat processor companies in North America. Carefully implemented and properly communicated to employees, it allows offices to open safely while the pandemic is still active.

In the absence of a vaccine, governments around the world are looking for ways to get people safely back to work.

Restarting the economy without triggering a new wave of infections is clearly a priority. But how do you reassure an anxious workforce that its employers will do everything in their power to protect them from infection?

To avoid mass outbreaks in the workplace, governments around the world have set out operational guidance for businesses preparing for a new way of working. While these recommendations are – rightly – informed by expert advice from clinicians, epidemiologists, infectious disease and public health specialists, they have largely ignored the critical role technology could play in making the workplace a safer place for employees.

We think that the conditional logic and rule-based systems of computer science coupled with IoT technology can provide organisations with a visualisation and management tool that could help protect their workforces and provide them with much needed reassurance. The use of a simple, unobtrusive and inexpensive digital device – the Bluetooth Low Energy (BLE) enterprise tag – in conjunction with site maps and context-based rules, could enable businesses to return to full, pre-Covid operations relatively quickly.

## How it works: test, tag and trace

### TEST

First, each member of staff is tested for Covid-19. Initially, this could be done by taking their temperature but laboratory testing could be introduced later as it becomes more widely available and turnaround times faster. If the test proves negative, the employee will be certified and their available-for-work status uploaded anonymously to a secure database. They are now safe to enter the controlled workspace.

### TAG

Next they will have a lightweight BLE tag, roughly the size of a stick of gum attached to their ID badge, swipe card or pocket. These tags will be read by IoT hubs strategically placed at key

points around the building or site, such as entrances and exits.

### TRACE

As they carry out their tasks, each employee's tag sends a signal to the hub which feeds information to a database. Real-time data analytics match their location with a role and context-based set of rules to check that they are in the right place at the right time, with the right number of people for that particular workspace. In addition, the employee could also choose to have an app on their phone which warns them if rules have been breached nearby or if there are places they should avoid.

## A digital infrastructure for a safe working environment

This digitally-enabled test, tag and trace approach will mean employees can get on with their work, confident that they will be alerted to any unsafe behaviours, either their own or their colleagues'. In fact, the presence of the digital infrastructure and its reinforcement of the required behaviours will help to minimise the number of infringements by ensuring that the rules are clear and properly explained.

### Why BLE tags?

Most of the national contact tracing apps in use or in development rely on mobile phone location services to track contacts with infected people. However, using mobile phones for a workplace management system would be problematic.

First, there are the logistical issues: every employee would need to have their phone with them at all times, and make sure it is both charged up and switched on. Then there are the privacy issues. For the approach to work, employees will need to accept that it is for their protection and actively support its implementation rather than seeing it as an unwarranted intrusion into their privacy. If the mobile phone were to be used as the principal means of location tracking, employees could have legitimate concerns that they would be personally identifiable, that their individual movements could be tracked (both inside and outside work) and that their employer could access confidential information on their phones.



BLE tags, therefore, have a number of clear advantages. They are cheap, simple tracking devices which don't need batteries or a mobile signal to operate. They are always 'on', continuously pinging their location to the reader but will stop tracking as soon as the tag is out of range. In other words, they will allow the organisation to track the movements of its employees without identifying them individually throughout designated areas of the workplace. This solution provides both employee visibility and privacy, acting as a digital twin when they are at work but conferring invisibility on the employee the moment they leave the site.

There is, however, one critical issue with BLE communications that needs to be addressed. Open BLE communication allows devices to pair, connect and share information freely. If a BLE tag uses a standard BLE protocol these vulnerabilities can be exploited. We need the tag to operate with the efficiency of a BLE device but to do so without allowing pairing and connection with unauthorised third-party devices.

This is possible by using BLE discoverable signals that are broadcast from the tag rather than the BLE tags themselves. This is the approach taken by a new generation of enterprise BLE tags that are being adopted for security-critical applications such as asset management and supply chain logistics. The broadcast messages from these enterprise tags can still be read by a smartphone using its BLE capability, but the smartphone is unable to pair to the tag, rendering them extremely secure.

It also means that mobile phones can still have an important role to play. For example, iBeacon-enabled devices strategically placed throughout a building could provide location information

to a phone app to provide additional functionality to employees, allowing them to read and transmit BLE tags, so that they can be kept informed of areas to avoid.

Combining iBeacon hub devices, tags and mobile apps in an integrated design makes the most operational sense and provides the best continuous visibility. When deployed in conjunction with databases, maps, rules and guidance to trace employees anonymously and securely, this digital infrastructure will help employers protect their staff and provide reassurance.

Establishing the right rules for particular contexts will be critical to the scheme's success. It will also be important to put in place analytical tools that measure adherence, so that adjustments can be made in response to any challenges that arise.

We think that technology has an important – and so far overlooked – role in delivering a secure working environment that is consistent with government guidelines. The test, tag, trace approach – carefully implemented and properly communicated to employees – could allow businesses to re-open safely while Covid-19 remains among us. When the pandemic is over, the same infrastructure could continue to provide employees with a secure working environment that could be quickly adapted to new circumstances and help minimise future disruption.



**Watch** our 'Tag, test and trace' webinar:  
[www.ifm.eng.cam.ac.uk/insights/manufacturing-a-better-world/webinar-test-tag-trace/](http://www.ifm.eng.cam.ac.uk/insights/manufacturing-a-better-world/webinar-test-tag-trace/)

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# A machine learning approach to quality control

Most of the products we take for granted, from laptops to jet engines, contain huge numbers of components assembled in multiple stages by different manufacturers. Quality control is vital throughout the assembly process with rigorous testing required at every step to ensure that the next customer in the chain – up to and including the end-user – does not receive faulty or sub-standard goods.

With large numbers of components and assembly stages, testing every part 'by hand' is time-consuming and expensive. We wanted to know if we could use machine learning to reliably predict failure rates and, by doing so, reduce the costs of testing, improve quality control and reduce delivery times.

To do this we needed a real industrial problem to work on. Step forward a global electronics company specialising in the manufacture of frequency inverter drives, used to control and regulate the speed of electric motors. Each product combines software with two or three electronic printed circuit board

assemblies (PCBAs). Every PCBA has four quality control stages, each of which includes up to 5,000 control tests or steps.

If a faulty product is sent to a customer, a number of costs are incurred. A replacement product has to be shipped,





**Read more** about the machine learning approach used by the authors, in their paper: 'Cost-sensitive learning classification strategy for predicting product failures' in Expert Systems with Applications Vol. 161 2020 doi.org/10.1016/j.eswa.2020.113653

customer service time and resources are needed to support the complaint and there is the potential for reputational damage.

