2.1 Innovation in Circular Economy

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Define and Differentiate between Conventional and Innovative Solutions

Conventional Solutions - these are the traditional or usual ways of doing something. Innovators design product or system to source, produce, and sell. Conventional innovation balances priorities like performance, cost, technology and attractiveness to produce a better solution for customers and business. This kind of inventions focuses mostly on technological developments such as new manufacturing techniques and technology and material innovation.

Innovative Solutions - these are creative approaches that incorporate sustainability across the value chain in various sectors. It incorporate life cycle thinking that includes all aspect of sustainability addressing economic, social and environmental needs in a holistic view.

Difference between Conventional Innovation and Sustainable Innovation

Conventional Innovation traditionally design for systems to source, produce, sell, and use their products or services, making them cheaper to make, easier to sell, or better to use.

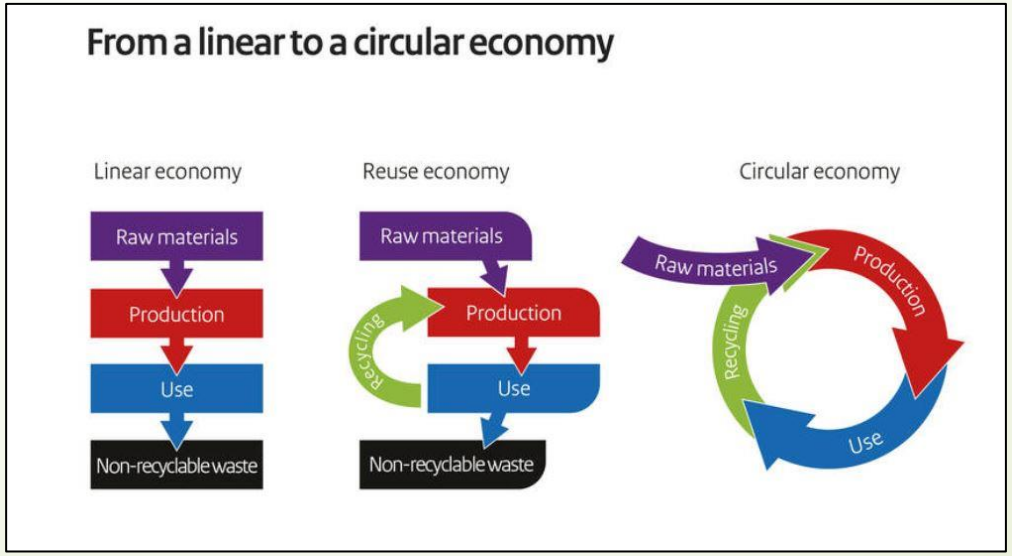
Sustainable Innovation – It is defined as innovation that leads to greater profits, better social outcomes and less environmental damage. It's not just about new concepts but is about commercialization of technologies, products and services and about entrepreneurship. Sustainable innovation is a process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization.

Source: http://www.katerva.net/index.php/about/sustainable-innovation

Difference between Conventional and Innovative Solutions

- **Conventional Solution** refers to the traditional linear economy of take – make and dispose. This means that raw materials are used to make a product, and after that the waste is thrown away.

- **Innovative Solution** refers to the transition from linear economy to a circular economy. Circular economy as define by Ellen MacArthur as "an industrial economy that is restorative and regenerative by design and intention".



Source: https://www.government.nl/topics/circular-economy/from-a-linear-to-a-circular-economy

Difference between Normal Innovation and Sustainable Innovation

Five fundamental differences between normal and sustainable innovation

Normal Innovation	vs	Sustainable Innovation
Balances Performance, Cost, Tech, Cool	+	Environmental and Social Factors
System = Source > Make > Sell > Use	+	Extract > Distribute > End-of-Life
Seeks Customer & Consumer Insights	+	Stakeholder Insights
Inspiration from Technology & Culture	+	Inspired by Nature
Serves Commercial Goals	+	Societal Goals

Source: http://www.innovationmanagement.se/2017/04/18/five-ways-sustainable-innovation-is-different-from-normal-innovation/

Five fundamental differences between normal and sustainable innovation

1. **Sustainability Factors are Balanced with Performance, Cost, Technology and Desirability:** traditionally innovation balances priorities like performance, cost, technology and attractiveness to produce a better solution for customers and business. Sustainable innovation also does this, but adds social and environmental factors too.

2. **A Wider Systems View is Adopted:** Innovators traditionally design for systems to source, produce, sell, and use their products or services. Sustainable innovation looks further to a wider set of lifecycle stages with the consideration of resource extraction, distribution, and waste disposal.

3. **Insights come from Stakeholders, as well as Customers and Consumers:** human-centered, customer-centric, people-driven are the trend for traditional innovation. Sustainability innovators also consider the stakeholders insights, delivering benefits to a broader set of stakeholders than consumers and customers alone.

