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Technology Adoption Hazards

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Challenges and Pitfalls in Adopting New Technology

Organisations that adopt new technology without a clear understanding of why it is needed, what integration might be necessary, and what vulnerabilities it might introduce risk wasting money on solutions that offer no benefit whilst exposing themselves to new and unforeseen threats.

This paper looks at what can go wrong when technology is introduced without understanding and mitigating the inherent challenges of adopting new technology. The paper provides some examples of technology benefits and identifies some important factors for consideration.



Introduction

Technology is becoming more complex by the day and it is likely that technology will continue to revolutionise business practice. Automation, artificial intelligence (AI), smart homes and even smart cities are now commonplace ideas, where not so long ago they were topics of science fiction. With consumers chasing the latest gadgets for their homes, businesses looking to find commercial advantage and public sector organisations looking for economies and efficiencies, the race to adopt new technology is picking up speed. As an article in The Week reported last year, then digital minister Matt Hancock told¹ a group of MPs “The risk is not that we adopt new technologies that destroy jobs, the risk to jobs comes from not adopting new technologies.”.

The speed of adoption is seen by many as critical. Harvard Business School published an article² in 2008 in which it states “... to compete in today’s global economy, countries must learn how to quickly leverage new technologies to ensure that their workforces remain competitive”. It is no surprise then that businesses and organisations are falling over themselves to adopt new technology in the belief that it will make them more competitive, more operationally effective and more environmentally friendly.

But there are risks to this. Organisations have a tendency to invest in new technology before attempting to understand the need for it or the effect it could have on their people and processes. As a result, money can be spent rashly on what appears to be a great investment but which can ultimately cost the organisation far more than it gains, either because the technology does not function correctly alongside existing systems, because significant adjustments to ways of working are needed to accommodate the new technology or because new and unforeseen risks are introduced with the technology.

The message is clear: pressing on with technology adoption without heeding the potential risks and planning adequately from the outset will lead to unintended and unwanted consequences.

¹ <http://www.theweek.co.uk/95281/how-4ir-technology-is-changing-british-business-for-the-better>

² <https://www.strategy-business.com/article/re00042?gko=8acc4>

Stuart Crawford describes in his IT solution blog³ a number of risks in adopting new technology, the first of which is “Adopting new tech just because it’s new”. This gets to the heart of what we perceive as a major problem in a world where technology is being developed faster than most of us can keep up with: the temptation to adopt new technology because of the inherent attraction of novel ideas, wanting to be seen as being innovative or needing to get ahead of the competition. All of these concerns can stifle our natural instincts of caution and restraint – traits that whilst not being fashionable in today’s fast-paced world are nevertheless essential if unnecessary mistakes and expense are to be avoided. Discussing the challenges surrounding the Fourth Industrial Revolution (4IR), Price Waterhouse Coopers⁴ suggest that “foresight, public policies and technological governance will be needed to avoid or minimise unintended consequences and protect public interests.” The message is clear: pressing on with technology adoption without heeding the potential risks and planning adequately from the outset will lead to unintended and unwanted consequences.

In this paper we consider four questions that should be addressed as part of the process of adopting new technology, questions that are all too often ignored but that if answered can make a significant positive difference to the level of benefit realised by the technology:

Question 1:

Will the technological solution provide the benefits expected?

Question 2:

Can the technological solution be integrated with the existing systems?

Question 3:

What impact will the solution have on working practices?

Question 4:

What new risks will a technological solution introduce into an organisation?

These questions will be addressed in each of the four parts of this paper.

³ <https://blogfeed.ulistic-projects.com/newtechnology>

⁴ <https://www.pwc.co.uk/services/sustainability-climate-change/insights/enabling-a-sustainable-fourth-industrial-revolution.html>

Part 1:

How will this help exactly?

Experience suggests that new technology is often identified by organisations as a “solution”, with little or no understanding of what the problem is. The notion that a technological solution will make things inherently cheaper, faster, or better tends to overshadow the question that should be asked which is “will this new technology actually help what we do?”. Without understanding the way an organisation works and how it achieves its objectives there can be little hope of determining whether new technology will improve matters.

