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Introducing technology and innovation management

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Introduction

This free course, *Introducing technology and innovation management*, will introduce you to technology and **innovation management** and should be of interest to all of you with an interest in technological innovation. You will learn about different types of product innovations (goods and services), process innovations and system innovations. You will learn about the process of innovation and how it can be managed and be diffused in markets and socioeconomic contexts to create value. We will consider some sceptical voices about the transformative and beneficial value of innovation. Finally, you will learn about innovation management and the importance of considering people, technology, organisational and contextual (PTOC) factors in effective management of innovation.

You do not need to have worked in a technology and innovation field or have any prior knowledge to be able to complete this course.

This OpenLearn course is an adapted extract from the Open University course TB801 *Technology and Innovation Management*

Learning Outcomes

After studying this course, you should be able to:

- recognise different perspectives and value that can be added by innovation
- appreciate innovation and diffusion processes
- identify key ‘innovation management’ activities
- understand the four key lenses of people, technology, organisational and contextual (PTOC) factors that influence and are influenced by innovation.

1 The significance of technological innovation

We live in a world where the history of technological change and innovation has been nothing short of remarkable, affecting our lives, the effectiveness of organisations, the profitability of industries, the well-being of societies, the sustainability of the environment and the prosperity of nations. Indeed, it has long been recognised that technological innovation is an essential driver of economic growth. This can be explained by the relationship between innovation and higher or better productivity, generated as a result of **product innovation** (goods and services), process, and **system innovations**. A consequence of higher or better productivity is economic growth.

Technological innovation sits at the core of capitalist economies and has been considered a major reason for the economic 'success' of capitalist societies compared with other forms of economic and social relations (Harvey, 2010). One of the most influential political economists in the mid twentieth century, Joseph Schumpeter, recognised innovation as a fundamental feature of the 'creative-destructive' tendencies of capitalism.

Approaching this issue from a different ideological perspective in the 19th century, Karl Marx also recognised the importance of science, **technology** and industry, although his focus was primarily on social progress. Taken together, these ideas have promoted scholarship on the relationship between science, technology, innovation and industry and the consequences of the interplay between these factors for different political economies and societies.

While many would accept that technological innovation is an essential driver for economic growth, the extent to which the negative aspects of this phenomenon are considered acceptable is a subject that can divide opinion.

- Can you think of some negative aspects of technological innovation in broad terms?
- Innovations that fail to deliver on the claimed benefits or, even worse, those that have harmful effects on customers, clients and citizens.

There are potential negative aspects specific to individual technological innovations. As technological innovations are widely adopted and used, they can destabilise existing technological and organisational arrangements and sometimes industrial, social and economic relations more broadly, often for better and sometimes for worse. One common result, for example – and one with which many of us are familiar – is what often seem to be continuous cycles of organisational change and a regular pursuit of technological 'fixes' that claim to result in better goods and services and systems, and more economical, more efficient and productive industrial processes.

While we can point to some negative consequences of technological innovation, the question of the value of innovation is being currently extended beyond a narrow focus on economic growth, as measured by Gross National Product (GDP) at a national level, to consider other benefits, such as indicators of 'economic well-being' and 'green growth' (OECD, 2017).

Clearly many technological innovations have a significant role in generating economic wealth and other benefits for society and the economy. It is consequently a challenge for us to find the best ways to innovate in terms of developing and capturing the value of technological innovation.

We have now used the word ‘innovation’ a few times. Before progressing further, this is an appropriate point at which to ‘unpack’ what we understand about innovation.

2 What is innovation?

Joseph Schumpeter, a seminal thinker on the crucial role of innovation in economic development, argued in his classic book *The Theory of Economic Development* that capitalism is fundamentally a dynamic system of change and is incapable of remaining static (Schumpeter, 1934). He describes the 'perennial gales' of 'creative destruction' unleashed by innovation, which drive cyclical patterns of growth and decline – boom and recession – in markets and economies. Schumpeter made an early characterisation of innovation that is still relevant today, defined as any of the following five phenomena:

- The introduction of a new good (product). This should be new to customers or offer superior quality compared with the past.
- The introduction of a new method of production that is new to an industry sector.
- The opening of new markets.
- The exploitation of a new source of the supply of raw materials or components.
- The implementation of new organisational forms that enable greater competition and can lead to restructuring an industry.

(Adapted from Schumpeter, 1934, p. 66)

Another key dimension of innovation is Schumpeter's distinction between radical and **incremental innovation**. **Radical innovations** occur as a result of the introduction or clustering of revolutionary new technologies that have major socio-economic impacts. Incremental innovations are associated simply with improvements (Schumpeter, 1934).

Schumpeter's view of innovation is that it can be found in introducing new or improved goods, establishing new production methods, opening up new markets, enabling access to new supplies of resources, and introducing new competitive organisational forms.

The term 'innovation' has since been extensively debated and used in a wide range of ways. One study (Baregheh, Rowley and Sambrook, 2009) identified 60 definitions of innovation in organisations alone. In part, at least, these differences are a result of the different concerns of different academic disciplines and the perspectives of different **stakeholders**, as well as the different contexts in which innovation is considered. The next activity shows some of the different perspectives on innovation.

Activity 1: Perspectives on innovation

Allow 10 minutes

Match the different stakeholders to the correct description of their interest in innovation.

Interested in the contribution of innovation to the performance of sectors or the national economy and therefore in the generation of new products or processes.

Interested in how individuals decide whether or not to adopt an innovation and its subsequent impact on their lifestyle.