Our task was to find a flexible classification method that could take into account the cost of supplying faulty goods and trade it off against the quality (or number of faulty goods) sent to the customer. Our challenge is that the data is voluminous, complex and often incomplete. Tests are sometimes – and entirely legitimately – skipped where they do not affect the outcome but this does create holes in the dataset.

Due to the highly optimised industrial process, the number of faulty products is very low. Thus, the data is 'imbalanced' where 99% of the products are classified as good and only 1% are faulty. For classification problems, this is a data characteristic that algorithms tend to struggle with.

While there are possibly hundreds of algorithms capable of dealing with datasets such as these, we needed one that could also introduce a cost dimension to the problem so that manufacturers could see if this approach would save them money.

Our solution uses a cost-sensitive classification strategy which we modified in order to address this specific industrial problem. It assumes that there is an interdependence between each stage of the manufacturing process and, therefore, we can predict the final stage by analysing data collected during previous production stages.

Our two-step process starts with the application of 'feature engineering'

methods to prepare the data, converting it from multidimensional to two dimensions and using some mathematical tricks to allow for missing data. We were then able to classify the data – predicting whether a product will be good or faulty – using our algorithm.

When classifying new products we ended up with four possible outcomes:

- ▶ A product that is faulty but classified as good
- ▶ A product that is faulty and is classified as faulty
- ▶ A product that is good but classified as faulty
- ▶ A product that is good and classified as good.

Our interest lies in the undetected faulty products that get shipped to the customer. If a faulty product is correctly classified as faulty it will be spotted and repaired immediately, at minimal cost. Similarly, if a good product is misclassified as faulty, it will be checked and found to be good straightaway – again with minimal cost.

However, a previous analysis had found that the cost of a false negative (in other words, sending a faulty product to a customer) is roughly 20 times higher than the cost of a false positive (a good product misclassified as faulty). We used this number ( $C=20$ ) as our cost parameter but we also compared it with a higher number ( $C=100$ ) to see how that would affect the outcome.

The results were interesting. When  $C = 20$ , 98% 'sensitivity' (where 100% is no faulty goods are sent to the customer) can be achieved at a cost reduction of 25%

against checking of individual products. Even when  $C$  is 100, a similar set of results was achieved. With sensitivity still at 98%, the cost savings are 23% instead of 25%.

We then checked our results by using the same algorithm against 25 real-world datasets with different levels of imbalance. The results confirmed that the approach is robust and is also flexible enough to be used when the cost is not specified.

Our research suggests that taking a machine learning approach to quality control can be beneficial for manufacturers when the numbers of faulty products are low. In those circumstances, the cost-savings of using an algorithm can outweigh the risks and costs associated with supplying sub-standard products.

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# Managing customer experience through a systematic approach to data analytics

We all know what a positive – or negative – customer experience feels like: a rush of pleasure or teeth-grinding frustration. Firms are acutely aware of the importance of how we feel – and how that translates into long-term loyalty – but feelings are a difficult and complicated thing to measure at scale. Dr Mohamed Zaki investigates.

Recognising the need to quantify the customer experience, and do so in a way that is easy to implement, many firms have relied on one-dimensional techniques such as satisfaction surveys and net promoter scores.

However, the limitations of these approaches have become increasingly evident over time. It is now clear that they can actively mislead by failing to elicit customers' true feelings and intentions. One of their weaknesses is that they are used to measure individual customer interactions when there is a growing recognition that in order to understand the customer experience, you need to consider the whole customer journey and not just isolated incidents along it.

Which is, of course, easy to say and hard to do. But the advent of machine learning and big data analytics brings previously unimaginable tasks within the realms of possibility. The tech giants show us what can be achieved on a daily basis. But most firms – particularly those born in the pre-digital era – are struggling with two fundamental tasks: how to capture the data they need from all the relevant touchpoints, channels, devices and applications they use to interact with their

customers and how to turn what data they have into insights they can act on.

To date there has been surprisingly little research carried out in this area and what there has been is relatively narrow, focusing on text mining open-ended answers to survey questions. We wanted to help firms take a more systematic approach to identifying the different types of data they could use at different points on the customer journey and how they can be translated into actionable insights.

## Know what you need to know

Data analytics can be enormously powerful but they can also be a snare for the unwary. Just because you can measure something doesn't mean you have to. In fact, there is a real danger of data paralysis if you don't have the right framework in place and know what you want to achieve. Insights gained through big data must be capable of driving change, of bringing about continuous improvement to the customer experience.

### 1. What data?

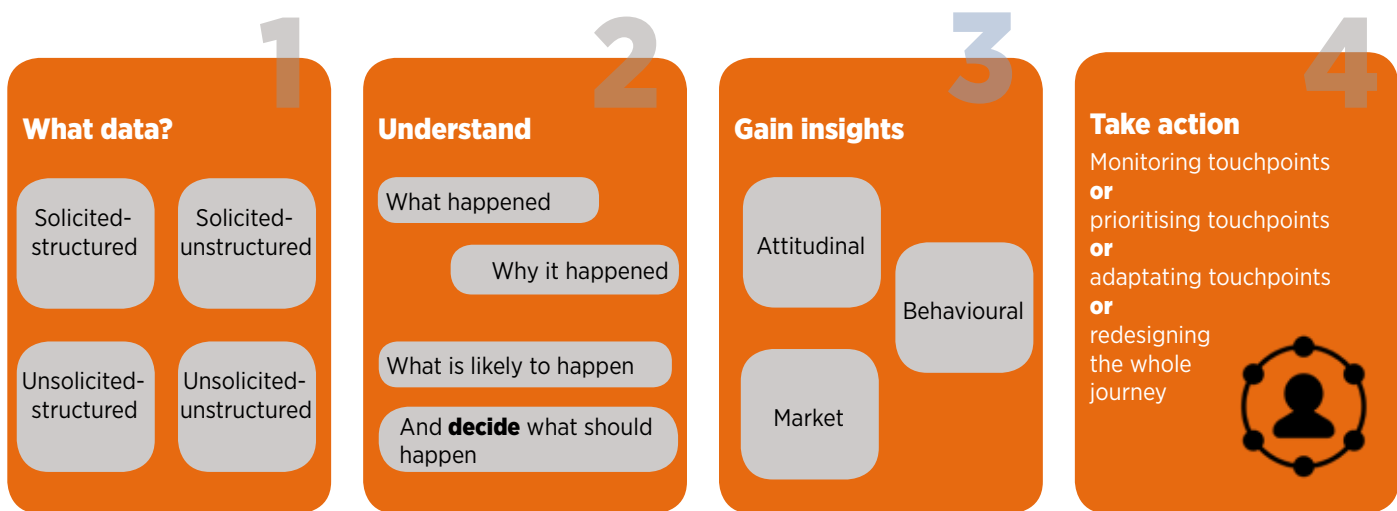
Based on previous research, our

framework takes as its starting point the fact that customers interact with organisations in a myriad of different ways across the physical, digital and social realms (see our article '[New thinking about the future of services](#)').