Large organisations such as government departments and commercial enterprises are complex entities with many parts that combine to produce the outcomes required. There are often many layers to an organisational structure and inefficiencies at any given layer can spread throughout the organisation, making it difficult to achieve the organisational objectives effectively.

The key to successfully introducing new systems into an organisation (and here we define success as a system that enables improvements to the organisation’s abilities to achieve its objectives) is first understanding how the organisation functions (or is intended to function) and identifying where any inefficiencies lie. Through a careful analysis of the dependencies in the organisational system, it is usually possible to identify the points in the system which are causing it to run inefficiently and also to target the areas where investment will yield the best results.

Consider as an example a train company that is struggling with poor punctuality of its service and is beginning to lose customer and shareholder confidence due to its poor performance. The board meet to decide how to address the problem and agree that investment is needed to enhance performance to keep its shareholders and customers happy.

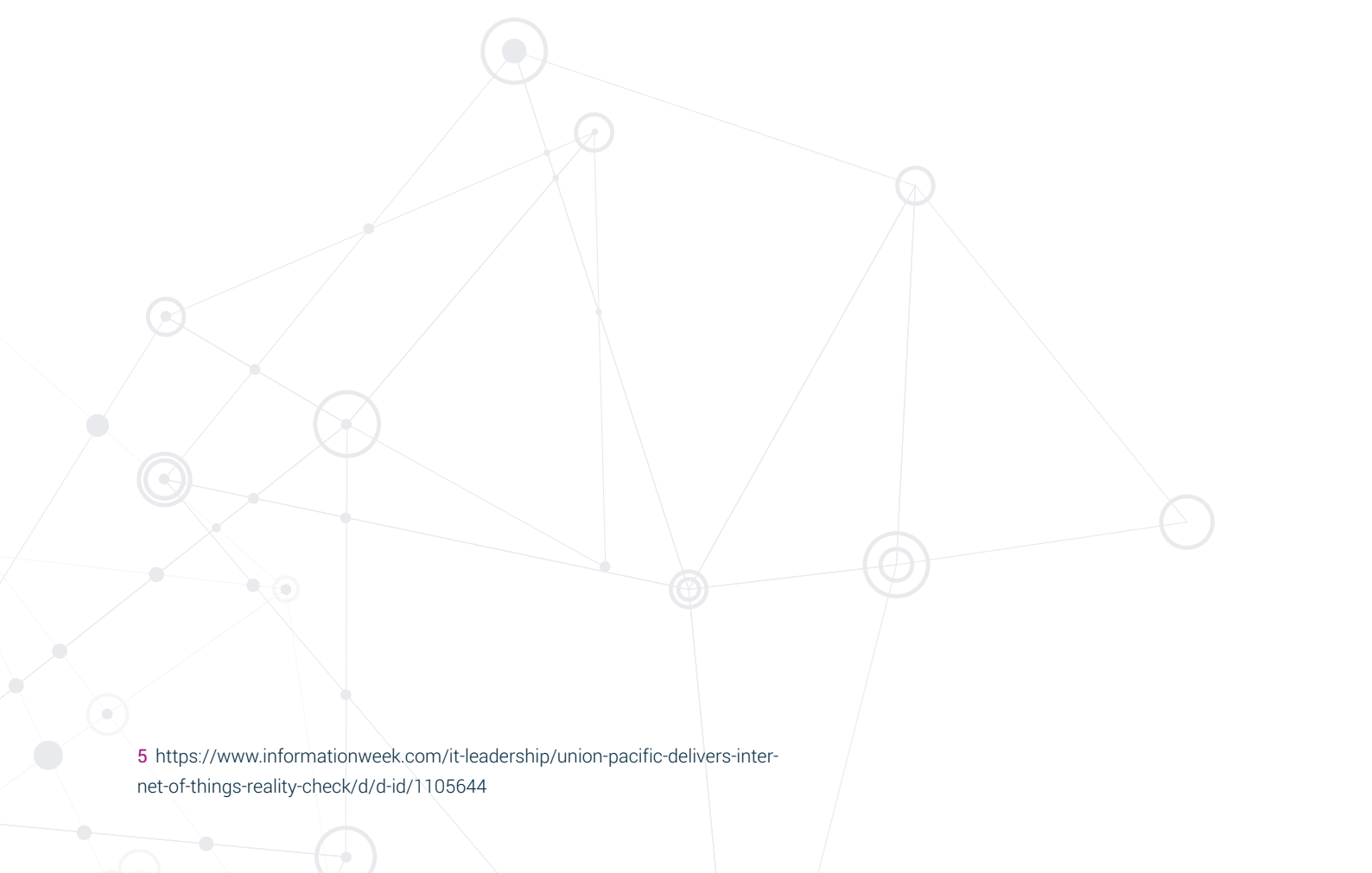
The company has had reports from its operators of disruption and vandalism on railways so decides to invest in 5G sensors that will provide a live feed to the control centre and allow the company to identify issues in real time and pursue offenders. A simple analysis of its organisational processes however would highlight huge inefficiencies in the antiquated and part-manual system used to assign operators to trains, which is delaying the departure of many of its trains on a regular basis. If the company focused its attention on improving the operator allocation system instead of investing in expensive monitoring equipment that would yield no immediate improvement to running times, it could improve its services and avoid wasting time and money on technology that will not address the core issue and may in fact further impact public perception and trust.

