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Contemporary Issues in Sustainable Operations Management

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Abstract

Global atmospheric and ecological changes necessitate the implementation of environmental regulations to manage global warming contributors and other waste-related matters. Better management of scarce resources and the protection of social, economic, and

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adapted. Despite tax and other benefits through corporate social responsibility initiatives, not all managers have embraced green operational initiatives. This chapter explores sustainability in operations and supply chain management, green labelling, design for the environment, environmental economics, and humanitarian operations management. A thematic desktop literature review of journal articles, books, and conference papers was conducted to compile the chapter. The traditional linear economy that disposed of waste after the production of products and services has evolved into a circular economy (also the theoretical underpinning) that uses waste as inputs into new products and services. With this new wave of sustainable operations management, jobs are created, waste becomes more useful, and the exploitation of scarce resources is reduced.

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1 Introduction

Operations management integrate people, technology, processes, and procedures of design, management, and the production of products and services according to customer specification at a lower cost (Jaehn, 2016). Operations management is, therefore, responsible for converting resources from inputs into outputs as goods

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al., 2017). The products and services span across various industries that range in size and price. Inputs may be obtained from various suppliers. Outputs from one organisation may become an input into a different process for another supplier.

When it comes to operations management, efficiency in the design, improvement, management, or administration of business practices to generate value by converting inputs (such as raw materials, technology, equipment, and workforce) into outputs (such as goods or services) is important because the higher the efficiency, the higher the profit generated by the business. The delivery of goods and services to customers at the right time, in the right quantity, and at the right quality is another major responsibility of operations management. Failure to ensure the right standards and quantities may negatively affect the business' credibility, market share, and profits. In addition, operations managers must deal with the challenges of climate change and the sustainability of the natural environment by controlling environmental pollution and minimising waste.

Many organisations are involved in the end-to-end process of producing goods and services for the end customer which forms a supply chain that needs to work together to enhance efficiencies by reducing turnaround times, coordinating deliveries, managing costs, and ensuring that the correct quantities reach the right end-

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the manufacturer of the products and services.

Operations management is also responsible for ensuring that limited resources are available to meet people's unlimited needs and wants. Hence, operations management, which is responsible for producing the products and services that a business sells, must be able to manage in a way that ensures that manufacturing processes are not harmful to the environment, that materials can be recycled and are not toxic to the environment (Ogunlela, 2018), and scarce resources are well managed to meet the demands of future generations.

Traditional methods of production and operations management practices have been critiqued for contributing to greenhouse gas (GHG) emissions in the form of carbon dioxide, methane, nitrous oxide, and fluorinated gases. These greenhouse gases contribute to global warming and climate change by trapping heat in the atmosphere. Climate change affects the primary sector through rising sea levels that affect the fishing industry, wildfires that may affect wildlife, and droughts that may affect agriculture (Mkansi et al., 2020).

Unsustainable operations also result in negative social and environmental consequences such as pollution and health and safety problems. Consequently, reducing the environmental impact of operations management is a key success factor in the sustainability of the economy.

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goods and services. Operations management practices must, therefore, respond to demands to address sustainability.

The objective of this chapter is to discuss the contemporary trends in operations management with a particular focus on sustainability within operations management to help stakeholders update their business processes to accommodate sustainability aspects and adjust supply chain management principles to enhance the efficiencies and effectiveness of operations. Many different aspects of operations management can be considered from a sustainability perspective.

This chapter focuses on the problem of limited resources, aspects that relate to green operations management principles, and sustainability in operations and the supply chain. These aspects include environmental design, green labelling, migrating from a linear economy into a circular economy, incorporating technology into operations, humanitarian operations management, and improvement strategies.

2 Sustainable Operations and Green Supply Chain Management

Sustainable operations encompass product design, choice of technology, logistics, supply chain network design, and supply chain management (Jaehn, 2016). It also requires recyclability and ease of disassembly for economic value with biodegradable products (Mkansi et al., 2020) and sustainable energy consumption.

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processes with minimum waste in the manufacturing and operational phases of the product life-cycle. Green supply chain management (GSM) is defined as "integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life" (Srivastava, 2007).

2.1 Current Trends in Operations Management

Operations management traditionally has been concerned with the production aspect only. In recent times, it starts with design so that waste can be minimised, scarce resources can be used appropriately, and products can be more environmentally friendly. Design has to do with the design of products and services as well as the design of processes.

Design is, therefore, integral to operations management as it is more than determining how the product will look, but includes the configuration of resources (people, equipment, raw materials, physical shape, nature of processes, etc.) and activities. Resources that are not environmentally friendly could harm the environment and incur financial losses for the business through fines, penalties, recalls, and redesign activities.