For each key touchpoint in each realm, different types of data may be available for analysis which we have characterised in four ways: structured and unstructured, solicited and unsolicited. Structured data is usually the easiest to find: most organisations capture it in the form of sales data or satisfaction scores. Unstructured data is often captured but is harder to do anything with: examples include free text responses to questions, or multimedia formats such as images, sound or videos.

Understanding the difference between solicited and unsolicited data is also key: solicited data has been sought by the organisation whereas unsolicited is unprompted and, therefore, may potentially provide more insight - but will need significant resources and expertise to acquire.

Categorising the different types of data you want to capture is a critical step for



firms planning their approach to customer experience analytics. It needs to be done within a strategic framework to guide investment in those areas which will best support organisational decision-making.

## 2. Understand: the questions you need to ask and the tools you need to answer them

Different types of data can be used in different ways: to *describe* what has happened, to *understand* what has happened, to *predict* what is likely to happen in the future and to *'decide'* what should happen in future. Different analytical tools are used for each of these activities, ranging from simple clustering methods, through root cause analysis, linear regression and classification models to dynamic mathematical programming models.

## 3. Gain insights: reading your customers' minds

Analysing what people say about your organisation is one thing but it doesn't take account of other factors that might be affecting their perceptions of your service. To get a complete picture of a particular customer experience, you need to be able to understand their previous experiences with your organisation, as well as other attitudinal factors that might affect their opinion: how susceptible are they to peer pressure, for example, or how intense is their desire to be pleased? Overlying these fairly stable personality traits there might

also be more temporary changes to their mental state brought about by transient events or day-to-day stresses. How can you find that out?

Attitudinal or psychographic insights are being collected by organisations on a regular basis. Contact centres receive huge volumes of data by phone, email, text, chat and other web interfaces. These are fertile ground for analytical tools looking for behaviours (such as shouting) which betray mood. These behaviours can have knock-on consequences if they influence other customers to switch providers, for example.

Going one step further than monitoring interactions with the organisation itself (or its service provider), it is now possible to explore customers' personality traits (such as agreeableness, conscientiousness, openness to new experiences) by analysing their social media presence.

### Understanding your customers' actions

Being able to track what your customers are doing has never been easier. Google Analytics, for example, gives you a real-time view of how your customers are interacting with you. These insights are more than just descriptive – by analysing past behaviours they can be used to predict future preferences as Amazon and Netflix have been so adept at doing.

But not all customer interactions take place online. Understanding customer

### Top tips for success

- 1 **Be strategic:** understand what you are trying to achieve.
- 2 **Be realistic** about your organisational capabilities: what can you do now, what do you need to be able to do and should you do it yourself or outsource?
- 3 **Be collaborative:** this is a company-wide endeavour, involving customer-facing staff, marketers, engineers, designers, data architects and data scientists. They all need to be involved in building the system. If it's to deliver real value, the insights it produces need to be used across the organisation.
- 4 **Be available:** if the system is going to drive organisational change, it needs to be available 24/7 with no downtime.
- 5 **Be agile:** learn the lessons from the implementation and continuously improve.
- 6 **Measure the impact** on the business: show how these insights are being turned into greater customer satisfaction, increased revenue streams, new service offerings, increased productivity and greater efficiency.





behaviours in the 'real world' is just as important and there are plenty of opportunities to do so. In places like shopping malls or airports it is possible to extract behavioural data from wireless local area networks which are provided free of charge to visitors. CCTV footage can also provide insights into customers' behaviour and preferences. However, acquiring and analysing this kind of data is not something to be entered into lightly, raising, as it does, significant legal and privacy issues.

#### Understanding your market

Customer experience analytics can also help you gain market intelligence by evaluating your performance against your competitors. Using the same techniques, it is possible to analyse your and your competitors' brand equity and positioning and to get early warning of emerging trends by, for example, using predictive big data analysis techniques on tens or even hundreds of Google trends time series.

#### 4. Take action

Data is only valuable if you do something with it, whether it's making incremental improvements or initiating radical transformation. At the incremental end of the spectrum, it's about continuously monitoring the customer experience at key touchpoints against a set of performance indicators. Or it could be used to drive improvements by identifying which touchpoints are the most important, what are the key drivers of customer satisfaction at each and how best to deliver them.