Interested in how to prepare their organisation to generate innovations new to markets and industries, or in how their organisation might most effectively adopt or configure innovations generated elsewhere for use in their own organisation.

Match each of the items above to an item below.

The economist

The social scientist

The innovation managers

What the term ‘innovation’ means, then, depends to some extent on who is using the term and the context in which it is used. An important message from this discussion is that innovation refers to both a process and to the outputs and outcomes of that process.

3 Definitions of innovation: the process and types

The broad definition of innovation by Schumpeter, which we have used as our starting point, has strongly influenced the widely-used definitions of innovation which are emerging from a wider tradition of research into the measurement of innovation used by organisations. For instance, Schumpeter's definition has been used by the Organisation for Economic Co-operation and Development (OECD) to set out the Oslo Manuals to inform innovation policy (OECD, 2005; OECD/Eurostat 2018).

The **innovation process** is defined, based on the OECD/Eurostat report (2018), as the process by which new ideas are developed and introduced, which are then either made available to potential customers/users through diffusion (in the form of products, including goods and services) or are brought into use (as processes or systems) in contexts for the purpose of creating or preserving value.

Invention is often, but not always, part of the innovation process in the form of the novel idea, concept, model or design that starts the innovation process. Some degree of novelty is core to innovation, as emphasised by Tidd and Bessant:

'Innovation is the process of turning opportunity into new ideas and of putting these into widely used practice.'

(Tidd and Bessant, 2009, p. 16)

Figure 1: A representation of the brain of the innovator

What results from the innovation process can be broadly classified, based on the OECD/Eurostat (2018) Oslo Manual, into two main types – product, and process innovation, or combinations thereof. Product innovations include goods and service innovations while process innovations can apply to a wide range of production and business processes. Importantly innovations can be difficult to classify in narrow innovation terms and types and can involve combinations of goods, services and/or processes (OECD/Eurostat 2018).

You will note how the OECD/Eurostat (2018) definition emphasises novelty and significant difference. This is supported by others, notably Tidd and Bessant (2009).

4 Thinking about product innovation

Expanding on the OECD/Eurostat (2018) definition, we can suggest the following:

- To qualify as a product innovation, new or improved goods or services should be significantly different to the previous offerings and should be introduced in a context to potential customers or users.

There are many examples of product innovation (goods), such as the recent emergence of 'Cubesats', or lower-cost microsatellites. These are becoming affordable for medium-large enterprises requiring custom solutions for enabling microwave communications between facilities and related applications, transforming the way we use space. Another example that may be familiar is drones, or remotely piloted machines also known as Uncrewed/Unmanned Aerial Vehicles (UAVs), which have their origins in the development of airpower during World War 1 and efforts to move away from the trench warfare associated with the deaths of more than 9 million soldiers.

Innovation in goods is perhaps what we think of most often when we think of product innovation. However, in line with the views of many academics, this course recognises that services, as well as goods, are products; by extension, service innovation is a type of product innovation. Familiar examples of service innovation are online platform services, such as Uber ride-hailing services or Airbnb room/property rental services that enable a sharing economy. Another is Fintech, the high-tech financial services that offer more convenient, competitive and cost-effective financial services. Another is Tesla's service product innovation which involved establishing their own network of electric vehicle chargers to create additional value to its customers.

Figure 2: A Tesla Model 3 using a Tesla charging point which is free for Tesla owners.

Take a few minutes to think of some of your own examples of innovative goods and services.

5 Thinking about process innovation

Expanding on the OECD/Eurostat (2018) definition, we can suggest the following:

- To qualify as process innovation, a new or improved process should be significantly different to previous processes (e.g. production, distribution and logistics, **ICT** systems, organisational, marketing and process development) and should have been introduced into use.

Process innovation is traditionally a term to describe innovation in the manufacturing or production processes used to produce a product (a good or service). There are many examples of process innovation, although the revolutionary concept of interchangeable parts in production is perhaps less well-known.

Example 1: Flintlock rifle

An original production process innovation is well-illustrated by the concept of interchangeable parts in flintlock musket rifles (Figure 1). This was demonstrated by the French gunsmith Honoré Blanc in 1785 to an audience of officials, dignitaries and experts (including an enthusiastic future President of the USA, Thomas Jefferson) at the Château de Vincennes near Paris (BBC, 2020).

The demonstration involved taking several rifles apart, putting the components into different boxes, then mixing up the components within the boxes, before reassembling the flintlocks by picking out random parts from each box. This could be done in minutes with little skill required. The demonstration was astonishing to the audience who were used to hand-crafted guns built from parts that were not interchangeable.

The way the mechanism was constructed from separate pieces that could be assembled into the whole rifle was considered revolutionary in its time. If one part became damaged, it could easily be replaced with another. As arms repair was time-consuming highly skilled work, the benefits were evident.

At the time Blanc was unable to find effective solutions to reduce production costs and improve the precision in manufacturing parts. Subsequently, a number of engineering solutions were invented during the Industrial Revolution, which helped to make the system of interchangeable parts work. Interchangeable parts innovation has since revolutionised engineering production and maintenance.

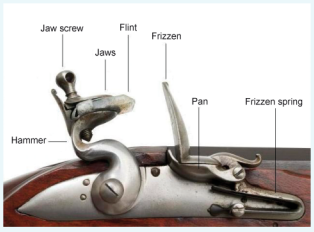

Figure 3: Flintlock rifle

A more recent example of production innovation is the **3D printing** process - a rapid prototyping technology that can produce three-dimensional artefacts for testing and for communicating concepts, as well as produce tools for manufacture and one-off or limited

batch production. The process of using a device in which thin layers of liquid chemicals are deposited and irradiated with ultraviolet light such that they react to create solid plastic was patented in 1986 by Charles W. Hull (Hull, 1986). By controlling the design of the process with computer software, it is possible to produce successive cross-sections of materials to build a 3D object of choice.