2.1.1 Design for the Environment

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Standardisation (ISO), namely, the ISO 14064 standard for the quantification, reporting, review, and verification of greenhouse gases at organisational and project level; the ISO 14065 for certification bodies; and the ISO 14067 that deals with product carbon footprint requirements (Zhu et al., 2016). ISO 14064 and ISO 14062 focus on the integration of environmental aspects into product design and development.

Designing for a greener environment requires attention to energy usage and consumption, the selection of materials, and the designing of manufacturing processes. Design for the environment (DfE) is a design approach that emanates from the suppliers of raw materials, through the manufacturing stages of the production process, to the end consumer of the product or service. Products and services follow a life-cycle as illustrated in Fig 8.1.

Fig. 8.1

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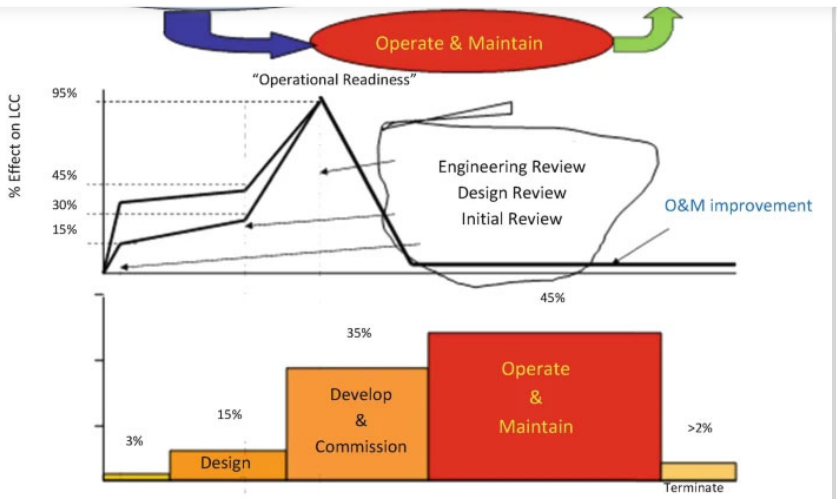

Engineering asset management life-cycle phases and stages. (Source: Amadi-Echendu and Amadi-Echendu (2015))

The management of an asset involves several phases (i.e., acquire, operate and maintain, and divest) and life-cycle stages (i.e., concept, design, develop and commission, and terminate). Typically, 95% of the total life cost is calculated when the asset is acquired (Amadi-Echendu & Amadi-Echendu, 2015).

Different role players are involved in different life-cycle stages of the product or service. Traditionally, a linear life-cycle was observed, as illustrated in Fig. 8.1, whereby a product was either terminated, divested, or rehabilitated at the end of its life-cycle. In recent times, the circular economy (CE) has replaced the linear economy. CE entails the end-of-life management of a product whereby a product's functional life is extended through reintroduction into the supply chain as non-waste (Govindan & Soleimani, 2017). No production in a

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A CE is planned and designed to be a regenerative industrial system and restores used products, uses renewable energy, removes toxic chemicals, and aims to eradicate waste by using environmentally friendly designs, resource systems, and business models. CE promotes reuse, remanufacturing, rebuilding, recovery, restoration, and recycling.

The circular economy is based on three basic principles (Tóth Szita, 2017), namely:

- regulating how resources are used to protect and develop environmental capital;
- circulating products, parts, and materials in the economy to extend their life through remanufacturing, refurbishing, and maintenance; and
- minimising negative externalities, eliminating toxic substances, and reducing waste by choosing appropriate materials in the design phase. Figure 8.2 is an illustration of the circular economy.

Fig. 8.2

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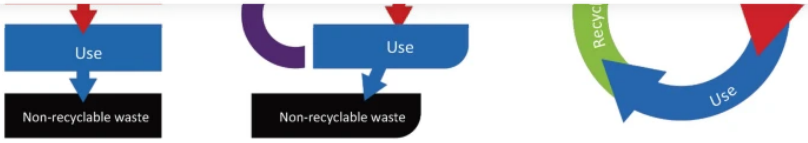

The circular economy. (Source: de Estarrona et al. (2019))

Figure 8.2 illustrates that recycling was introduced into the reuse economy whereby parts or products may be reused and not necessarily destroyed, resulting in lower manufacturing needs. Remanufacturing is incorporated into product design processes due to increased environmental and resource governance. Environmentally friendly products are easier to remanufacture (Zheng et al., 2019). When designing products and services, recyclable materials should be used to promote reuse and remanufacturing processes. Materials should not be hazardous and should be safe to handle to minimise health and safety risks.