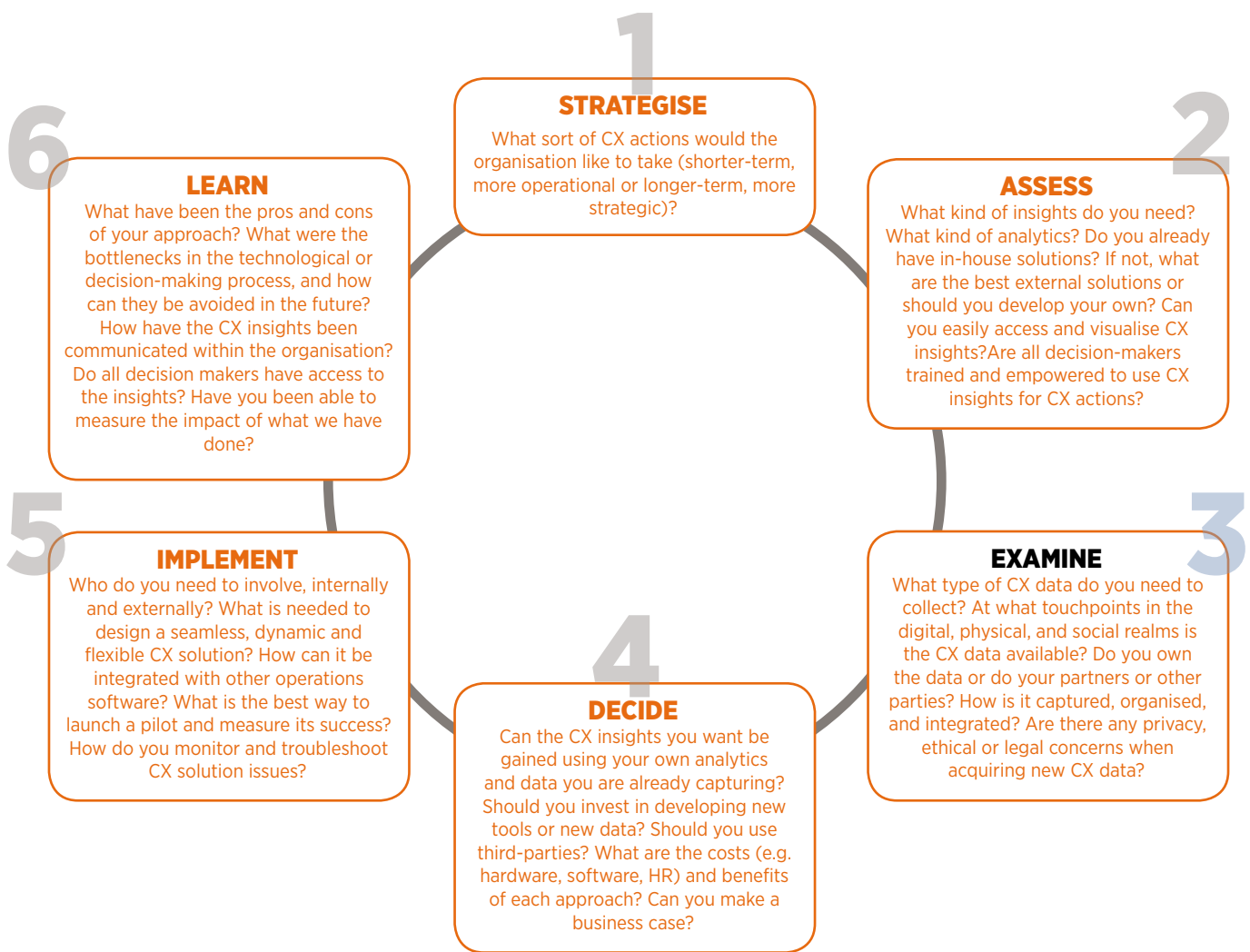
Or you can use customer insights to redesign the entire customer journey and, by extension, business model. In 2012 agricultural equipment manufacturer, John Deere, fitted sensors to its machinery and gave its customers software that enabled them to access their data, benchmark it against others and combine it with external data sources such as information about the weather. The company brought everything under the myJohnDeere.com

platform, which it opened to suppliers, retailers and software developers. In doing so, it created an entirely new customer journey and transitioned from a manufacturing business model to a platform-centric one and, as a result, revolutionised not only its own business but the entire agricultural sector.

Big data analytics undoubtedly has the potential to transform organisations' understanding of their customers' experience. However, extracting meaningful and actionable insights from data is a resource-hungry activity, whether you develop your own capabilities in-house or commission a third-party supplier. Without a strategic approach, there is a very real danger of trying to capture and analyse too much data and seeing little return on your investment. Our framework has been designed to help you understand the problem, consider your options and guide you through the decision-making process.



**Read more:** this article is based on 'Customer experience management in the age of big data analytics: a strategic framework' by Maria Holmlund, Yves Van Vaerenbergh, Robert Ciuchita, Annika Ravald, Panagiotis Sarantopolous, Francisco Villarreal Ordenes, Mohamed Zaki. *Journal of Business Research*, doi.org/10.1016/j.busres.2020.01.022



Credit: iStock: vgaajic

*Step-by-step guide on how to use big data analytics for customer experience management.*

WHITE PAPER

**Unlocking the secrets of customer loyalty**

Customer retention plays a critical role in a firm's long-term sustainability. Until recently, however, firms have tended to rely on one-dimensional survey techniques to measure their customers' loyalty. This often masks underlying dissatisfaction with a company's products and services and that a significant proportion of its customers are at risk of churn.

This white paper shows how machine learning can help overcome these limitations by looking at what customers think, feel and do in order to arrive at a more accurate prediction of their future behaviour.

By combining a new conceptual framework with advanced machine learning techniques in a B2B context, we developed an approach which was 93% reliable in its prediction of churn.

**Read** the white paper: [www.cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/customerloyalty](http://www.cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/customerloyalty)



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# Workplaces to thrive in: measuring the employee experience

The global pandemic has had a huge impact on office workers. Many are still advised to work from home. Others are back part-time with complicated rotas determining desk occupancy in order to comply with social distancing requirements. Is this an opportunity to rethink the workplace - and how we know if it's good for us?

Working from home has been embraced by many but others have found it isolating and detrimental to their physical and mental health. While video conferencing and collaboration tools have been invaluable in the short term, it is too early to say what effect a long-term reliance on them could have on levels of social engagement and employees' emotional states.

From an organisational perspective, it also remains to be seen how effective home-working for long periods of time will prove to be. Creativity - in any role or sector - tends to require serendipity. It is often those chance conversations in the corridor or by the water cooler that spark the truly transformational ideas and collaborations. It may also prove difficult to create and sustain a strong corporate culture if a significant proportion of staff are always working offsite.

It is also too early to understand the impact more broadly of COVID-19 on people's wellbeing, but one thing is clear: as we return to the workplace - some hesitantly, some enthusiastically - more than ever organisations will need to put their employees' physical and mental health first.

First and foremost, that means the workspace needs to be COVID-compliant. As employers set about making the necessary adjustments are there other things they could be doing to create a better physical environment which could help to improve the mental health of their employees?

The pandemic has created an opportunity to re-examine the workspace. If organisations seize that opportunity, how will they be able to assess the effect their changes are having on their staff? Many workers are reluctant to open up to their bosses about their mental health in case it negatively affects their job prospects. Is there a way of gaining insight into their emotional state even if they don't come forward for help?

We think that there is, using video capture. It has long been possible to record people's physiological and psychological responses to their surroundings using video. Some car manufacturers, for example, already use this technique to measure a driver's emotional state and level of concentration

when driving. We suggest that a similar approach could be used to monitor individuals' physical and emotional states in the office and prompt them to take steps to improve their wellbeing and productivity by, for example, taking a fresh air break or adjusting their lighting levels.