Source: http://www.innovationmanagement.se/2017/04/18/five-ways-sustainable-innovation-is-different-from-normal-innovation/

4. **Inspiration comes from Nature as well as Technology and Culture:** Traditional innovation mostly consist of technological breakthroughs such as new manufacturing techniques, digital technology and new social-cultural developments. Sustainable Innovation incorporate nature as valuable source of inspiration. Concept such as cradle to cradle, close loop manufacturing and ecological design uses nature as their model and inspiration for doing innovation.

5. **Serves Sustainable Development Goals in addition to Commercial Ones:** The primary concern of innovation is economic prosperity and profitability. Traditional Innovation serves commercial goals. Sustainable innovation has a new purpose to reorients the goal towards societal need and give benefits to society.

Source: http://www.innovationmanagement.se/2017/04/18/five-ways-sustainable-innovation-is-different-from-normal-innovation/

Difference between Invention and Innovation

- **Invention** is the creation of a product or introduction of a process for the first time. It has to be something entirely new or something that has never been done before. To invent something is to discover a new thing.

- **Innovation** occurs if someone makes a significant contribution to an existing product, process or service. To innovate is to introduce something new to the market and turn them into a product or process that has an impact to the real world.

Sources: https://www.huffingtonpost.com/tom-grasty/technological-inventions-and-innovation_b_1397085.html
https://www.uk-cpi.com/blog/the-difference-between-invention-and-innovation

Role of Innovation

- Collaboration of businesses and researchers from different sectors.
- Connecting people with different interdisciplinary aspects
- Bring together groups that would not normally meet
- Connecting people to fast-track innovation
- Encourage open and collaborative learning approaches

Source: The Role of Innovation in Delivering a Circular Economy: By: Catherine Joce, Circular Economy Lead, KTN

Main Level of Innovation in the context of environmental improvement:

Level 1: ***Incremental*** - Incremental or small, progressive improvements to existing products

Level 2: ***Re-design*** - Major re-design of existing products

Level 3: ***Functional or Product alternatives*** - New product or service concepts to satisfy the same functional need

Level 4: ***Systems*** - Design for a sustainable society

Source: http://www.katerva.net/index.php/about/sustainable-innovation

Significance of Innovation in Circular Economy

Increasing awareness in environmental challenges and resource scarcity lead businesses and organizations to embrace the concept and principles of circular economy.

One of the key principles of a circular economy is that the goods of today are the resources of tomorrow at yesterday's prices. This is because the general concept of circular economy as defined by Elllen MacArthur as process that is regenerative by design and intension in which it replaces the 'end-of-life' concept with restoration. It is a system of resources utilization where reduction, reuse and recycling of materials prevails.

In order to meet Circular Economy **modern and innovative solutions** should be applied for the recovery of environmental resources. Innovating is inventing something tangible and efficient solutions to generate and restore resources. Researches and New Innovative solutions such as eco innovation and business model innovation drive the transition from linear economy to circular economy

Impact of Innovation in Circular Economy and Sustainable Development (SDG12)

Many companies have noticed that linear economy increases the exposure to ecological risks because of the unsustainable consumption and production pattern to satisfy human wants. Adopting modern approaches to innovation can fast-track transformation from a linear economy into a circular economy

The following are the key impact of adopting new innovative approaches:

- Future proof the business against resource scarcity and price volatility
- Businesses can have a brand differentiation
- Creating a service that will match customer needs instead of customer wants
- Increase productivity and profitability without harming the environment.

Benefits of Innovation to CE and SGD12

Benefits of businesses in adopting modern innovation towards the goal of transforming their business to Circular Economy and promoting SDG12

- It creates new market opportunities, partnership and investment for businesses and profitability
- It can achieve customer expectations and improve customer engagement
- It can enhance the environmental performance and resource efficiency through preserving and optimizing the environmental resources
- Innovation can transform business from linear economy to a vision of circular economy
- It promotes collaboration and participation of different groups by merging of talents and expertise from private companies, local government and educational institutions.

Types of Innovation

Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organizational, financial and commercial activities.

Product innovation: A good or service that is new or significantly improved. This includes significant improvements in technical specifications, components and materials, software in the product, user friendliness or other functional characteristics.

Process innovation: A new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

Source: The Measurement of Scientific and Technological Activities OSLO MANUAL page 31 to 33

Types of Innovation

Other types of Innovation

- **Technological innovation** - "It is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Oslo Manual).

- **Social innovation** –this are new strategies, concepts, ideas and organizations that meet social needs of all kinds. This includes social process of innovation. It is related to the ability to take ideas and apply it in the society to innovate socially to provide solutions even if there is no scientific or technical development.