The point of this simplistic (and entirely fictitious) example is that the most effective solution may not be the most immediately obvious, and simply opting for the latest and most high-tech system may not yield any benefit whilst costing the organisation dear.

Taking time to understand all components of the organisational system can help avoid expensive failures and optimise the benefits of new technology

An example of where technology has been introduced effectively is Union Pacific Railroad's use of big data processing to help identify structural anomalies before they cause derailments. Using the knowledge that imperfections in train wheels place huge stress on wheel bearings, Union Pacific invested in sensors and data processing technology to tackle the problem. Trackside microphones together with infrared and ultrasonic sensors collect vast amounts of data on the health of wheels of passing trains, then pattern matching algorithms are used to identify structural anomalies that can indicate defects in the wheels, such as flattening, that in turn can lead to dangerous and costly derailments. This well-thought through introduction of new technology has reportedly helped reduce bearing-related derailments by 75%⁵.

⁵ <https://www.informationweek.com/it-leadership/union-pacific-delivers-inter-net-of-things-reality-check/d/d-id/1105644>



Part 2:

Of course it will work...

The last time I upgraded my personal computer, I found it wouldn't work with many of the other digital devices kicking around the house. "I guess that means we're getting a new printer as well then..." I mutter as the old inkjet is tossed in the bin along with its various paraphernalia. I am ashamed to admit that I had fallen foul of the second of our common failings in new technology procurement – systems integration.

Integration of personal computer system components is easier these days since file formats and physical interfaces are made with "plug and play" compatibility. Moreover personal digital devices are fairly regularly replaced by consumers, meaning that technology manufacturers need only reach back a few years to achieve sufficient backward compatibility. When we consider the multitude of systems of different ages and architectures used in large organisations such as defence, energy, health services or transportation, it is easy to see how ensuring integration of technology is a far more complex and challenging proposition.

Mark Gilchrist writes about this issue in a military context⁶, where equipment is often bought before the full challenge of integrating it is understood or planned for. He states that "Integration is a constant challenge in a perpetually changing technological context." There are many examples of failed technology integration in the history of the great institutions of the UK Armed Forces and National Health Service. So why does the problem keep occurring? One possible reason is that these types of organisations have an incredibly complex set of objectives, operating conditions and parts. But this is no reason to ignore it. Indeed Gilchrist states with remarkable directness: "technology without integration... is the hype before the letdown."

Consider again the fictional train company that needs to improve the punctuality of its services. Having done some analysis the company realises that their existing system used to assign operators to trains is causing major delays. Following an impressive sales pitch by a public transport IT supplier, the train company decides to invest in a new AI-enabled dynamic allocation system that will automate the assignment of operators to trains. They believe the marketing information which claims that the system will alleviate the delays to departures that are occurring repeatedly, helping to make their services more punctual and allaying the fears of shareholders and reducing the ire of their customers. The problem they now have is that their existing systems are not designed to integrate with the sophisticated AI system, which requires as an input a live feed of train locations and driver timetable, which currently exist partly on paper and partly on the old computer system.