Products may be returned to an organisation because of defects, damage, dissatisfaction, or another reason. These products form waste through a process known as reverse logistics. Some of the parts may be disassembled, sorted, and cleaned for use in subsequent life-cycles. Certain worn assets may be reprocessed to restore them to their original state through remanufacturing. Remanufacturing may realise additional incomes for organisations and adhere to environmental and regulatory requirements and sustainability goals. Both recycling and reuse methods

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Singh, 2019). Systems need to be redesigned to consume less energy and use resources more efficiently. The CE promotes greater land productivity, reduces waste in the food value chain, improves soil nutrients to increase the value of land, and endorse soil as assets. Sustainability promotes good governance throughout products' life-cycles.

Environmentally friendly or eco-friendly products are organic, energy-efficient, recyclable, non-toxic, and not dangerous to consumers. DfE is involved throughout the entire process and all life-cycle stages of a product. It ensures that all environmental specifications are integrated into how products are designed and manufactured, which may affect supply network configuration. Policies, procedures, strategies, and objectives should reflect environmental considerations that should be mirrored in operational activities like process layouts and processes. The product design activity passes through various stages (Slack et al., 2017).

First, the **concept-generation** stage is where innovative ideas are gathered from customers, competitors, staff, research, and innovation initiatives. Environmental considerations are encouraged from this stage.

Second, **concept screening** occurs when the ideas are evaluated and assessed against predetermined design criteria. The feasibility, acceptability, and vulnerability of

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Third, in **preliminary design**, the components and their order of addition are specified. The most elegant designs are typically the simplest where common elements are used. Costs are often offset by standardising products, offering alternative products, and modularisation in line with set environmental standards.

The fourth stage entails **evaluation and improvement** that may occur before the product is tested in the market. The final design must meet customer needs and environmental requirements. Costs must support value and performance imperatives by applying innovative and creative thinking to reduce the number of components, use less expensive input materials, and/or simplify the process.

In the fifth stage, the **prototyping and final design** stage, a prototype is created for testing. All potential effects and impacts on the environment and natural resources must be evaluated from the production phase to disposal, that is, from cradle to grave (Deniz, 2017).

Products and services follow similar steps. In the manufacturing of products, the following environmental requirements should be considered:

- pollution during manufacturing should be avoided;
- fewer materials should be used;

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- environmentally safer materials and processes should be used.

Carbon footprint refers to calculating CO_2 of the organisational or an individual's output of greenhouse gases to determine the effect it has on climate change. The product carbon footprint refers to the carbon emission produced through the exploitation of raw materials, production, transportation, manufacturing, consumption, and eventual disposal (Zhu et al., 2016). Governments have implemented taxes to curb high emissions and pollution.

Pollution is introduced by humans in the form of pollutants of gas, liquids, and solids or waste material that deteriorates the quality of the air, water, or land. Pollution may result in infections, diseases, premature deaths, and premature births by pregnant women. Clean water for drinking and cooking is essential for good health and life. A lack of access to clean water may increase the risk of bacterial diseases that may lead to urinary tract infections, cholera, diarrhoea, typhoid, and death. Sources of water pollution include factories, wastewater treatment facilities, septic systems, fertilisers, chemicals, construction sites, mines, and animal wastes from farms and fields. Damage can cause loss of ecosystems, biodiversity, and fishery resources. To clean

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Energy efficiency refers to methods to reduce energy consumption and usage and is used to assess manufacturers' competitiveness and drives economic development (Benedetti et al., 2015). Enhanced energy efficiency can be realised by finding alternatives that reduce total energy consumption. The environmental requirements are reduced energy demand during use, flexible energy use, and designs for:

- use with renewable energy
- zero emissions
- carbon neutrality
- zero toxins

The use of smart grids is also increasing. A smart grid allows for large-scale integration of renewable energy sources to distribute power to deliver more cost-effective and environmentally friendly electricity through the active involvement of customers on a digital platform (Benedetti et al., 2015).

2.1.2 Green Labelling

Ecolabelling identifies overall environmental preferences for products and allows consumers to practice environmental considerations in their purchasing decisions (Deniz, 2017). There are numerous green labelling programmes that follow different rating

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economic issues and energy savings, looking at the distance a material travels, or analysing toxin emissions in the air (Beatson et al., 2020).

Green marketing may essentially communicate the environmental benefits of products to potential consumers. Ecolabels encourage the demand for and supply of environmentally friendly products.

Ecolabelling has educated consumers about reducing negative environmental effects (Gossling & Buckley, 2016). Agricultural producers are focusing on organic farming (avoiding chemical fertilisers and pesticides) for their products to become labelled as environmentally friendly. The International Organisation for Standardisation provides general definitions and principles for the creation of voluntary ecolabels (Minkov et al., 2020). The standards apply to all businesses of any size as a generic framework (Mkansi et al., 2020). According to Minkov et al. (2020), there are three broad types of voluntary ecolabels to consider:

1. ISO 14024 (ISO 2018) type I ecolabels;
2. ISO 14021 (ISO 2016) type II ecolabels; and
3. ISO 14025 (ISO 2006a) type III environmental declarations, ISO 14040 (ISO 2006b) and product category rules for product groups.