- **Business model innovation** – it is about how an organization create value, for companies, for customers, and society. Business model innovation represents a new dimension of innovation, distinct to traditional dimensions of innovation, such as product, process, and organizational.

Source: Edwards-Schachter, M. (2018). The nature and variety of innovation. *International Journal of Innovation Studies*, *2*, 1–15. https://doi.org/10.1016/j.ijis.2018.08.004 ; https://thegentleartofsmartstealing.wordpress.com/types-of-innovation/

Types of Innovation

- **Environmental Innovation- also known as Eco-innovation –** it is a special kind of innovation that contribute to creating new solutions that provide added value to consumers and businesses by reducing the use of natural resources. It is the introduction of new production processes, products, services or business method that is novel to the organization which result in a reduction of negative impacts on resources across the whole life cycle.

- **Sustainable Innovation –** it is a development of a new product, process, service and technology which contribute to the development and satisfaction of human needs, and at the same time consider the use the natural resources and the ability to recreate them in the environment.

- **Green Innovation** – this is not only to promote energy conservation and emission reduction, but also improve the competitiveness of the organization. Green innovation follows the principles of the eco-economy and ecology, which can effectively reduce energy and resource consumption and reduce environmental pollution.

Sources: de Jesus, A., Antunes, P., Santos, R., & Mendonça, S. (2016). Eco-innovation in the transition to a circular economy: An analytical literature review. *Journal of Cleaner Production*, *172*, 2999–3018. https://doi.org/10.1016/j.jclepro.2017.11.111

- **Incremental innovation** is a series of small improvements or upgrades to products, services, processes or methods. The changes implemented through incremental innovation are usually focused on improving an existing product's development efficiency, productivity and competitive differentiation.

- **Radical innovation -** It represents a major technological breakthrough. It is when a new product, service, process or strategy is introduced to a market to make a significant impact by completely replacing existing technologies and methods. Radical innovation requires a significant investment of time and resources, making incremental innovation less associated with risk.

- **Disruptive Innovation** – an innovation that creates a new market that disrupts an existing market and value network, displacing established market-leading firms, products, and alliances (Wikipedia). It represents a new product or service that enters at the low end of the market and gradually moves up-market, disregarding all established competitors existing, established products. (Clayton Chistensen)

Global Innovation Index

The Global Innovation Index (GII) provides detailed metrics about the innovation performance of 126 countries which represent 90.8% of the world's population and 96.3% of global GDP. Its 80 indicators explore a broad vision of innovation, including political environment, education, business sophistication, and infrastructure and business sophistication.

Global Innovation Index 2018

1. Switzerland (number 1 in 2017)	11. Israel (17)
2. Netherlands (3)	12. Korea, Republic of (11)
3. Sweden (2)	13. Japan (14)
4. United Kingdom (5)	14. Hong Kong (China) (16)
5. Singapore (7)	15. Luxembourg (12)
6. United States of America (4)	16. France (15)
7. Finland (8)	17. China (22)
8. Denmark (6)	18. Canada (18)
9. Germany (9)	19. Norway (19)
10. Ireland (10)	20. Australia (23)

Source: https://www.globalinnovationindex.org/gii-2018-report#

Global Innovation Index – Southeast Asia

The Philippines has retained its ranking in the 2018 Global Innovation index, Out of 126 economies, the **Philippines ranked 73rd**.

According to the report, the Philippines' performance was weak in the areas of investment, political stability and safety, ease of starting a business and expenditure on education, PTC Patents and Scientific and technical articles. However, the areas of strength are graduates in science and engineering, gross capital formation, ecological sustainability, knowledge diffusion and ICT Service exports

Meanwhile, among the Southeast Asian country's strengths were trade, competition and market scale, as well as knowledge absorption.

South East Asia as a region is becoming an important engine of innovation as they are rising quickly through the ranks of GII. Many East Asian countries are ranked within the top 20 in the 2018 GII: Singapore (5th), South Korea (12th), Japan (13th), Hong Kong (China) (14th), and China (17th).

Source: https://www.globalinnovationindex.org/analysis-economy ; https://www.globalinnovationindex.org/gii-2018-report#

Innovative Technology

As people all over the world go about their daily routines—working, shopping, commuting, and spending time with loves ones—virtually every aspect of our lives is increasingly influenced by an invisible network of technologies and devices that collect, transmit, and analyse incomprehensibly large amounts of information in the blink of an eye.

The rise of sophisticated hardware and software—sensors, mobile apps, robots, supercomputers, and ever-faster internet, to name a few—is changing the way the world lives, plays, and works; and Asia Pacific is no exception to its outsize influence. But one thought is emerging among sustainability advocates – as long as our consumption and production patterns are changing so radically, can we seize the opportunity to leverage the change for sustainability?