While process innovation is traditionally associated with manufacturing or production processes, the OECD/Eurostat (2018) recognise that *all* business processes can be innovated and therefore there is recognition of the many types of process innovations. This means that any and all of the following processes can be innovated:

- production process
- distribution and logistics
- information and communication **technology systems**
- organisational processes (e.g. business practices, workplace organisation, external relations, and administration and management practices)
- marketing processes (marketing and sales/after sales)
- process development.

Innovations in production and business processes – the way things are made, distributed, organised, marketed and developed – can reduce the costs of manufacture, improve performance, affect the costs and the accessibility of products and therefore influence market success. As with Schumpeter's characterisation of innovation, the OECD/Eurostat (2018) definition represents a broad understanding of innovation and a recognition that innovation is not only associated with technological **artefacts** or things.

Take a few minutes to think of some of your own examples of innovative processes.

6 Thinking about system innovation

The OECD (2015) defines system innovation ‘as a conceptual framework for understanding and managing transitions in response to radical technological and social change’ in both industry sectors and places in city, regional or national contexts. This reflects the influential research by Frank Geels, who understands system innovations in terms of ‘socio-technical transitions’ in response to major challenges (Geels, 2005; 2011).

Instead of defining system innovations in terms of the technical workings of a closed system, this approach recognises that system innovation is fundamentally sociotechnical (i.e. social and technical) and that when it happens, it involves a transition to a new sociotechnical system. You might be used to thinking about systems in purely technical terms, so it is of note that this definition extends to cover social change as well. This is because system innovations are never simply technical and will usually involve people, even if it is just as users.

- Based on your learning so far, what is system innovation?
- System innovation refers to the introduction of a new or improved system in response to technological and social change to fulfil a societal and/or economic function. This is a transition from an old to a new sociotechnical system and involves potential changes to a system or to any of its components, such as goods, services, buildings and infrastructures, accepted practices, and people associated with the system.

Many smart city projects are good examples of initiatives designed to bring about system innovations. An example was initiated through the MK:Smart programme (MK: Smart, 2020) as part of the UK Milton Keynes Future City Programme. Led by the OU, this involved collaborations between Milton Keynes Council, British Telecom and other business and universities. A new ICT infrastructure centred on a data hub, which draws together city datasets relevant to city functions to develop smart innovative solutions across transport, energy, water, enterprise, citizen engagement and education.

Figure 4: A Virtual Reality view of Milton Keynes, north-east from the railway station towards the city centre, which has been identified for urban transformation through the Council-led Future City Programme.

System innovations can be the most challenging type of innovation to work on because they involve change at the highest level of a complex sociotechnical system, in which there are many interacting subsystems and sub-subsystems leading to many different outcomes and impacts. The results can be difficult to predict and manage.

Activity 2: Examples of innovations

Allow 20 minutes

Think of some examples of innovation that align with the discussion set out so far in this course. They might refer to your interests or could include a current innovation in your organisation, sector or field of work.

Table 1

Type of innovation	Examples
Product innovation (goods)	
Product innovation (services)	
Process innovation (e.g. production, marketing, organisational, distribution and logistics, information and communication technology (ICT) systems, process development and so on)	
System innovation	

Discussion

Here are some suggested examples of different types of product, process and system innovations.

Table 1 (with examples)

Type of innovation	Examples
Product innovation (goods)	The first smartphone, IBM's Simon Personal Communicator integrated the functions of a cellphone and personal digital assistant (PDA), including phone and email communications, contact information, calendar management, document and spreadsheet management etc.
Product innovation (services)	Seller feedback – the idea of sellers and customers rating each other on apps such as eBay and Uber services.
Process innovation (production)	Henry Ford's standardised mass production processes for manufacturing the Model T car in 1908.

Process innovation (marketing and sales/ after sales)	Amazon Marketplace, the global online retail platform for goods and services, which rocketed Jeff Bezos from online bookseller to tech titan.
Process innovation (organisational e.g. innovation in business practices, workplace organisation, external relations, and administration and management practices)	The transition to online (and hybrid) work communication practices during the COVID-19 pandemic, using digital technologies like Teams and Zoom.
Process innovation (distribution and logistics)	Asset Tracking of mobile goods across the world by combining Global Positioning System (GPS) tracking software with cellular positioning technology in real-time. This is often combined with other technologies to monitor the conditions (e.g. temperature) applicable to products in transit.
Process innovation (information and communication technology (ICT) systems)	Integration of artificial intelligence (AI) technologies into business and management processes to support enhanced capabilities through automation of administrative, financial, HR and other management processes, and through data analytics and predictive learning to support customer engagement.
Process innovation (process development)	The production of the musical score for the Denis Villeneuve's 2021 film 'Dune' led by Hans Zimmer, which required the invention of new instruments to create original sounds, including a house sculpted by Chas Smith to function as a musical instrument. The score in 'Dune' brings sculptured sounds together with rhythmic banshee singing, compressed voice chanting and new sounds using cellos, bagpipes and newly constructed flute type instruments (Zimmer, 2022).
System innovation	City and regional electric vehicle (EV) automobility systems, with EV charging infrastructure, such as in Coventry, Brighton and Hove, Milton Keynes.