## How buildings affect people

Understanding how people experience architecture has been a subject of research since the 1960s but it is only relatively recently - in the 2000s - that the impact of our physical surroundings on the human brain have been studied. This has resulted in more 'human-centric' design and, with the advent of digital technologies, the development of 'smart services'. Previous studies demonstrating a link between design in the workplace and organisational performance have led to the development of 'productivity inducing' workspaces. To date, however, there have been few attempts to measure the effects these kinds of workspaces have on the people who occupy them.

One notable attempt to bridge this gap has been through the development of the WELL building standard which uses a number of metrics to evaluate a building's performance such as its acoustics, lighting, thermal comfort and air quality. But these measures don't take account of an employee's emotional state or 'subjective wellbeing'. New architectural approaches have tended to focus on smart services that allow an individual to control their personal light levels and ambient temperature but they are not necessarily derived from insights into how these features affect our psychosocial states.

## A new approach

We propose to remedy this by using a combination of video and environmental sensors to assess both the physical environment and the employees' emotional state. Building on previous research, the physical assessment uses a number of key attributes to determine how positive a workspace is likely to be. Can you open the windows, for example? Do the windows have blinds or other means of preventing glare? How noisy is it? Can you see or, better still, access the natural world outside? Are there plants in the office space?



We will also use video to assess how the employees are faring emotionally. It would, of course, be possible to use wearable sensors to detect things like heart and respiratory rates. However, for most people this would feel very ‘medical’ and intrusive whereas facial video cameras could capture emotional responses unobtrusively. By combining video capture with machine learning techniques such as Facial Expression Recognition (FER), it is possible to detect a range of emotional states such as happiness, sadness, anger and fear.

### **A new framework for monitoring wellbeing in the workplace**

By combining video data capture to evaluate room design with environmental sensors to monitor air quality and noise and light levels, we can assess the physical space. By combining video capture with machine learning, we can gain insight into employees’ emotional state. Our framework integrates these two scores into an overall ‘subjective wellbeing’ score which could be used to detect warning signs and to suggest improvements to the physical environment.

### **Opportunity**

Managers are accountable for the wellbeing of their staff. This is enshrined in the UK government’s health and safety regulations. In a post-pandemic world, the physical and psychological wellbeing of employees will be paramount. The framework we propose could play a useful part in demonstrating accountability. It can also be calibrated to deal with, for example, the threat of new viral outbreaks and their impact on staff.

### **Challenge**

As the means to capture data becomes ever more sophisticated and ubiquitous, people’s concerns increase over how that data is used. General Data Protection Regulation (GDPR) has been put in place to help protect individuals’ privacy.

To comply with GDPR, video data used for monitoring wellbeing would need explicit consent from employees and a detailed statement from the employer about how long the data will be stored, what it will be used for and who can access it. We recognise that legislative and ethical compliance will be critical for the success of this approach and this will be the focus of our next study.

We believe there is an urgent need for different disciplines to come together to help us better understand and measure how our physical surroundings are affecting our wellbeing. This is more important than ever as we re-evaluate our working experience and are able to compare the benefits of office life to working from home.



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**Read more:** ‘Measuring Thriving Experience in Physical Spaces’ in *New Future of Work 2020*, August 2020



Keynote speaker: Professor Andy Neely, University of Cambridge Pro-Vice-Chancellor for Enterprise and Business Relations and Director of Cambridge Service Alliance



Keynote speaker: Graham Budd, President and Chief Operating Officer, Arm

In October, the Cambridge Service Alliance hosted its 2019/20 Industry Day at which keynote speakers from some of the world's leading companies shared their insights into the challenges and opportunities of developing digitally-enabled service businesses.

### **Benefit from the 'Fifth Wave of Computing'**

Graham Budd, President and COO of Cambridge success story Arm, talked about the 'Fifth Wave of Computing', resulting from the convergence of three technologies: IoT, AI and 5G. Together they will give us access to unprecedented amounts of data as well as the means to analyse that data and derive insights from it – using 5G connectivity – in real time.

For Budd, the challenge is how to maximise the potential of this new wave of computing. In order to derive real value from it, he contended, you need standardised, industry-wide infrastructure otherwise everyone is reinventing the wheel and getting nowhere fast. And that requires a "collaborative mindset that builds trust across the ecosystem and acts as a powerful accelerator of innovation."

### **Putting the customer first**

Sheldon Hee, General Manager UK and Ireland, Singapore Airlines, described the customer-led digital transformation programme undertaken by his firm over the last seven years. Hee emphasised: "Digital is not just about the technology, it's about understanding the problem, knowing what our customers and staff need and being able to anticipate and deliver that proactively."

The programme has had an impact on all aspects of the business, providing insight and intelligence to enable, for example, more seamless and highly personalised customer service, the recruitment of high performing front-line staff and more reliable scheduling.

### **Achieving competitive advantage through digital technologies**

Cambridge Service Alliance partner HCL Technologies is the world's largest provider of third-party research and development services. For Ashish Gupta, Corporate Vice-President, Head of EMEA, this means helping customers like Manchester United to get value from digital.



### **Find out more**

Watch the video at:  
[bit.ly/36MirCh](https://bit.ly/36MirCh)



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# The future of digitally-enabled services: collaboration, customers and competitive advantage

According to Gupta, it's those businesses that are moving beyond back office efficiency to transform first their business processes and then their entire business model that are achieving real competitive advantage through digitalisation.

## The 'digital first' perspective

Offering a different perspective on digitalisation was Alex Bazin, Managing Director of FLEC, a digital start-up joint venture with DHL, which has set up a new platform-based business to help logistics firms recruit staff who want to work flexibly. The issues for FLEC are very different from those facing multinationals. Establishing a new digital business is not easy but it has the benefit of being almost infinitely scalable and with no legacy system – or mindset – to overcome.

## Understanding your customers

Whatever the size of your organisation or its stage on the digital journey, understanding what your customers are thinking, feeling and doing is fundamental to your success. Dr Mohamed Zaki, Deputy Director of the Cambridge Service Alliance, concluded the talks by explaining how the research he is leading applies machine learning to the language customers use and combines the outputs with conventional approaches such as Net Promoter Scores to produce valuable and actionable insights about the customer experience.

The day also included workshops exploring the CSA's key research themes and a series of three-minute presentations from CSA researchers on a range of topics including: digital transformation strategies, customer experience analytics, putting blockchain into practice and developing an Industry 4.0 maturity model.