⁶ https://www.realcleardefense.com/articles/2018/07/26/emergent_technology_military_advantage_and_the_character_of_future_war_113655.html

The new centralised system will also generate outputs that are not compatible with the individual systems in each of the stations the train company operates. Thus the new AI system is in danger of being redundant before being taken out of the box due to the lack of integration options with the existing system. The result if the train company presses ahead would be either a waste of time, money and reputation as the new system is jettisoned and the old one reinstalled, or a substantial increase in required investment to update all of the peripheral systems to ensure compatibility with the new AI-enabled system.

Had the train company considered the limitations of their existing system next to the interfacing requirements of the new system they would have been able to make a judgement on the efficacy of their chosen option and the potential additional expense it would incur. An example of a more prudent approach given the knowledge of their existing systems would be a phased IT upgrade, allowing the company to upgrade components gradually, ensuring the services are able to continue whilst the company introduces incremental improvements, and thus enabling more effective use of available budget.

An organisation should have a clear understanding of the challenges associated with integrating a new technology with existing systems

Crossrail, the UK Government project to introduce a new rail service across London, connecting Reading and Heathrow airport in the West to Abbey Wood and Shenfield in the East, has been beset by problems. The programme is currently expected to cost over £3Bn more than was forecast in the 2010 spending review and to complete at least 2 years later than forecast. The causes of the issues are complex but are due in part to a failure to predict and plan for challenges integrating new high-tech signalling systems with existing systems. Heidi Alexander, then Deputy Mayor of London for Transport, said in September 2018 "One of the problems that we are dealing with here is the fact that we are trying to integrate three signalling systems. We need to find a way to simplify big infrastructure projects... With the nature of signalling arrangements... whilst it might sound a bit geeky, that needs to be considered right at the outset."⁷

⁷ https://www.london.gov.uk/sites/default/files/final_-_london_assembly_transport_committee_crossrail_investigation_report_0.pdf

Part 3:

They'll get the hang of it!

It is a common story: an organisation introduces what it believes is a wonderful technological improvement into the workplace, but then watches as it is met with mistrust, confusion and frustration as staff wrestle with the new system and struggle to undertake standard tasks using the new improved system. This is a ubiquitous problem caused by a seemingly incurable belief that technology on its own will yield positive results, combined with a near universal inability to correctly assess the impact of new technology on an organisational system. It is no less prevalent when the system in question is critical to people's safety, such as a healthcare system or criminal database. Yet the problem refuses to go away. It is possible that this is due to the complexity of the problem combined with pressures to adopt new technology, but whatever the cause it requires great care to address it fully.

Organisations are built around means, ways and ends. Ends are the objectives – what the organisation is aiming to achieve, such as profit, prosperity, safety, security or simply 'success'. Ways are the functions and processes by which the objectives are achieved, such as sales and marketing, project delivery and organisational policy. The means are the resources the organisation uses to drive its processes, such as people, energy and tools. One of the mistakes that seems to occur again and again is the assumption that a change in the means can directly deliver an improvement to the ends, without consideration as to whether this will necessitate a change in the ways of working.

This is especially prevalent in a military context and the effects have been written about widely. Gilchrist talks about the "tendency to focus on technology (means) rather than the strategy, concepts (ways) and political objectives (ends)". He goes on to state that "The critical challenge advanced militaries face is... the reshaping of large military bureaucracies so that they are best postured to integrate the currently unknowable technological potential"⁶.

The challenge Gilchrist describes has analogies in a wider commercial or critical infrastructure setting, with organisations being offered a smorgasbord of new technology to improve their outputs and profit, including artificial intelligence, big data analysis, automation and robotics and more. How organisations adapt to accommodate this new technology will be critical to their ability to realise efficiencies from it and unlock its full potential.

Let us return again to our fictional train operator, who now has a plan for a phased IT upgrade that will introduce a new system for assigning operators to trains. It has been designed to integrate gradually with existing tools and systems and the company hopes it will lead to vast improvements in the punctuality of its trains.