2.1.3 Supply Chain Management

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factors that include customer demand, resource availability, consumer behaviour, and regulatory policies. Sustainable supply chain management (SCM) aims to strike a balance among all these factors while managing environmental concerns, different demands, cultures, and contexts on a global scale. The success of trade and commerce depends on a seamless flow of goods, services, money, and information among different supply chain stakeholders (Amadi-Echendu, 2017), as well as coordination of stakeholders, relationships, value, efficiency, and performance (Ahi & Searcy, 2013).

The objective of supply chain sustainability is to create, protect, and grow long-term environmental, social (related to human beings, and includes poverty, violence, injustice, education, public health, labour, and human rights), and economic value for all stakeholders involved in the supply chain so that products and services that are supplied to the market meet customer and environmental requirements. Economic value includes economic activities for people (securing food, water, and shelter, as well as creating prospects on the value of life) and for businesses, growth prospects, and generating profit within the compliance and stewardship parameters of the King IV Report (Institute of Directors in South Africa, 2016).

It is also important that products and services are traced back from the source to the consumer to assist with the recall of products where necessary through reverse

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and resulted in food recalls of ready-to-eat processed meat (Grobler, 2018) that took more than a year to trace. In 2018, *Salmonella* bacteria-contaminated eggs resulted in the hospitalisation of 30 people in South Africa (Knowler, 2018, p. 1) and traceability again was a major problem (Thomas et al., 2020).

2.1.4 Logistics

Logistics traditionally dealt with the movement of raw materials and finished products, as well as the protection, storage (warehousing), inventory, and transportation of finished products to their destination (Slack et al., 2017). It is imperative in the traceability of products and services. Supply chain logistics integrates social and environmental aspects which include reverse logistics, waste management, and transportation. Air, land (rail, road, and pipeline) and water (shipping) freight traffic transport significantly contribute to CO_2 emissions (Rodrigues et al., 2017). Maritime transportation has been the most cost-effective way to move large quantities of cargo over long distances.

Highly individualised products and services are increasingly being demanded, and logistics need to adapt to this volatile environment. Industry 4.0 technologies like blockchain were introduced into the logistics space (Tijan et al., 2019), a phenomenon known as Logistics 4.0, to enhance better traceability, accurate information, and faster processes through real-time information-sharing (Barreto et al., 2017). Errors are

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Procurement is an essential part of supply chains and ensures that required goods and services are sourced and obtained. This function entails the planning of purchases and purchasing strategy development, setting up specific processes with specific suppliers, contract formation and administration, outsource planning, and acquisition planning (Mkansi et al., 2020). Proper supply chain management systems may minimise expenses by allowing a just-in-time approach, whereby materials and other resources are secured as they are needed, instead of carrying huge inventories.

The use of electronic systems in procurement (e-procurement) may reduce costs, enhance efficiencies, and save time due to a shorter purchasing process, higher price transparency, lower administrative costs, improved collaboration with suppliers, being able to access historic data for better forecasting capabilities, improved information flow for better communication, and consolidated supplier information. Green purchasing decisions may be enforced in the procurement process that may lead to a specific supplier selection.

2.1.5 Environmental Economics

Environmental and social accounting aims at balancing a company's financial health with its broader obligations by incorporating environmental management principles and conservation into reporting practices and

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and reported so that decision-making can include meeting environmental regulations and not just financial profit. Environmental costs must be quantified in relation to how natural resources are treated to reduce pollution and environmental damage (degradation), and to develop strategies that can address these environmental issues. In a circular economy, waste production is managed through repair and recycling strategies where waste is used as a resource.

Environmental assets are under threat of depletion and degradation (deterioration of the quality of the environment) from economic activity, thus affecting the welfare of society negatively. Environmental assets comprise soil, land, and surface water, as well as terrestrial (tropical rainforests, deserts, grasslands, deciduous forests, tundra, and taiga) and aquatic (lakes, rivers, ponds, wetlands, oceans, and seas) ecosystems. Environmental degradation causes social and financial costs to society such as poor health, loss of income, and increased poverty and vulnerability.

The degradation of land affects the output of food production, which leads to food insecurity. It is imperative to establish the contributing factors to determine prevention and control measures. Forest degradation and deforestation affect wildlife and the land. The cost imposed by degradation differs from one country to another, depending on the contributing

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The degradation of natural resources such as sea, forest, land, and water are of major concern to all economies because it has a direct impact on economic growth, and can have repercussions for employment, attracting foreign investors, and living standards. Natural resource degradation includes agricultural damage from soil salinity and soil erosion, deterioration of grazing areas, deforestation and damage from natural disasters such as cyclones, severe droughts, and floods. The degradation of soil increases soil salinity, soil erosion, and degradation of grazing areas that in turn reduces agricultural productivity and the availability of livestock feed (Mkansi et al., 2020).