Innovative Technology

Some of the key technologies and trends expanding their influence on society are:

1. Internet of Things (IoT)
2. Blockchain
3. Big Data
4. Artificial Intelligence

These technologies are both disruptive and exponential. That is, they are set to replace well-established ways of doing things with new process and markets; and they become more effective and cheaper extremely fast—which will see their adoption skyrocket rapidly.

Innovative Technology

1. Internet of things (IoT)

Internet of Things (IoT)- a network of smart, interconnected devices and services capable of sensing or listening to requests or needs, and then acting on them.

- can monitor metrics such as air and water quality, energy consumption, temperature and traffic flows, and help make many of the UN Sustainable Development Goals a reality, including Responsible Production and Consumption; Affordable and Clean Energy; and Smart Cities and Communities.

Innovative Technology

1. Internet of things (IoT)

Applications of IoT

1. **Smart meters** - help manage energy challenges.
   - digitally measure energy use, transmit this information, and perform energy management functions such as electricity sources and adjusting energy demand.
   - can enable energy suppliers to predict electricity demand more accurately and manage generation effectively.
   - gives users control over when they consume energy from the grid, solar, and batteries.
   - can facilitate demand response during times of peak demand some users can temporarily reduce non-essential electricity use.
   - frees up capacity for heavy users, reduces the need for investment in new power generation, and cuts electricity costs.
   - can enable people with access to renewable energy generation and consumers to trade clean energy amongst themselves by recording how much energy is generated and consumed.

1. Internet of things (IoT)

Actual Examples of IoT

1. **Singapore's Jurong Lake District** - aims to demonstrate how technology can enable a liveable and sustainable urban environment, and a key featureis IoT technology.
   - Data from farecards and sensors throughout the district will give planners a clearer sense of the location, types, and frequency of transport services that are needed and cater to these needs more effectively.

Innovative Technology

1. Internet of things (IoT)

Actual Examples of IoT

2. **Manila Electric Co. (Meralco)** - began rolling out smart meters to 40,000 households in 2013, and has installed more than 80,000 to date where incomes are low and electricity prices are high in the region.

   - could tell if your fridge is using more power this month than last so if may need servicing, or make suggestions on other products that are more efficient.

   - Budget-conscious consumers can also get alerts if they exceed their target daily consumption.

   - Meralco also plans to use the smart meters and communication network for demand response, distributed energy integration and smart streetlights.

Innovative Technology

1. Internet of things (IoT)

Historic and projected growth as a disruptive technology

-McKinsey forecasts IoT as one of the three most impactful technological advancements globally before 2030—along with mobile internet and the automation of knowledge work—and expects its economic impact to be around US$11.1 trillion by 2025.

-In 2017, Asia Pacific (excluding China) installed 17.5 million smart electricity meters. 360,000 of these were in Southeast Asia. Four Japanese utilities aim to have 27 million meters installed by 2024, while Korean utility KEPCO aims to install 26 million smart meters by 2020. Australia and New Zealand are expected to average 500,000 smart meter installations every year between 2018 and 2025.

2. Blockchain

Blockchain- is a transaction ledger where blocks of new information can be added, but old blocks cannot be changed.

- transactions on the blockchain are performed across network, with no need for a central intermediary such as central bank.
- a large number of computers are connected to this network, and there must be consensus among these computers before data can be added to the blockchain.
- Blockchain's decentralized, immutable, and consensus-oriented nature makes it a trustworthy and secure way to transact information.

2. Blockchain

Applications of Blockchain

1. **Peer to peer clean energy sharing-** Australian firm Power Ledger commenced a trial in Bangkok's Sukhumvit neighbourhood where an apartment complex, a school, a mall, and a dental hospital with solar panels trade clean energy with one another, and the city's electricity grid, over a blockchain marketplace.

   - the system is one of the world's largest peer to peer renewable energy trading platforms using blockchain.

2. Blockchain

Applications of Blockchain

2. **Supply chain transparency-** Blockchain is a tamperproof way to ensure environmental violations and human exploitation in supply chains are not illegally concealed.

   Provenance- a London-based technology which used blockchain to monitor Indonesia's tuna industry in 2016. Provenance worked with fishermen to get them to register their catch on its smartphone app, which stores data on the blockchain. Information about the fishermen, their catch, and suppliers were all securely stored and conveyed to shoppers in the UK.

   Cambio coffee worked with ScanTrust to increase supply chain traceability using blockchain. When customers scan this QR Code, they can access nutritional data, information about ingredients, certifications, and blockchain enabled data about the beans' point of origin, harvest date, shipment date, and roast date.

2. Blockchain

Applications of Blockchain

3. **Tokenising recycling-** In August this year, blockchain firm TrustNote partnered with a local environmental technology company in Hangzhou, China that lets citizens digitally tag their recyclables using an app, and be rewarded with tokens for their efforts. Citizens can track where their recyclables end up and redeem their tokens discounts on renewable energy products, or recycled items.