Keynote speaker: Sheldon Hee, General Manager UK and Ireland, Singapore Airlines



Keynote speaker: Ashish Gupta, Corporate Vice-President, Head of EMEA, HCL Technologies



Keynote speaker: Ashish Gupta, Corporate Vice-President, Head of EMEA, HCL

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# COMMUNITY OF INTEREST

## The future of digital services & digital twins

Cambridge Service Alliance researchers and industry partners get together three times a year at our Community of Interest (CoI) meetings to agree and progress our joint research themes. CSA partners receive a full report of the discussions. This year was a little different, with our gatherings held virtually. While it was disappointing not to be able to connect in person it gave us the opportunity to invite some stellar guest speakers to share their insights with us.



### APRIL

Digitalisation has brought about deep and pervasive organisational change, affecting every aspect of a business. Previously, a firm would define its business model and its business strategy and then develop a technology strategy to help it realise those ambitions.

How delightfully old-fashioned and linear that approach seems today. The world has become a whole lot more complicated since then, with new technologies informing business strategy as much as the other way round. Or, as one of our speakers succinctly put it: “business is becoming IT and vice versa.”

In our virtual, coronavirus-compliant, Community of Interest in April we heard from business, government and academia about the challenges and opportunities this new reality presents for digital service providers. As well as our own CSA researchers, we had speakers from the Estonian government, from the Fraunhofer Institute in Dortmund and from one of the UK’s largest gas distribution companies, SGN,

## April: top 10 insights

- 1 One organisation can’t change a whole industry: to realise the value of digital twins you need to take an ecosystem approach in which everyone contributes something to achieve a greater collective benefit.
- 2 To do this you need to overcome the barriers to sharing data by developing architecture, standards, security and trust.
- 3 Estonia’s e-infrastructure coupled with digital twin technology is helping to address the fragmentation and productivity challenges in the construction sector.
- 4 This will make the industry more efficient and will also result in a better designed and managed built environment.
- 5 You need to balance your technology investment so that it protects the value for your customers and shareholders today while ensuring you have the capabilities to create new value tomorrow.
- 6 Top-level buy-in is critical.
- 7 The UK construction sector is lagging years behind manufacturing in its ability to adopt digital twin technology.
- 8 To accelerate its development, we need a common digital twin platform (akin to android) that creates a community of developers who can innovate at speed.
- 9 Satisfying your customers is no longer enough to keep them: you need to delight them.
- 10 But you also need to interact with them brilliantly, solve their problems instantly, treat them to an exceptional sensory experience (even online), communicate with them at the right time and make them feel in control at all times. Easy!

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## JULY

Digital transformation and business model innovation: how can we do both better? These themes were explored with our speakers agreeing that in order to realise their benefits, you need to do them together.

Digitalising existing ways of working may help firms improve their margins but it is not going to have the seismic impact on productivity or, indeed, profitability that they may expect. That only comes through genuine business model innovation. The Head of Innovation at Siemens Smart Infrastructure showed us what this might look like in the construction sector, through the development of digital twins. CSA's Dr Erika Pärn went on to explore the connection between digital twins and business model innovation, and how the former can drive the latter through platform strategies.

The second half of the agenda looked at a different but inextricably linked topic: customer experience and how to design, measure and continuously improve it. We heard from Proctor & Gamble about how its growth strategy is founded on improving customer experience and from Dr Mohamed Zaki on how machine learning provides a window into customers' behaviour, thoughts and feelings.



## July: top 10 insights

- 1 Don't jump on the nearest digital bandwagon: only invest in the technology that supports your business strategy.
- 2 Don't get fixated on measuring efficiency - you need to understand the impact of business model innovation on different parts of the business to measure its effectiveness.
- 3 Cross-functional leadership teams are key: they need to take joint ownership of the business model.
- 4 Do an audit of your workforce's digital capabilities and upskill where necessary.
- 5 Building twins - blending BIM and digital twins - will drive workplace productivity.
- 6 Firms need to think about their position in the ecosystem and they can become 'keystone' players.
- 7 Innovation to deliver customer experience drives performance in FMCG.
- 8 Consumer brands need to differentiate themselves through their behaviour and expression of brand values as part of their covid response.
- 9 To really understand your customers you need to analyse what they are saying about you across all channels.
- 10 Don't be frightened of complaints - they are an opportunity to enhance brand engagement and loyalty.

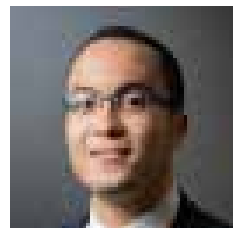
# 2019/20 PEOPLE

**RESEARCHERS**  
 Left to right:  
 Professor Andy Neely,  
*CSA Director*, Professor  
 Duncan McFarlane,  
 Dr Mohamed Zaki, *CSA  
 Deputy Director*, Dr  
 Alexandra Brintrup

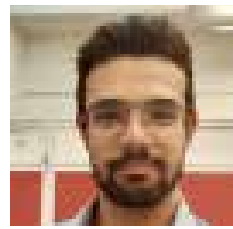


This row, left to right:  
 Dr Veronica Martinez,  
 Dr Ajith Parlikad, Dr  
 Florian Urmetzer, Dr  
 Chander Velu

**RESEARCH ASSOCIATES**  
 This row, left to right:  
 Dr Zakaria Dakhli, Dr  
 Yasmin Fathy, Dr Erika  
 Parn



**PHD STUDENTS**  
 Below left to right:  
 Ruben Amenyogbo,  
 Francisco Gomes Medina,  
 Xia Han (Graduated),  
 Karolina Kuta, Paula  
 Melfe,



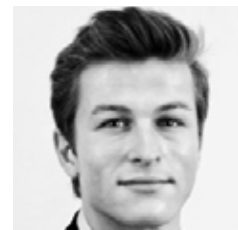
**PhD STUDENTS**

left to right:  
Tim Pearce, Tuhfatur  
Ridwan, Sunil Sarferaz,  
Thayla Zomer



**VISITORS**

This row, left to right: Dr  
David Diaz, Rob Jago  
Floetgen, Dr Ebru Gokalp,  
Professor Stephan  
Henneberg



This row, left to right:  
Professor Janet  
McColl-Kennedy, Victor  
Naumann, Professor  
Lars Witell, Annika  
Wollermann.