The ecological footprint (EF) measures ecological assets by calculating what would be required for a given population to produce the natural resources that it consumes and how waste is managed. It tracks the used cropland, grazing land, fishing areas, urbanised land, forest areas, and the carbon demand on land (Global Footprint Network, 2019). An ecological risk profile is developed for each country. Most countries are recording ecological deficits which means that they demand more from nature than what their ecosystems can restore. Other countries import resources from elsewhere, which burdens the countries of origin. Figure 8.3 depicts the ecological footprint according to Global Footprint Network (2019).

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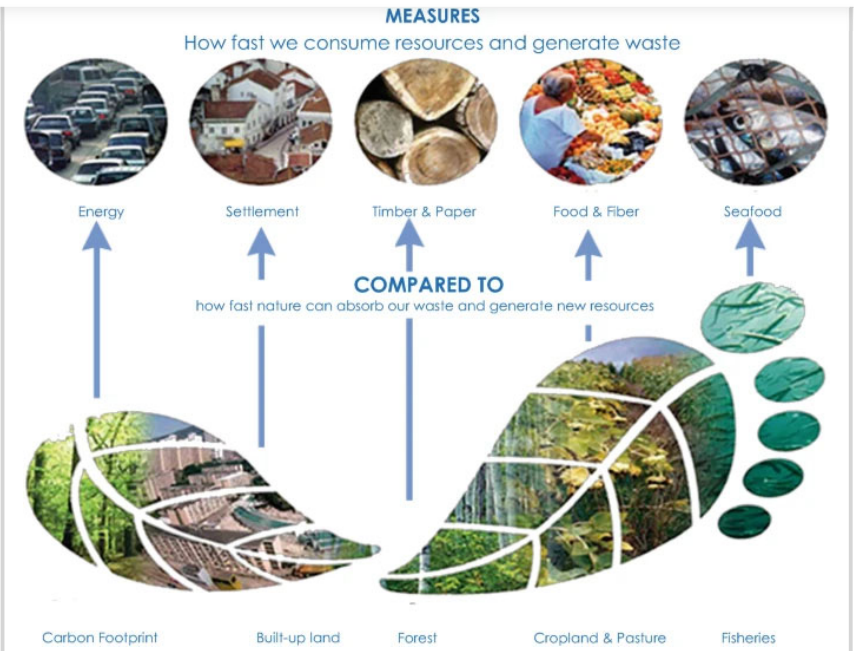

The ecological footprint. (Source: Global Footprint Network (2019))

A community has an ecological deficit if its EF exceeds its biocapacity (the capacity of its productive land area to continually generate the required renewable resources and to absorb the wastes it produces). An ecological deficit is an indication of not being sustainable. An ecological reserve occurs when the community's EF is less than its biocapacity which indicates sustainability.

The size of a community's EF is directly related to the amount of natural resources consumed and the amount of carbon waste produced by the community. EF is closely related to lifestyle. More luxurious lifestyles that

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EF provides useful information to aid governments in the development of policies and decision-making to promote sustainable resource utilisation through maximising resource efficiency. One of the limitations of EF is that it accounts for renewable resources in the biosphere, but not for non-renewable resources and their depletion.

Human activities affect environmental quality the most, which leads to threats to biodiversity that can harm nature. EF also does not consider other greenhouse gases apart from carbon dioxide. As it continues to be improved, EF will become a more widely accepted indicator of sustainability.

2.1.6 Economic Valuation

People are generally willing to exchange money for value. Economists use certain methods to calculate (or estimate) the economic value of market and non-market goods and assign a monetary or non-monetary value to the natural resources and ecosystem services. The process of estimating such value is known as environmental valuation. An ecosystem can have concurrent objective and subjective (individual and social perceptions), inherent (non-substitutional), and instrumental (specific) use as well as fluctuating exchange values (exchanged ratio of scarce and useful goods based on subjective preferences) (Spangenberg & Settele, 2016).

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for which the resource is required, the price, or the quantity of the resource. When deciding on an economic value for a resource or service, one needs to have the following in mind:

- The number of alternative goods and services a person is willing to trade (or sacrifice) to have a natural resource or ecosystem service/product.
- The benefits that people would receive if a policy or management plan was implemented so that the quantity or quality of a resource can improve (e.g., cleaner water or air).

The methods of assigning a value to an ecological resource still produce errors because ecosystems have complex functions and usages. When resources are scarce, choices about how society will use what is available must be made based on complex trade-offs. Decisions about how individuals and society collectively choose to allocate these resources help to reveal value. Linking a price to resources helps to facilitate the production and exchange of environmental goods and services in a market system. The price is decided through the influence of the consumers' willingness to pay. Economics regards all resources (such as land, water, labour, and plants) as scarce.