2. Blockchain

Applications of Blockchain

4. **Carbon Footprinting-** Blockchain can track a product's raw material stages to storefronts. It can also ensure that carbon credits are credible and effective. A product's carbon footprint can then be used to charge a carbon tax at the point of sale, pushing consumers towards products with lower carbon footprints. This has not been achieved yet, but signs are promising that this could be the future. Ben and Jerry's in May this year began paying for carbon credits to offset the impact of scoops sold in Soho shop in London. This is the first example of blockchain-powered carbon credits on the high street.

2. Blockchain

Applications of Blockchain

5. **Rewarding good behaviour-** Companies can also be given a reputation score based on their carbon or waste footprint—this would be managed using blockchain so that companies cannot tamper with the score; this would encourage companies to strive for lower emissions and waste generation, and shift economic drivers away from pure profits low-carbon, sustainable practices. Goodchain is a platform where brands place products and pledge consumer tokens to causes. This makes it possible to link provenance information and create a mechanism for rewarding consumers for verifying products with "IMPACT" points.

2. Blockchain

Applications of Blockchain

6. **International treaties-** Using blockchain to store environmental data in a public and transparent fashion can help hold corporations and governments to account on their progress on international environmental commitments, and prevent them from deleting or tampering with the data or backpedalling on their commitments. Brazil the International Tropical Timber Agreement, which aims to curb illegal timber, in 2013. Yet, illegal deforestation persists in the country. Brazilian non-profit BVRio analyses timber trade documentation data, satellite imagery, and other deforestation and labour-tracking databases to identify consignments of timber that might be illegal. All data is stored using blockchain.

2. Blockchain

Applications of Blockchain

6. **Enabling CSOs-** Charities and civil society organisations can also use blockchain to show donors that money is spent on the intended cause rather than lost to bureaucratic expenses. Blockchain-based money could even be released automatically to the correct parties when certain environmental targets are met. Bitgive and Bithope are two cryptocurrency charities.

2. Blockchain

Historic and projected growth as a disruptive technology

-WEF has predicted that by 2027, 10 per cent of global GDP will be stored using blockchain.

-A December 2017 study by technology giant Cognizant, found that 88 per cent of banking and finance sector executives view blockchain as critical to the future of their industry.

3. Big Data

Big Data - refers to datasets that are so big and complex that traditional computers and data processing software cannot handle them.

- Often, this data is captured from devices such as sensors, mobile devices, cameras, and microphones and it is then processed by super computers and algorithms, in real time.

- it is a new source of evidence with which to hold governments and corporations to account; for others, it can be an opportunity to help facilitate and support public sector efforts to deliver essential services; or inadequate technology infrastructure.

3. Big Data

Applications of Big Data

1. **Human travel patterns and malaria-** In Kenya, Caroline Buckee, a Harvard University researcher processed data from 15 million cell phones in 2012 to identify how human travel patterns contributed to the spread of malaria—this helped officials allocate resources to disease control efforts.
2. **Global Fishing Watch-** launched in 2016, the platform processes over 22 million position messages from more than 200,000 ships ever day to detect patterns that signify which vessels are fishing, when and where. This allows anyone with an internet connection to see fishing activity anywhere in the ocean in near real-time, for free.

3. Big Data

Historic and projected growth as a disruptive technology

-Accenture found that 59 per cent of companies say big data is “extremely important” to their organisation.

-Almost eight in ten users (79 percent) agree that companies that do not embrace big data will lose their competitive position and may even face extinction.

-Forrester predicts the global Big Data software market will be worth $31 billion in 2018, 14 per cent more than 2017.

4. Artificial Intelligence

Artificial Intelligence- refers to technologies ranging from robots that move around autonomously and perform tasks, to algorithms that can analyse enormous volumes of data and automate decision-making without human intervention to chatbots and household names like Alexa and Siri.

- it also refers to a set of machine learning algorithms inspired by the structure and function of the brain—or "neural networks".

- it is designed to imitate human decision-making, deep learning involves feeding a lot of data into a computer system through neural networks—these are logical constructions which ask a series of binary true/false questions, or extract a numerical value, of every bit of data which pass through them, and classify it according to the answers received.

4. Artificial Intelligence

Applications of Artificial Intelligence (AI)

A report by WEF and PwC this year found that there are six key environmental challenges that AI can help solve:

- climate change,
- biodiversity and conservation
- ocean health,
- water security
- clean air
- weather and disaster resilience.