**PROGRAMME  
MANAGEMENT &  
COMMUNICATIONS**

Jacqueline Brown



Our other visitors are:  
Nora Fanderl, Shun Long  
Hong, Dr Jens Neuhuttler,  
Iacopo Rubbio and  
Muhammed Suleman,

# Cambridge Service Alliance

## AWARDS

**Mohamed Zaki:** 2019 finalists for the JSR Best Articles Award  
*Journal of Service Research*

**Mohamed Zaki:** 2018 Robert Johnston Award for Highly Commended Paper, *Journal of Service Management*

**Thayla Zomer:** Best Paper Award for construction industry digital transformation. 36th Annual Conference, Association of Researchers in Construction Management (ARCOM). Glasgow, UK

**Stephan Henneberg:** Visiting Professor in Marketing, University of Bamberg, IULM Milano and Culverhouse College of Commerce, University of Alabama

**Stephan Henneberg:** Servitization Conference Best Paper Award 2019

**Stephan Henneberg:** Inaugural member of the Honorary Board of *Industrial Marketing Management*

## PUBLICATIONS

Frumosu Dalia, Flavia, Abdul R Khan, Henrik Schiler, Murat Kulahci, **Mohamed Zaki**, Peter Westermann-Rasmussen (2020), Cost-sensitive learning classification strategy for predicting product failures, *Expert Systems with Applications*, 161,113653.

Parasuraman, A., Joan Ball, Lerzan Aksoy, Keiningham, Timothy, **Zaki, Mohamed** (2020), "More Than A feeling?: Toward A theory of Customer Delight", *Journal of Service Management*, Forthcoming.

Holmlund, Maria, Vaerenbergh, Yves Van; Ciuchita, Robert; Ravald, Annika; Sarantopoulos, Panagiotis; Villarroel Ordenes, Francisco; **Zaki, Mohamed** (2020), "Customer Experience Management in the Age of Big Data Analytics: A Strategic Framework", *Journal of Business Research*, 116, 356-365.

**Zaki, Mohamed, McColl-Kennedy, J.** (2020), "Text mining analysis roadmap (TMAR) for service research", *Journal of Services Marketing*, 34(1),30-47 .

**Zaki, Mohamed**, (2019), "Digital Transformation: Harnessing Digital Technologies for the Next Generation of Services" *Journal of Services Marketing*,33 (4), 429-435.

**Zaki, Mohamed**, Theodoulidis, Babis, Shapira, Philip, **Neely, Andy**, Tepel, Matthias (2019), "Redistributed Manufacturing and the Impact of Big Data: A Consumer Goods Perspective", *Journal of Production Planning & Control*, 30 (7), 568-581.

**McColl-Kennedy, J. R., Zaki, M.**, Lemon, K. N., **Urmetzer, F. & Neely, A.** (2019). "Gaining customer experience insights that matter", *Journal of Service Research*, 21(1), 8-26.

"Servitization -The Holy Grail? Considering The Strategic Dark Sides of Servitization" MP Fritze, **F Urmetzer**, M Leyer, **A Neely** 2020

H Lütjen, C Schultz, F Tietze, **F Urmetzer** "Managing ecosystems for service innovation: A dynamic capability view" *Journal of Business Research* 104, 506-519

Honary M., **Martinez V.**, Wlazlowski T., Helal S., von Oertzen H. and Honary S. (2020) "Getting the country back to work, safely: A digital solution", *ACM Digital Government: Research and Practice*, COVID-19: Rapid Responses, Government Policies, and Impacts. 1(4)

**Sousa-Zomer, T.T., Neely, A. and Martinez, V.** (2020), "Digital transforming capability and performance: a microfoundational perspective", *International Journal of Operations & Production Management*

**Martinez V.**, Zhao M., Blujdea C., **Han X., Neely A.** and Albores P. (2019). Blockchain-Driven Customer Order Management. *International Journal of Production and Operations Management*. 39 (6/7/8): 993-1022. (Published 2nd Dec 2019). ISSN:0144-3577

**Y. Fathy, E. Parn**, D. Wilkins and **M. Zaki**, "Measuring Thriving Experience in Physical Working Spaces", *The Microsoft Symposium on the New Future of Work (NFW)*, 2020.

**Y. Fathy** and P. Barnaghi, "Quality-Based and Energy-Efficient Data Communication for the Internet of Things Networks," in *IEEE Internet of Things Journal*, vol. 6, no. 6, pp. 10318-10331, Dec. 2019, doi: 10.1109/JIOT.2019.2938101.

**Zomer, T., Neely, A.**, Sacks, R., **Parlikad, A** (2020). Exploring the influence of socio-historical constructs on BIM implementation: an activity theory perspective. *Construction Management and Economics*, in press, //doi.org/10.1080/01446193.2020.1792522

**Zomer, T., Neely, A., Martinez, V** (2020). Digital transforming capability and performance: a microfoundational perspective. *International Journal of Operations and Production Management*, in press, <https://doi.org/10.1108/IJOPM-06-2019-0444>

Gustafsson, A., Snyder, H., & **Witell, L.** (2020). Service Innovation: A New Conceptualization and Path Forward, *Journal of Service Research*, 23(2), 1-5.

Holmlund, M., **Witell, L.**, & Gustafsson, A. (2020). getting your qualitative service research published. *Journal of Services Marketing*.

Hunter-Jones, P., Line, N., Zhang, J. J., Malthouse, E. C., **Witell, L.**, & Hollis, B. (2020). Visioning a hospitality-oriented patient experience (HOPE) framework in health care. *Journal of Service Management*.

Korper, A. K., Patrício, L., Holmlid, S., & **Witell, L.** (2020). Service design as an innovation approach in technology startups: a longitudinal multiple case study. *Creativity and Innovation Management*, 29(2), 303-323.

**Witell, L.**, Kowalkowski, C., Perks, H., Raddats, C., Schwabe, M., Benedettini, O., & Burton, J. (2020). Characterizing customer experience management in business markets. *Journal of Business Research*, 116, 420-430.

**Witell, L.**, Holmlund, M., & Gustafsson, A. (2020). Guest editorial: a new dawn for qualitative service research. *Journal of Services Marketing*.