2.1.7 Resource Scarcity and Utilisation (Supply and Demand)

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and capital (plants, equipment, and inventories). If the amount of a product or resource supplied is less than what users demand, resource scarcity arises. Some goods or natural resources (e.g., atmospheric oxygen and sunshine) are available in abundance. These are referred to as free or non-scarce goods. A condition of scarcity forces households, businesses, and governments (known as economic agents) to make economic choices regarding scarce resources.

Society has evolved to use disposable goods rather than goods that can be reused and recycled which contributes to waste that is detrimental to the environment. Using wastes as resources must be done with care to avoid the transmission of contaminants into the ecosystem that ultimately affects the food chain. Overexploitation of natural resources and releasing waste into the environment are also contributing to the degradation of ecosystems (Velenturf & Purnell, 2017).

Resource management includes how changing climates affect the environment, economic globalisation, and growing populations so that we can adapt supply chain configurations. Valuation methods that deal with how resources recover from waste must be created. Water scarcity may affect lifestyles and businesses. For example, a Coca-Cola plant in Southern India was shut down due to water shortages (Kalaitzi et al., 2018).

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and pollution may also hamper sustainability, negatively affect pricing, and impact food security. In India, overconsumption of certain resources has led to hunger, food insecurity, and malnutrition (Tyagi et al., 2014). In Nigeria, floods and soil erosion, the overutilisation of natural resources, and the exploitation of oil has negatively affected forestry, biodiversity, and air that negatively impacted agricultural growth and economic growth (Dalil et al., 2016). UN organisations forecast population growth to be between 8.3 and 10.9 billion people by 2050. Such growth rates will require a 50–75% increase in the food supply. At the same time, the needs of developing countries will double, including a 60% growth of rice-consuming countries and sub-Saharan African growth by 250% (Prosekov & Ivanova, 2018).

According to the UN data, agricultural production will have to grow by 75% by 2050 (Godfray et al., 2010). Modern technologies may assist to increase food production through enhanced fertility of land, using organic ocean resources, switching to renewable energy sources, advances in genetics, and breeding more productive breeds of animals (Prosekov & Ivanova, 2018). Technological innovations and advancements may also assist with renewable energy issues.

2.1.8 Operations and Technology

Traditionally, organisations have worked in their own technological systems and shared only certain types of

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conducted via telephone and email, while records were largely maintained by using spreadsheets. Many operations have adopted modern manufacturing equipment to increase their economies of scale, which has also affected the exploitation of natural, human, and economic resources. Now businesses need to integrate sustainability aspects into their operations which necessitates tracking the origin of resources and products. Thus, boundaries and silos need to be removed through the digitalisation of the supply network.

Enabled by the Internet of Things (IoT), digitalisation is associated with organisation-wide and inter-organisational modernisation efforts (Valenduc & Vendramin, 2017). A digitally networked economy will augment value for the supply network through increased collaboration among supply chain partners. All customer interactions, every transaction, and all product and process development should be completely visible throughout the supply chain in the digital economy.

Technological innovations like 3D printing, the Internet of Things, machine learning (ML), and blockchain are transforming operations and creating new value to advance productivity, profitability, and sustainability. Value, therefore, extends beyond simply closing the deal. In the manufacturing process, blockchain can be used to eliminate counterfeits that enter a supply chain

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Blockchains can also help to verify the origin of the product and provide information about its path from origin to the final consumer (Dujak & Sajter, 2019). For example, Walmart's blockchain pilot of mangoes and pigs identified which data was important to record and made a list of important features such as tagging the pigs at the farm, types of fertilisers used in the pre-seedling stage of mangoes, the quality of trees, the lot number of where the pigs are stored, the date in which the pork and mangoes were packed, temperatures at the storage facilities and during distribution, the quantity that was shipped, and purchase order numbers (Kamath, 2018).

Many customers demand sustainable products and services, and the origin of these products and services must be traceable to prove that they were sustainably produced and delivered. Blockchain may be used to enhance the traceability of goods in a supply chain (Kshetri, 2018) and may also assist to minimise the distribution of fraudulent and counterfeit products. Automation in factories and machines can be enabled through blockchain connections. Organisations no longer compete on an individual basis, but must globally compete against other networks. Blockchain technology could facilitate trustworthy collaboration by connecting all partners in a peer-to-peer, decentralised production network in real time (Lohmer & Lasch, 2020).

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needs, building a unique customer experience, helping to cross-sell more products, and growing customer market share while maximising profitability. Information that is needed to achieve a unique customer experience requires more than customer demand, forecasts, and manufacturing data. It requires information about factors that may influence customer behaviour, what the current trends are in the environment and globally, weather patterns, and buying patterns, among other things.