7 Additional ways to characterise innovations

In this course, we focus on types of product (goods/services), process and system innovations. Can you think of additional ways to describe innovations, for example:

- the degree of novelty – are the technologies involved in innovation more incremental or more radical?
- the level of innovation – what level of a system is an innovation at? For example, is it at the architectural or component level?
- the impact of an innovation – does the innovation have disruptive or sustaining impacts on organisations, markets and in other contexts?
- the form of innovation – what form does an innovation take in a real-world context? For example a social innovation is a form of innovation that will be shaped and defined by the social context.

Innovation cannot be simply understood in terms of the type of innovation or specific characteristics, but is instead more complex (Mitra, 2017). This complexity comes from the influence of people, technological, organisational and contextual (PTOC) factors that shape the form that an innovation takes.

8 Innovation process: how innovation happens in an organisation

The OECD/Eurostat definitions focus on what is innovated – goods, services, processes, or systems – rather than on how and why people or organisations might choose to develop or use an innovation, or how an innovation might be produced. So next we turn to consider the innovation process. The innovation process is not the same as a process innovation, but is instead the process of how innovation happens in organisations.

Innovation is a knowledge-based process, the means by which new ideas are developed and introduced. By itself, invention (or having a new idea, concept or design) is not enough – it needs to be part of a wider process that realises value. However, invention is not necessarily a part of the innovation process, although an element of novelty always is.

The innovation process may be understood with reference to the activities undertaken by individual innovators and organisations that are intended to result in innovation, including the research and development (R&D), financial and commercial activities required throughout the process. This is central to the management of technological innovation, and hence to much of this module.

While implementation is a necessary part of the innovation process, success is neither a requirement for an innovation to be counted as such, nor an essential consequence of the process (OECD/Eurostat, 2018). Clearly, success in capturing value from the innovation process is the main goal of the innovating organisation. However, innovations can fail once launched, although innovation management, innovation strategy and the innovativeness of the organisation play a big role in achieving success (Tidd and Bessant, 2018).

Figure 5 illustrates a simple model, developed by Tidd and Bessant (2018), of the innovation process as a series of phased activities, progressing from searching, selecting and implementing ideas in a context to capturing value for the innovating organisation.

Figure 5: The Search, Select, Implement, Capture (SSIC) model of the innovation process (Tidd and Bessant, 2018)

To learn more about the different phases of the innovation process, the next activity involves matching the description of the Search, Select, Implement and Capture (SSIC) phases to the correct description.

Activity 3: SSIC phases

Allow 20 minutes

To learn more about the different phases of the innovation process, match the description of the SSIC phases to the correct description.

Looking for ideas in the internal and external environment, such as market signals of opportunities and threats.

Choosing an idea for innovation and making a strategic decision about what the organisation is best placed to do in response to the options identified as a result of the searching phase.

Transforming an idea to be ready to launch in a context in conditions characterised by uncertainty.

Exploiting the value from the innovation, sustaining value for the organisation and learning to improve innovation management.

Match each of the items above to an item below.

Search

Select

Implement

Capture

Before moving on, take a few minutes to think through some of the activities that could be taken at each of the Search, Select, Implement and Capture phases of the innovation process. You might find it helpful to focus your thoughts on an innovation relevant to an organisation or sector that you are familiar with or have an interest in.

Discussion

What makes this model attractive is its generic features, which means that it can be used to describe and examine most innovation processes associated with product, process and system innovations in different contexts. That said, the SSIC model developed by Tidd and Bessant (2018) is one of several models of the innovation process available to look at relationships between innovation and organisational processes. This model presents innovation as quite a simple process, when in reality the risks and uncertainties associated with innovation can make success difficult to achieve. For now, though, it serves our purpose in recognising that the process of innovation needs to describe what happens in situations where the aims may be to introduce different types of innovations.

9 Innovation diffusion process

Another definition of innovation that we consider is from the work of one of the most influential writers on the diffusion of innovations, Everett Rogers. This definition is concerned primarily with how innovations spread, or ‘diffuse’, through markets and contexts over time. It recognises that the novelty of an innovation is not the only determinant of ‘success’.

An innovation is an idea, practice or object that is perceived as new by an individual or other object of adoption. It matters little, so far as human behaviour is concerned, whether or not an idea is ‘objectively’ new as measured by the lapse of time since its first use or discovery.

(Rogers, 2003 p. 12)

Figure 6: Diffusion of contrails in the air above Schipol (NL) airport.

As Rogers is concerned primarily with why people and organisations decide whether or not to adopt an innovation, it matters more to Rogers that an innovation is new to potential adopters and the circles in which they move than it is novel in some objective sense.

Crucially, an understanding of how and why a target audience of people or organisations decides about an innovation over time can be critical to its success or failure. The characteristics of people or organisations (adopters and users) and their perception of innovations, as well as market contexts and other success factors, such as effective communication channels, good timing and a supportive social structure, will have an influence on how quickly and widely innovations will diffuse.

Diffusion is an essential and recognisable aspect of the product innovation process. Diffusion works differently with process and system innovations where the issue is introducing innovations to industrial and socioeconomic contexts (rather than into markets). So this requires a different way of thinking about the application of diffusion theory to product, process innovation or system innovation.

10 Adding value through innovation

A key element of the innovation process is the idea of creating or preserving value. For business organisations, this value is principally about creating value in financial terms (profits) through gaining competitive advantage, whereas public or third sector organisations may be more focused on goals to create value in human, social or environmental terms. The value that an organisation seeks to create usually shapes their business model and strategy.