AI is also a crucial feature of:

- smart electricity grids
- help predict demand and supply
- improve load management
- stabilizes grids as they integrate renewables into the system

4. Artificial Intelligence

Applications of Artificial Intelligence

1. **The International Transport Forum-** transport fleets using AI-powered self-driving vehicles to take nine out of 10 cars off city streets in the future, and completely remove the need for street parking in the process—freeing up the space for green or community uses instead.
2. **MIT's Senseable Lab-** xploring the application of AI to the design of our cities – from reducing traffic and parking space to enabling share economy models.
3. **The Climate Corporation's Climate Fieldview software-** uses deep learning to analyse data entered by farmers, as well as that collected by IoT sensors. It gives farmers insights to improve their yields without time-consuming analysis. With these, farmers can optimise their seed investments, manage fertilisation, and analyse crop performance, get a real-time snapshot of field health.

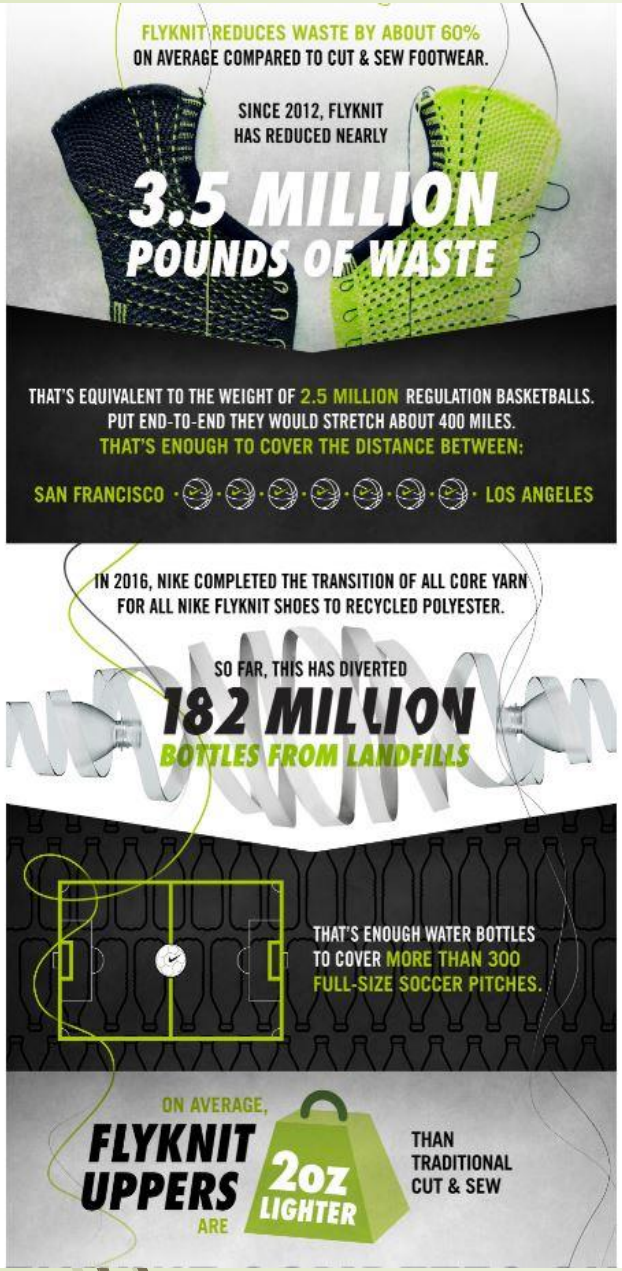
Innovative Technology

The disruptive technologies that will shape the world's—and Asia's— future over the next decade have broad capabilities, but are also deeply intertwined with one another.

Together, they form a complex ecosystem capable of delivering outcomes as game-changing as enabling low-income households to access solar energy and helping eradicate modern slavery; but they also carry risks such as privacy breaches, security threats, and perpetuating a divide between technology haves and have-nots.

These trends are also exponential—they are increasing in capability and cost-effectiveness at a breakneck pace, and the defining challenge of Asia Pacific's future will be delivering interventions that are effective, secure, and sustainable, even as they protect the privacy, livelihoods, and human rights of the region's inhabitants.

Cases of Innovation in achieving Circular economy and promoting sustainable development



Nike Footwear

Nike Footwear priority is zero waste, their vision is a circular future in which the concept of waste doesn't exist. In order to achieve this, innovation plays an important role by exploring new business model innovation that focuses on reuse and regeneration.

Nike are working toward a circular future, where everything is reused and nothing is wasted. They have developed new materials and manufacturing processes that generate less waste. Flyknit technology creates footwear uppers directly from yarn rather than cut them from fabric. All the core polyester yarn for Flyknit shoes is now 100% recycled polyester.

To date, Nike diverted more than 4 billion plastic bottles from landfills by using recycled polyester. Flyknit also breaks the mold of sustainable performance, not only shaving ounces off each shoe upper, but saving millions of pounds of waste from ever reaching landfills.