Online platforms allow for customers to place orders within seconds, and the expectation is that goods will be delivered as promised. Organisations must ensure that they have visibility to know what needs to be done, by whom, by when it must be done, and what is required at the push of a button. Interconnectedness among supply chain partners and digitalisation of processes make this possible.

Enterprise resource planning (ERP) integrates information and resources within an organisation as well as across the supply network to streamline operational activities. There is a need to integrate the various ERP systems of different organisations to improve communication between customers, suppliers, and other stakeholders in the supply network. The ERP system enhances visibility across business activities resulting in improved business efficiencies through continuous improvement efforts; it provides accurate

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(Slack et al., 2017).

Digitilisation requires more than sharing of information and the automation of processes. Organisations will also need to adjust their policies and strategies to take advantage of technological advances. Business segments may need to be redesigned as digital technologies are integrated into organisational business processes and operations, thus affecting the composition of distribution channels and hierarchical structures (Plekhanov & Netland, 2019).

Organisations need information to make the right decisions. Smart devices have allowed businesses to gather customer information to understand consumer behaviour which translates to inconceivable amounts of data. It is just data with no real value until it can be converted into a format and perspective that can be used in a business context. The task of making sense of vast amounts of data cannot be managed by humans and has been fulfilled by big data analytics. For example, data can originate from the internet, social media, mobile platforms, sensors, ERP systems, and cloud platforms, and can exist in text, graphics, audio clips, and videos (Choi et al., 2018). Big data analytics helps to make sense of vast amounts of data and provides deeper insights into production processes, quality, and risk management (Lohmer & Lasch, 2020). Big data analytics has been successfully used in forecasting, revenue management, marketing, transportation

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Artificial intelligence (AI) aims to programme machines and computers, as well as to perform routine and repetitive tasks that were previously performed by people. Machine learning is a sub-discipline of AI that develops algorithms that can automatically identify and learn associations in large amounts of data in real time (Dogru & Keskin, 2020). AI applications like robotics and automation have enhanced operational productivity, predictive modelling, and marketing predictions of customer demand.

Organisations need to move from responding to customer needs to predicting customer needs. With real-time data, an organisation can move away from responding to machine failures, alerts, and deadlines that have not been met by monitoring all situations continuously in real-time through IoT technologies. Technologies such as machine learning, AI, and advanced analytics can predict and pre-empt future needs through insight into various assets and processes to enable less disruption, fewer costs due to reworks and shortfalls, on-time deliveries, and fewer machine breakdowns. Predicting future trends could enhance an organisation's responsiveness and assist to offer customised products and personalised services at short notice and at reduced lead times (Dogru & Keskin, 2020).

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logistical processes, while improving customer satisfaction. Many companies today are striving for zero waste and zero impact (or even a net positive impact) on the environment, which requires focusing on a circular economy where optimisation of assets, equipment, and inventory is critical and only possible through better use of digital technologies (Mkansi et al., 2020). Organisations, therefore, need to move from linear supply chains to agile ecosystems to meet the needs for constant innovation which requires collaboration and co-innovation with all partners.

Customers are becoming more informed and expect individualised products. As assets and products get "smarter" through IoT, the information transmitted about the state, location, and performance of such products should be used to enhance innovation strategies and business performance (Choi et al., 2018). Organisations are redesigning their manufacturing capabilities to move from continuous production lines to configurable manufacturing capabilities that can produce lower volumes of various configurations.

Organisations are moving away from selling products to delivering outcomes. IoT and the servitisation of assets are enabling new ways of engaging customers and creating value for them. The introduction of servitised business models comprises the selling of the use of a product and not the product itself. For instance, in the transportation sector, providers do not sell cars, but

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include after-sales maintenance and service of the operational assets in the market. Servitisation takes advantage of the digitalisation of assets.

2.1.9 Humanitarian Operations Management

It is important to note that the response to acts of God also comprises operations management processes and imperatives, even though humanitarians seek social impact rather than profit. A humanitarian supply chain deals with logistics decisions that need to be made before, during, and after a disaster to provide on-time support and assistance. Disasters could take different forms, including hunger, explosions, infestations, disease outbreaks like COVID-19 and ebola, refugee crises, natural disasters, conflicts, drought and other environmental factors, and manmade disasters. Humanitarian logistics involve various processes of planning and managing efficiencies, managing costs, warehousing, and moving relief supplies to where it is needed. Various role players are involved in this process: governmental and non-governmental bodies, civil society organisations, and humanitarian organisations, all of whom collaborate by integrating relief operations. Supply chains need to be flexible and agile to rapidly respond to unpredictable events.