You may have heard of the Five Capitals Model, developed by Forum for the Future (2007). This model describes five capitals, or stocks of capitals (i.e. types of value or benefit), that might be created or added to by innovations (Figure 7).

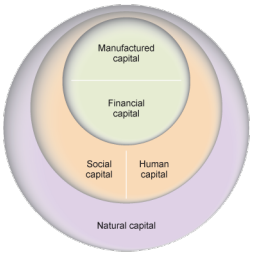

Figure 7: The five capitals: natural, social, human, financial and manufactured capitals

Activity 4: The five capitals and innovation

Allow 20 minutes

Consider the different types of capitals (types of value or benefits) that can be created or added by an innovation of your choice.

Name your innovation and note the different types of capital (or value) it adds

Discussion

You can compare your ideas with the following classification of capitals or types of value (Forum for the Future, 2007):

Natural capital: the value added by natural, ecological or environmental resources and processes.

Human capital: the value added by individuals, including their health, motivation, knowledge, skills, and capacity for relationships and achievements.

Social capital: the value added by relationships, communication networks, partnerships and cooperation.

Manufactured capital: the value added by materials, goods, buildings, technologies and infrastructure.

Financial capital: the value added by tradeable assets.

While the way in which capitals or types of value are classified can vary, these areas are clearly relevant to value creation, increasingly seen as a critical element of the innovation process. The value that an innovation seeks to create will also indicate which measures are appropriate for evaluating an innovation.

11 Sceptical voices

Clearly many innovations signal important benefits or potentially wide-ranging impacts. However, some claims about the transformative power of certain innovations need to be treated with caution. Online shopping may be convenient, and Facebook may have ushered in an age when people could have an almost infinite number of 'friends' regardless of their location or whether they have actually met, but shopping without physically entering a shop and 'virtual' friendships both existed long before the advent of the internet, through mail order or catalogue shopping and pen pals writing letters to each other. Mail order shopping and writing letters were made possible by innovations that were groundbreaking in their day.

Compare the impact of the introduction of running water, electric lighting and indoor plumbing with some more recent innovations. As Chakrabortty (2012) comments, 'You might love your iPhone, and I might spend too much time on Twitter, but we'd both be fine if they'd never been invented'.

Few would doubt the huge social changes associated with ICT-based innovations during the internet age, but Mitra (2017) observes that, so far, ICTs do not appear to have delivered the level of revenue that society benefited from during previous periods of technological change.

We can also debate the extent to which a new good or service adds value compared with previous offerings. Wilby (2012) notes that:

> Supermarkets are full of things that claim to be "new and improved". Technologists tweak vegetables and fruits to make them last longer and look better, without regard to flavour. Bankers develop "products" that, however you cut it, are still about borrowing and lending. We have digital radio and high-definition TV, though not everybody thinks either improves on what existed before.
>
> (Wilby, 2012, p. 33)

So, there are sceptical voices raising questions: Is an innovation novel? Is it transformative? Is it tackling the right challenges? Does it deliver economic growth or anything of value? Embedded in these questions is the broader question of the relationships between innovation, novelty and value.

Figure 8: An image of questions

Box 2: Thinking about innovation critically

The use of the term 'innovation', and the willingness of some to attribute groundbreaking powers to it, has become an idealised – almost mythical – construct

over the twentieth and twenty-first centuries. It can seem that if we can be more innovative, then people and societies will benefit, economies will automatically grow and solutions will be found for environmental problems.

Innovation is one of the most well-used terms in the organisational literature, irrespective of whether we are referring to private, public or third sector organisations, or national and regional institutions. Tidd and Bessant (2018) state ‘It leaps out at you from 1000 mission statements and strategy documents, each stressing how important innovation is to “our customers/our shareholders/our business/our future and most often, our survival and growth”’. In reality, the overuse of the term is in danger of devaluing its utility. It is for this reason that we would like you to develop a critical approach to thinking about the nature, value, impact and consequences of technological innovation.

12 Innovation management

Developing an integrated management approach to innovation is a key challenge, as it often involves working with staff representing different disciplines and functions, sometimes from external organisations and sometimes involving customers, users and wider stakeholders in innovation.

There have been several attempts at defining innovation management, of which we only draw on a couple of examples here. An early attempt by Brown (1997) concluded, on the basis of a survey of tools and techniques for managing innovation across 17 European countries, that innovation management was concerned with technology, people, culture, communication and the organisation of business processes. This is also similar to Bartol and Martin's (1998) early definition of change management, which covers technology, human resources, organisational culture and structure.

In addition, a wide-ranging review of innovation management studies found that 'the terms innovation management and technology management are often used interchangeably, or rolled into one' (Igartua, Garrigos and Hervas-Oliver, 2010). This is unsurprising as we note that technology is almost always present in any innovation or innovation process. There are some examples of innovation with a minimal new technology input, e.g. the innovation of Cubism in art. Nevertheless, innovation management is a broader concept than technology management.

In their review of Ben Dankbaar's work on innovation management, Igartua, Garrigos and Hervas-Oliver (2010, p. 42) go on to note two complementary approaches:

> On the one hand, innovation management can be defined as the creation of preconditions to promote human creativity, including strategic commitment and context management. On the other hand, innovation management can be seen as a process to foster the application of knowledge.
>
> Igartua, Garrigos and Hervas-Oliver (2010, p. 42)

Activity 5: Identifying innovation management activities

Allow 5 minutes

Which of the following areas of management are applicable to innovation management, in your opinion?