Source: https://sustainability.nike.com/waste

2.2 Achieving Circular Economy through Data Utilization

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Sub section researcher: Justine Ruiz

How important is data in achieving Circular Economy?

- It is an indicator of progress towards Circular Economy
- It highlights which areas needs more urgent attention
- It can make different sectors/enterprises realize the economic benefits of their involvement.

Decoupling Indicators

- Circular economy entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system.
- Decoupling is used to describe an improvement in resource efficiency, usually at the aggregate level of an economy.
- To develop the circular economy, we must be able to measure how much progress has been made, and to assess the importance of different levers and potential public policies. We need to come up with appropriate indicators, both on a macroeconomic and microeconomic level.

Sources of Data

- Primary Sources
  - Original researches
  - Survey data e.g. census or economic statistics
  - Reports by direct observers/data collectors
  - Self-collected data
- Secondary Sources
  - Reports from usual "economic" sources; e.g. banks (IMF, ADB, WB, etc.)
  - Government sources, e.g. National Statistics Agency
  - Corporate filings (e.g. annual reports)
  - Media (broadcast, internet)
  - NGO data collection initiatives
- There is a need to evaluate both sources if they match, thus, validating the data. If they do not match, then "noises" must be traced or corrected by the research community.

Barriers in getting data

- Currently, problems related to information can be seen as one of the major barriers to the implementation of the CE. Such are underdeveloped availability of information, increased transaction, and lack of knowledge.
- Also, ensuring access to data and questions related to data ownership are crucial since sharing data between competitors, ensuring privacy and property rights, and lacking trust are a big challenge
- Integration of big data owned by multiple sectors and management of information flows are considered as challenges as well.
- On the other hand, these challenges can be overcome with co-creation, networking, increasing transparency and providing information.

Importance of Data Standards

- Data standards are important to foster seamless exchange of data and it helps improve the ability of involved groups to exchange data efficiently and accurately. It also assists secondary data users in understanding, interpreting, and using data appropriately.

- "Environmental data standards are documented agreements on representations, formats, and definitions of common environmental data. They improve the quality and share-ability of environmental data by increasing data compatibility, improving the consistency and efficiency of data collection, and reducing data redundancy. They also provide a common vocabulary for citizens, local governments, States, Territories, Tribes, Federal Agencies, and private-sector organizations to communicate about environmental data". (Environmental Protection Agency, 2018)

- These data standards should be taken into account when collecting data for indicators. Having an accurate, timely and comparable data for all the global indicators is important to have a robust, voluntary, effective, participatory, transparent and integrated follow-up and review framework. However, according to UNESCAP, the reality is far from this. "The Inter-Agency and Expert Group on Sustainable Development Goal Indicators highlighted that more than half of the indicators either have very limited data coverage across the countries around the world, or do not even have existing agreed definitions or measurement standards.

Achieving Circular Economy through Data Utilization

- Utilizing available data from past to present can aid policy makers and implementers in assessing how far or near are we from attaining circular economy. In order to do this, there is first a need to understand what is already being done

- Furthermore, present data will drive decisions and actions based on the assessment of the current situation.

- Moreover, continuous use of data and assessment of indicators in the years to come is imperative in order to know if the taken actions or programs implemented were correct or not. In that case, rectifications or improvements could be done. Plan-Do-Check-Act cycle is a useful tool that can help measure performance and improve processes in order to get better results.