Technological advancements also play a major role in this area. Drones, big data, and AI technologies are finding application in humanitarian operations (Besiou & Van Wassenhove, 2020). For example, Facebook

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Drones transport supplies to affected areas. Satellite images provide real-time information on damage to infrastructure after a disaster. Big data and AI techniques analyse and convert data into intelligence for decision-making. Global positioning system (GPS) equipment can track vehicles and the movement of staff in disaster areas. Social media circulates information faster and accelerates relief distribution after disasters.

Humanitarian operations (HO) centre on all stages of a disaster life-cycle including mitigation, preparedness, and response. When funding is scarce, HO needs to carefully prioritise the core issues and rehabilitation. HO is very different from commercial operations as they operate in volatile environments, face high uncertainty, encounter changing priorities and requirements, have unstable supply chains, and face sudden surges in demand with a limited supply of material and funds (Day et al., 2012). HOs must reach their beneficiaries speedily (effectiveness) and at the lowest possible costs (efficiency) (Besiou & Van Wassenhove, 2020). Regardless, operations management principles remain valid.

2.2 Improvement Strategies

Businesses nowadays tend to compete on their ability to continually improve their processes and imply an upgrade of current skills and knowledge of staff on all levels within the organisation and across the entire supply chain (Murray et al., 2016). Therefore, there has

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The scope of operations management has grown from a subject that largely focused on manufacturing to one that embraces all processes across sectors. Emergency services want to reach distressed people faster, customer deliveries need to occur more reliably, manufacturing wants to emit less pollution at lower production costs, while stakeholders require more profits. It is, therefore, clear that improvement strategies will depend on the type of operations, as well as the type of products and services that are being manufactured. Different role players in the supply chain may also attach different types of value and, therefore, different strategies for improvements become necessary.

Improvement strategies can be incremental (also known as continuous improvement) or radical (e.g., a total redesign of systems or installing new machines) and include lean management and Six Sigma principles that identify and eliminate causes of defects and waste in operations. Standards provide the benchmark against which improvements can be measured (Sraun & Singh, 2017). From a green operations perspective, improvement strategies may target the elimination or reduction of waste, remanufacturing strategies, and the reuse of products and resources that have reached the end of their life, enhancing the speed of reverse logistics processes, maintaining the value of soil and other assets, as well as the protection of the environment.

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operations management with a particular focus on sustainability within operations management. We saw that there are limited resources from which to satisfy unlimited wants. The resources need to be protected to ensure their use in the future. Sustainability had become a global focus area whereby organisations need to consider the environment, economy, and society in their business dealings. Consumers are more educated and demand sustainable products and services. Green labelling that complies with ISO standards may be used to highlight sustainable products.

It has, therefore, become imperative to track resources and products throughout the supply chain. Criteria that relate to sustainability may be used to choose supply and agree on the supply chain configuration. Organisations do not operate in isolation but depend on other organisations to deliver their products and services to customers. Some of these organisations are suppliers of raw materials or other parts and components, while others may store and deliver the finished products to customers. Within the supply chain, organisations need to reduce the silos and become more integrated for IoT technologies to be implemented and used more successfully. Logistics also need to be mindful of carbon emissions that may arise through transportation.

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either recycled, reused, or remanufactured to reduce the waste at the end of the product's life-cycle through reverse logistics and waste management. Essentially, products that have come to the end of their life-cycle may be reused in either the same or a different capacity in order to extend the life of a product and reduce waste in the environment.

Environmental economics is introducing environmental concerns into reporting practices and supply chains are assessed in terms of meeting environmental regulations in addition to financial profits. Environmental depletion and degradation may lead to food insecurity. The ecological footprint measures the human demand for natural capital that is used to assess responsible resource utilisation. Environmental valuation is a process used to assess economic value of products, services, and resources. Economics regard all resources (such as land, water, labour, and plants) as scarce and in need of protection.

Various Industry 4.0 technologies are available to use in operations. These include drones, big data analytics, artificial intelligence, blockchain technologies, sensors, drones, and many more. The technologies can help to monitor business processes, predict behaviour, reduce costs, enhance efficiencies, and assist to make products and services more sustainable. Blockchain technologies can help to trace the origin of products from the source to the end-user.

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supplies in emergency situations and disasters across the world. All elements that pertain to green initiatives in operations management also apply to humanitarian operations management. We have recently experienced the global COVID-19 pandemic where humanitarian operations were at the forefront of delivering masks and other health and safety supplies and equipment during lockdown. The supplies and equipment needed to be sourced, transported, and managed responsibly.

Businesses need to continually improve what they do to enhance efficiencies, decrease cost, improve competitiveness, improve profitability, and remain in business. Various approaches can be linked to improvement strategies that can be radical, incremental, or continuous. Improvement efforts extend to the entire supply chain and not just individual organisations and have become a competitive advantage.

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