Select one or more:

- ☐ project management
- ☐ resourcing
- ☐ organisational design
- ☐ external relations and networking
- ☐ innovation processes
- ☐ portfolio management
- ☐ technology management
- ☐ human resources
- ☐ leadership and organisational culture
- ☐ innovation strategy
- ☐ marketing
- ☐ knowledge and intellectual property management

- ☐ performance measures

Answer

Innovation management involves the management of many different areas, including all of the above (based on Igartua *et al*., 2010). The **knowledge** and skills to address this range of activities is, therefore, arguably needed by the innovation manager.

The broad scope and diversity of innovation management activities identified by Igartua, Garrigos and Hervas-Oliver (2010) underlines that innovation management is a core business activity in many organisations that requires skilled inputs from people working across management functions and areas of disciplinary expertise to create value. However, while innovation may be considered to be core business, nevertheless it is a *risky* core business activity that requires a systematic approach to management (Tidd and Bessant, 2018).

It could be argued that if innovation, change and technology represent key challenges in almost every organisation, then that would mean innovation management is relevant to nearly all organisations. However, the extent of the applicability or use of these management roles, activities and skills will be dependent on the characteristics of the innovation that an organisation is involved in, and its context, which will undoubtedly change over time.

13 Tick the PTOC factors!

There are four ‘key lenses’ through which technology and innovation management in organisations could and probably should be considered, as illustrated in Figure 9. This refers to the role of people, technological, organisational and contextual (PTOC) factors in conditioning and shaping innovation outcomes and impacts in real-world contexts. In turn, we recognise that technological innovation will shape people, technology, organisations and contexts. This means that considering PTOC factors is important for effective technology and innovation management. For shorthand, we refer to ‘Tick the PTOC factors’.

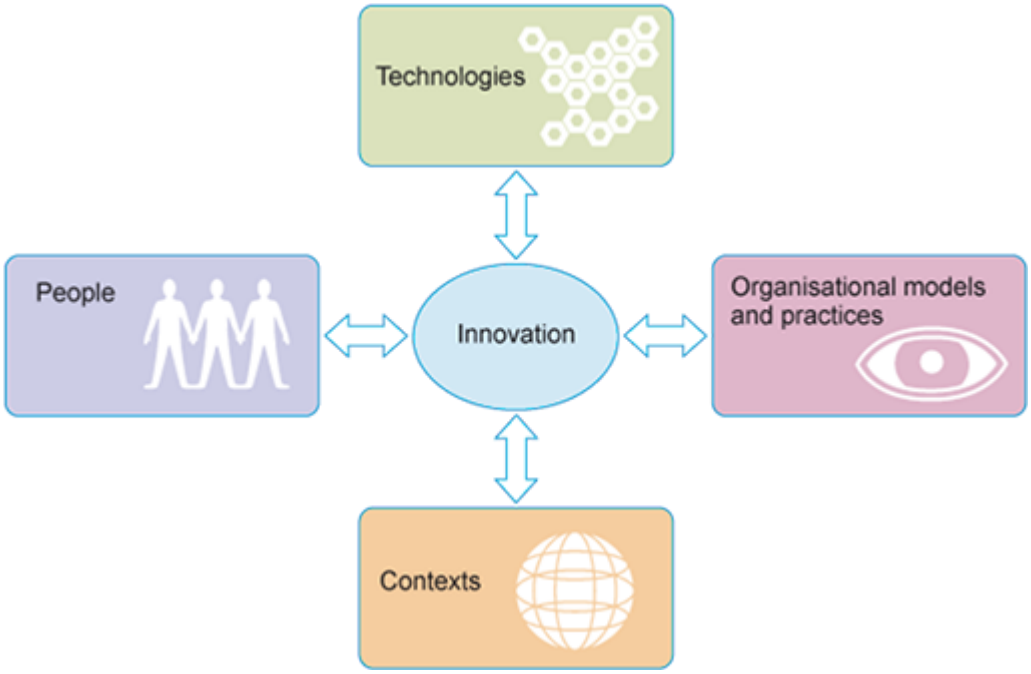

Figure 9: Tick the PTOC factors: Four key lenses for exploring innovation

Activity 6: ‘Tick the PTOC factors’ in technology and innovation management

Allow 15 minutes

So, what might ‘Tick the PTOC factors’ mean in technology and innovation management? Jot down a few thoughts about the role of people, technological, organisational and contextual (PTOC) factors.

Table 2

Role of PTOC factors	Issues for Technology and Innovation Management
People	
Technology	

Organisation
Context

Answer

The term ‘Tick the PTOC factors’ means considering the PTOC factors in technological innovation both shaping and being shaped by innovation.

Here are a few introductory thoughts about the role of people, technological, organisational and contextual (PTOC) factors that should be considered in technology and innovation management.

Table 2 (with answers)

Role of PTOC factors	Issues for Technology and Innovation Management
People	The role of people driving, enabling and impacted by innovation, and related issues. Such people might be individual inventors, innovators, entrepreneurs, intrapreneurs, project champions, customers and users, but might also be groups, organisations or intermediaries (e.g. designers, marketers, suppliers, the media, etc.), or stakeholders involved with innovation and innovation management.
Technology	The role of technologies, including artefacts, knowledge or ‘modes of enquiry’, and technological change in innovation and innovation management.
Organisational factors	The role of organisational models and practices associated with an organisation’s approach to innovation management.
Context	The role of context shaping and being shaped by the context for innovation and innovation management. Contextual factors and features can be spatial, temporal and human-constructed (e.g. technological, organisational, sectoral, social, political, economic and environmental factors).