On the first day of the initial phase of this upgrade the company introduces (with some fanfare) the new system and how it will make grand improvements to their efficiency and punctuality. Staff glance nervously at each other as it becomes clear that the new system requires knowledge of an operating system and software that most of them are not trained on, it will remove the need for many of the staff who previously managed operator allocation and it will introduce entirely new reporting structures and maintenance requirements. As the system is introduced and staff are laid off, remaining staff struggle with teething problems, others begin to become disillusioned with the loss of their colleagues and the new training and reporting burden, and others worry for their jobs.

In ignoring the effect on the people and processes in the company, the management have put a significant additional burden on staff and the reporting process and risked losing the core of their workforce through erosion of trust and confidence. Had the company considered how the new system would impact their existing people and processes rather than rushing the introduction of new system, they could have foreseen this problem and planned for it in advance, implementing effective communications, training staff on the new system and supporting those whose jobs were at risk.

A failure to consider the potential impacts on people and processes when introducing new technology can cause an organisation to function inefficiently and thus impact its profitability

An example of where operator training is critical to safe operation is commercial airlines. Following the recent crashes involving Boeing's 737 Max 8 aircraft, whilst no cause of the crashes has yet been identified, there has been some focus on the level of training pilots were offered on the new anti-stall system installed on the Max 8. House Transportation Committee Chairman Peter DeFazio, D-Ore., and the head of the aviation subcommittee, Rep. Rick Larsen, D-Wash., said in a joint statement that "...there must be a rigorous investigation into why the aircraft, which has critical safety systems that did not exist on prior models, was certified without requiring additional pilot training."⁸ It is important to note that it is not claimed by this article that inadequate training contributed to either crash.

⁸ <https://eu.usatoday.com/story/news/politics/2019/03/15/737-max-8-software-scrutinized-after-2-fatal-crashes-training-regulation-boeing/3166679002/>

Part 4:

We didn't see that coming!

The 21st century has seen commercial technology companies overtake aerospace and defence as the most influential forces in innovation. This shift threatens to weaken nations' resilience by placing increasingly powerful consumer technologies into the hands of individuals and groups intent on using them to cause harm.

There are many examples where new technology has reduced the resilience of an organisation by adversely affecting the organisation's capacity to resist, absorb, accommodate, adapt to, transform and recover in a timely and efficient manner. We have witnessed how commercial off-the-shelf (COTS) quadcopters can shut down international airports, or carry explosives with the aim of destroying high value targets. It is likely this is just the beginning. Greater degrees of autonomy and the ability to control multiple drones simultaneously will enable operators to launch sophisticated, co-ordinated attacks and to do this on a small budget and with little prior training.

Leaving our fictional train operator behind and turning to a real world example of how new technology risks can manifest themselves we turn to a recent study into the potential vulnerability of rail automation technology. The European Rail Traffic Management System (ERTMS) is a multi-million Euro program to technologically revolutionise rail services across Europe by introducing track-side sensors to centrally manage and control train movement. The hopes for the technology were grand – it would provide centralised control of trains on tracks and automatically start and stop trains to maximise track capacity. The technological solution selected for ERTMS is to use an open standard wireless communications network from track-side to train driver and train position sensors. A European study conducted by IFSTTAR⁹ identified that the communication system could be highly vulnerable to malicious interference such as jamming by the use of easily acquired (albeit illegal) jammers.

The variety of technological threats to large organisations is staggering. Insertion of new technology if not done with care can seriously reduce an organisation's resilience.

Conclusion

There can be little doubt that technology is a good thing for business; it has the potential to help us work more productively, more effectively and more safely. And as many commentators suggest, adopting early can yield many benefits, especially to business wishing to gain a competitive advantage.

The desire to be an Innovator or Early Adopter however can cause organisations to jettison caution and sense in the rush to lead the way, and often to their detriment. When your business is defence or provision of critical infrastructures, getting it wrong could cost lives.

Price Waterhouse Coopers suggest that "The G20 should explore, and recommend, governance structures and policy mechanisms to ensure governments have the agility and ability to keep pace with the 4IR"⁴.

A wrong decision (and they happen often) can end up costing the organisation dear, having negative effects on profit, staff morale and client confidence. The challenge to organisations now is in making sure that their systems, processes and staff are ready for the new technology offered by 4IR, that they choose the correct technology for the job and that the potential vulnerabilities and threats have been accounted for.