Kowalkowski, C., & **Witell, L.** (2020). Service innovation. In *Bridges, E. and Fowler, K. (Eds.) The Routledge Handbook of Service Research Insights and Ideas* (p. 3-23). New York:

# awards and publications

Routledge.Chicago

Gökalp, E., Gökalp, M. O., & Çoban, S. (2020). Blockchain-Based Supply Chain Management: Understanding the Determinants of Adoption in the Context of Organizations. *Information Systems Management*, 1-22 <https://www.tandfonline.com/doi/abs/10.1080/10580530.2020.1812014>

**Gökalp, E.**, Demirörs, O., & Eren, P. E. (2020). Public Personnel Management Process Capability Assessment. *Public Personnel Management*, 49(1), 111-140 <https://journals.sagepub.com/doi/abs/10.1177/0091026019833412>

Gökalp, M. O., Kayabay, K., **Gökalp, E.**, Koçyiğit, A., & Eren, P. E. (2020, September). Towards a Model Based Process Assessment for Data Analytics: An Exploratory Case Study. In *European Conference on Software Process Improvement* (pp. 617-628). Springer, Cham. [https://link.springer.com/chapter/10.1007/978-3-030-56441-4\\_46](https://link.springer.com/chapter/10.1007/978-3-030-56441-4_46)

Ronika Chakrabarti, **Stephan Henneberg**, Bjoern Ivens (2020 forthcoming). "Open Sustainability-Conceptualisation and Considerations.", *Industrial Marketing Management*

Veronica Martinez Hernandez, Marko Kohtamäki, **Stephan Henneberg**, Ken Kimita, Heiko Gebauer (2019). A Configurational Approach to Servitization: Review and Research Directions. *Service Science*, 11, 3, 213-240.

Sabrina Thornton, **Stephan Henneberg**, Alexander Leischnig, Peter Naude (2019) "It's in the Mix: How Firms Configure Resource Mobilization for New Product Success.", *Journal of Product Innovation Management*, 36, 4, 513-531.

Nima Heirati, **Stephan Henneberg**, Ansgar Richter, Peter Harste (2019) "Differential Importance of Social and Economic Determinants of Relationship Performance in Professional Services", *Industrial Marketing Management*, 76, 23-35.

Special Issue Editor of *Industrial Marketing Management: Digital Servitization and Autonomous Solutions* (2021 forthcoming, together with Marko Kothamaeki, Vinit Parida and David Sjoedin)

Special Issue Editor of *Industrial Marketing Management: Open Sustainability* (2020 forthcoming, together with Bjoern Ivens and Ronika Chakrabarti)

Combinations and Periodic Functions, *Conference on Uncertainty in Artificial Intelligence (UAI)*

Mert Onuralp Gökalp, Kerem Kayabay, **Mohamed Zaki**, Altan Koçyiğit, P. Erhan Eren, **Andy Neely**, 2019, Open-Source Big Data Analytics Architecture for Businesses, *IEEE International Informatics and Software Engineering Conference*

**T Pearce**, F Leibfried, **M Zaki**, **A Brintrup**, **A Neely**

Uncertainty in Neural Networks: Approximately Bayesian Ensembling *AISTATS 2020*

**T Pearce**, Andrew Y. K. Foong, Alexandra Brintrup

"Structured Priors for Convolutional Neural Networks: Uncertainty & Robustness in Deep Learning" *Workshop, ICML 2020*

Çaldağ, M. T., Gökalp, M. O., & **Gökalp, E.** (2019, November). Open Government Data: Analysing Benefits and Challenges. In *2019 1st International Informatics and Software Engineering Conference (UBMYK)* (pp. 1-6). IEEE

**Gökalp, E.**, Çoban, S., & Gökalp, M. O. (2019, November).

Acceptance of Blockchain-Based Supply Chain Management System: A Research Model Proposal. In *2019 1st International Informatics and Software Engineering Conference (UBMYK)* (pp. 1-6). IEEE.

Keynote: **Martinez V.** (2020). 2020 Digital Twins Industry Conference – Digital Twins and Service Business Model Innovation. Organised by the University of Middlesex. 9th March 2020 **Zomer, T., Neely, A., Parlikad, A** (2020). Institutional pressures and decoupling in construction projects: an analysis of building information modelling implementation. In: *Association of Researchers in Construction Management Conference, 2020, conference in the cloud.*

**Zomer, T., Neely, A., Sacks, R., Parlikad, A** (2020). A Practice-Based Conceptual Model on Building Information Modelling (BIM) Benefits Realisation. In: *International Conference on Computing in Civil and Building Engineering, 2020, conference in the cloud.*

**Zomer, T., Neely, A., Parlikad, A** (2020). Institutional pressures and decoupling in project-based contexts. In: *British Academy of Management Conference, 2020, conference in the cloud.*

**Zomer, T., Neely, A., Parlikad, A** (2020). Institutional pressures and decoupling in project-based contexts. In: *British Academy of Management Conference, 2020, conference in the cloud.*

## ► CONFERENCE PAPERS

**Yasmin Fathy, Erika A. Parrn**, Denise Wilkins and **Mohamed Zaki** (2020), Measuring Thriving Experience in Physical Working Spaces, Microsoft, New Future of Work 2020 Conference

**Tim Pearce**, Felix Leibfried, **Alexandra Brintrup, Mohamed Zaki** and **Andy Neely** (2020), Uncertainty in neural networks: Approximately Bayesian ensembling, *International Conference on Artificial Intelligence and Statistics*, 234-244

**Tim Pearce, Mohamed Zaki, Alexandra Brintrup, Andy Neely** (2019), Expressive Priors in Bayesian Neural Networks: Kernel

2019/2020



## **CAMBRIDGE SERVICE ALLIANCE (CSA)**

A unique collaboration between the University of Cambridge and some of the world's leading businesses to design and deliver the services of the future. Its focus for 2019 is service transformation through digital innovation.

“Our partnership with the CSA will create a wealth of new opportunities for HCL and our customers. Working alongside the world's foremost academics and leading organizations, we aim to pioneer new digital solutions for the next decade, today. Through these efforts, we will uncover new ways in which digital technologies can empower and transform businesses. We are also excited to be able to uniquely offer our customers the benefits of being a member of such a prestigious alliance.”

**Ashish Gupta, CVP and Head of EMEA, HCL Technologies**

“CEMEX has started its journey to design new services focusing on improving our customers' experience. The Design Lab Services was launched to research, diffuse and implement new approaches and best practices for service design. We are also committed to collaborating with the best universities and experts around the world on applied research and innovation projects to get prepared for the digital revolution.”

**Martin Adolfo Herrera Salado, Digital Enablement, Business Consulting Services, CEMEX**

“One of the key things about the Alliance is the non-competitive nature of the partners within it. That allows us to move away from some of the more traditional IP and confidentiality rules, to openly share our challenges, dig beneath the surface of some of the hype about digital and get into the nuts and bolts about how we really deliver it and the challenges we all face.”

**Caroline Burstall, Supply Chain Manager For Industrial Power Systems, Caterpillar**

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- LinkedIn: [linkedin.com/groups/386613](https://www.linkedin.com/groups/386613)