In your study and practice of technology and innovation management, we recommend you ‘Tick the PTOC factors’ by considering the role of people, technological, organisational and contextual (PTOC) factors in innovation – both influencing and being influenced by innovation.

From the review, we can suggest that innovation management involves the strategic management of people, technology, organisational and contextual (PTOC) factors to create preconditions to promote effective searching for ideas and technologies, and then selecting suitable ideas for development, implementation and introduction as innovations into a dynamic context (commercial or social), with the intention of capturing and creating the maximum value of an innovation.

14 Check your learning

Have a go at the following quiz to check what you have learned.

Activity 7: Quiz

Allow 10 minutes

Select all the statements below that are true.

- ☐ Invention is always the starting point for innovation.
- ☐ There are different types of innovation.
- ☐ A service innovation is a type of product innovation.
- ☐ Process innovation can apply to a range of processes, for example, production, distribution and logistics, information and communication technology systems, marketing processes, organisational processes and process development.
- ☐ An innovation can always be clearly defined.
- ☐ An innovation is not usually characterised by novelty.
- ☐ The Tidd and Bessant (2018) simplified model of the innovation process focuses on the Search, Select, Implement and Maturity phases of innovation.
- ☐ Innovation diffusion refers to how an innovation gradually loses value to customers.
- ☐ Innovation management is a core business activity.
- ☐ 'Tick the PTOC factors' refers to considering the role of people, technological, organisational and contextual factors for effective technology and innovation management.

Conclusion

In this short course, we considered what the term ‘innovation’ actually means, in terms of definitions and types of innovation. We learned that most types of innovation can be broadly classified in terms of product innovation (i.e. a good or a service) or process innovations (i.e. production, distribution and logistics, information and communication technology systems, marketing, organisational process and process development etc.) or combinations thereof. System innovations are more complex and can comprise products and processes as well as social features, that is to say they are usually sociotechnical. Examples of different innovation types were considered as an activity. We also learned that it is difficult to classify some innovations by type or characteristics alone, and therefore that it is important to consider other factors when trying to understand innovation, including the role of people, technological, organisational, and contextual (PTOC) factors.

A model of innovation in an organisation was also introduced, based on Tidd and Bessant’s (2018) Search, Select, Implement and Capture (SSIC) model. This simple model appears to be generally applicable to describing the innovation process, phases and activities in many situations. This was underpinned by an activity to identify the phases and consider how it might apply to innovation management activities. You were also introduced to innovation diffusion, which refers to how innovations spread across users and market contexts over time once an innovation has been launched or implemented. We then discussed added value or value creation as an essential innovation process, including the natural, human, social, manufactured and financial ‘capitals’ (or types of value) that an innovating organisation seeks to capture or create through innovation.

Perhaps unusually, in the section ‘Sceptical voices’ we also highlighted some of the hype that surrounds the subject of innovation, particularly the belief in the transformative power of innovation. We emphasised the importance of considering different perspectives and of thinking critically about the claims made about technological innovation.

You were then introduced to innovation management as a distinct area of management, albeit one that is considered a core but risky business for many organisations. The range of skills and resources required by the innovation manager and the type of roles and activities performed will depend on the nature of the innovation project, which will change over time as the context changes. We suggested that considering the role of people, technological, organisational and contextual (PTOC) factors as 4 key lenses- is important for effective technology and innovation management, with the recommendation to ‘Tick the PTOC factors’ in your study and practice of technology and innovation management.

One feature of studying innovation, as distinct from the scientific and technological disciplines which generate much innovation, is that it is a fundamentally a sociotechnical and economic field, albeit with a multidisciplinary focus. Consequently, thinking about the contribution of different academic perspectives from different disciplines, and reading about contemporary practices, will deepen your understanding of these ideas. Finally – and perhaps most importantly – now you have completed this block, you should have gained an awareness of the fundamental technology and innovation management (TIM) concepts for the study of innovation, which you can build on in your future studies.

Congratulations, you have now completed the course! If you enjoyed this course, you might want to consider an Open University course. This OpenLearn course is an adapted extract from the Open University course TB801 *Technology and Innovation Management*.

Glossary

3D printing

A rapid prototyping technology that can produce three-dimensional artefacts for testing and for communicating concepts, as well as tools for manufacture and one-off or limited batch production. There are several different 3D printing technologies, which vary in terms of how the artefacts are formed, which materials are used, and the quality and strength of the finished artefact.

App

A software application that can be downloaded to a mobile ICT device.

Artefacts

Technology that includes physical products, components, machines, devices or tools.

Degrees of novelty

Refers to whether an innovation is more radical or incremental in terms of its novelty.

Diffusion

Refers to how something spreads across a population e.g. innovation, technology, knowledge, disease etc. For innovation, it refers to how an innovation spreads across users, markets and contexts once launched (Rogers, 2003). For technology, it refers to how a technology transfers across users, markets and contexts once it is launched or implemented.

Electric vehicle

An electric vehicle is powered by an electric motor using energy stored in batteries that need to be charged from an external source. Fuel cell electric vehicles are a variant whereby energy storage is in a hydrogen tank, with the fuel cell converting hydrogen to electricity to power the vehicle's electric engine.

Entrepreneur

Someone who takes a calculated risk to provide resources for developing an innovative idea through starting a new business for profit (based on Schumpeter, 1934).

ICT

Information and communication technologies

Incremental innovation

Evolutionary improvements to goods, services, processes and systems using existing technologies.

Innovation combination

An innovation that combines product (goods or services) or process elements (based on OECD/Eurostat, 2018).

Innovation management

Involves the strategic management of people, technology, organisational and contextual factors to create preconditions to promote effective searching for ideas and technologies, and then selecting suitable ideas for development, implementation and introduction as innovations into a dynamic context (commercial or social), with the intention of capturing the maximum value of an innovation (based on Tidd and Bessant, 2018).

Innovation process

The process by which new ideas are developed and introduced and are made available to potential customers/users either through diffusion (in the form of goods or services)

or brought into use (as processes or systems) in contexts for the purpose of creating or preserving value (based on OECD/Eurostat, 2018). Invention is often part of the innovation process in the form of the highly novel idea, concept, model or design that starts the process (based on Freeman, 1971). Although innovation always starts with ideas, invention is not always the starting point for innovation.

Innovator

Someone who develops and introduces new ideas to potential customers/users or implements new ideas into use (based on OECD/Eurostat, 2018).

Institution

A type of organisation, often associated with government and public services, with mechanisms established to govern behaviour in society and the economy.

Intermediary

An intermediary works across organisations as an enabler. An innovation intermediary is an enabler of innovation.

Intrapreneur

An intrapreneur creates, promotes and introduces innovations while working as an employee within an organisation.

Invention

Invention is often, but not always, part of the innovation process in the form of a highly novel idea, concept, model or design that starts the process (based on Freeman, 1971). Invention is more strongly associated with radical than incremental technologies. It refers to a concept that is patentable, although an inventor may choose not to patent.

Inventor

An inventor creates highly novel ideas, concepts, models or designs for new goods, processes, services or systems (based on Freeman, 1971).

Knowledge

Knowledge can refer to the architecture and design of a product technology. It can also refer to the systems of operation and control and related practices embedded in production process technology.

Marketing innovation

The introduction of a new or significantly improved marketing method that differs significantly from the previous marketing processes in use (based on OECD/EUROSTAT, 2018).

Mode of enquiry and action

A particular approach taken to develop or improve a product and/or a particular approach taken to the production process.

Organisation

People working together for a purpose under some form of management structure. It can be for profit or not-for-profit and can be place-based or in digital space. Not-for-profit organisations include charities and public sector organisations. For-profit or business organisations are often called companies or firms. A large company is called a corporation.

Organisational innovation

The introduction into use of a new or significantly improved organisational method. This can apply to administration and management, business practices, workplace

organisation and external relations that differ significantly from the previous organisational process (OECD/Eurostat, 2018).

Organisational model

The design of an organisational structure around a strategic purpose, for example to enable innovation, and specify the relations between the roles and functions of staff.

Process innovation

Refers to the introduction of a new or significantly improved process into use that differs significantly from a previous process in use. It refers to a high-level category of process innovations that can apply to a range of business processes, for example production, distribution and logistics, information and communication technology systems, marketing processes (marketing and sales/after sales), organisational processes (administration and management) and process development (OECD/Eurostat, 2018).

Product innovation

A high-level category that can apply to types of goods or service innovations. Product innovation is defined as the introduction of new or significantly improved products (goods or services) to potential customers or users that differ significantly from previous products introduced in a context (based on OECD/Eurostat, 2018).

Product innovation (goods)

The introduction of a new or significantly improved goods to potential customers or users. This includes new goods and designs that differ significantly from previous goods introduced to potential users in a context (OECD/Eurostat, 2018). Product innovation is often equated with goods innovation in the academic literature.

Product innovation (services)

The introduction of a new or significantly improved service offering to potential customers or users that differ significantly from previous services (based on OECD/Eurostat, 2018). It is often an improved delivery or performance of an existing service. Unlike goods, services refer to intangible offerings that can be bought, sold and experienced, but which cannot be touched or stored. Product innovation (services) is often simply referred to as ‘service innovation’ in the academic literature.

Project champion

Someone who plays a key role in promoting the development of an innovation.

Radical innovations

Radical innovations are characterised by their revolutionary technological novelty and effects.

Service innovation

The introduction of a new or significantly improved service offering to potential customers or users that differ significantly from previous services (based on OECD/Eurostat, 2018). It is often an improved delivery or performance of an existing service. Unlike goods, services refer to intangible offerings that can be bought, sold and experienced, but which cannot be touched or stored. Product innovation (services) is often simply referred to as ‘service innovation’ in the academic literature.

Sharing economy

A socioeconomic system for sharing resources between organisations and communities.

Social innovation

Refers to (1) innovation in social interactions and relationships irrespective of the outcome of the innovation and/or (2) innovation to address a social need.

Sociotechnical

Refers to factors and features of technology in its social context.

Sociotechnical systems

Complex systems with elements such as goods, services, buildings and infrastructures, as well as accepted ways of doing things (laws, rules, practices and behaviours).

Stakeholders

Individuals and groups that have an interest and involvement in the innovation process and its outcomes.

System innovations

The introduction of a new or improved sociotechnical system in response to technological and social change that fulfils a societal and/or economic function (based on OECD, 2015). This involves a transition from one sociotechnical system to another (Geels, 2005), involving potential changes to a system of elements, such as goods, services, buildings and infrastructures, accepted practices and people.

Technology

Technology can have several meanings, including in terms of artefacts (i.e. physical products and components, machines, devices and tools), knowledge and a mode of enquiry and action.

Technology change

Refers to the evolution and trajectory of a technology.

TIM

Technology and Innovation Management.

Technology systems

A system that connects hierarchies of technologies focused on industrial structures (Dodgson et al., 2008).

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