2.3 DESIGN THINKING: A Methodology Towards Sustainable Problem Solving

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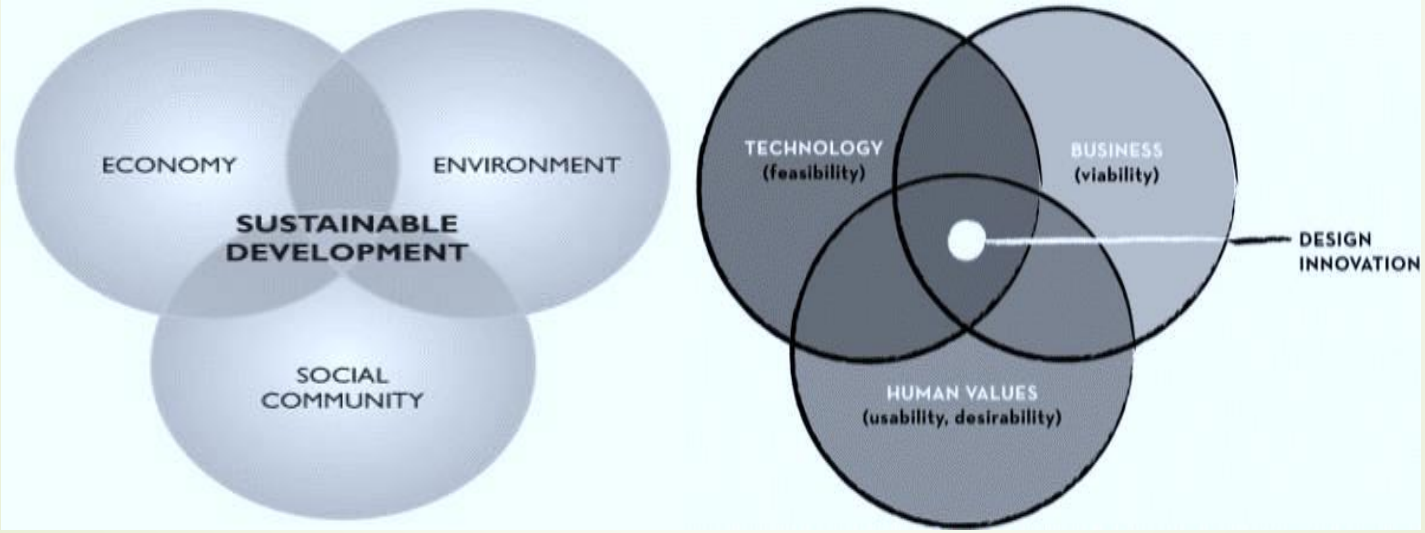
Sub section researcher: Keith Enriquez

The Role of Education in Sustainable Development

- Education for sustainability (EfS) is a transformative learning process that equips students, teachers, and school systems with the knowledge and ways of thinking in order to achieve economic prosperity, and produce responsible citizenship while restoring the health of living systems (Foster, 2001).
- Education is a key policy instrument for transition to sustainable development, but only a little is being done to change education (Huckle & Sterling, 1991).
- Critical for promoting sustainable development
- Socially critical skills are essential for understanding the problematic concepts of sustainability
- Higher education should seek to produce individuals with critical skills to understand the complexity of environmental, social, and economic problems and solutions

Design Thinking and Sustainability

- Sustainability concept is based on the fact that the earth's resources are not limitless (Munyai, 2016)
- Design thinking is a methodology for innovation that combines creative and analytical approaches and requires collaboration across disciplines



- Framework for sustainable development and design thinking (Munyai, 2016)

Design Thinking and Sustainability

Process of design thinking draws on methods from engineering, design, and combines them with ideas from the arts, tools from social sciences, and insights from the business world

Design thinking program:

- Learn the process in a team environment
- Internalizes
- Applies in own context

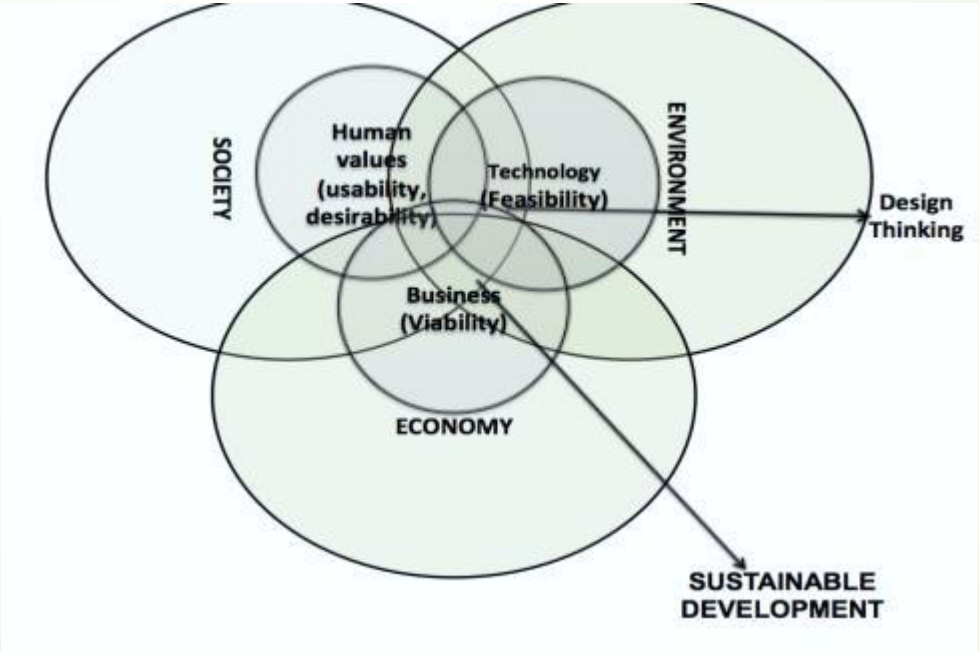
(Novak, 2011).

Traditional education system:

- Working in silos
- Working on tamed problems

Design Thinking and Sustainability

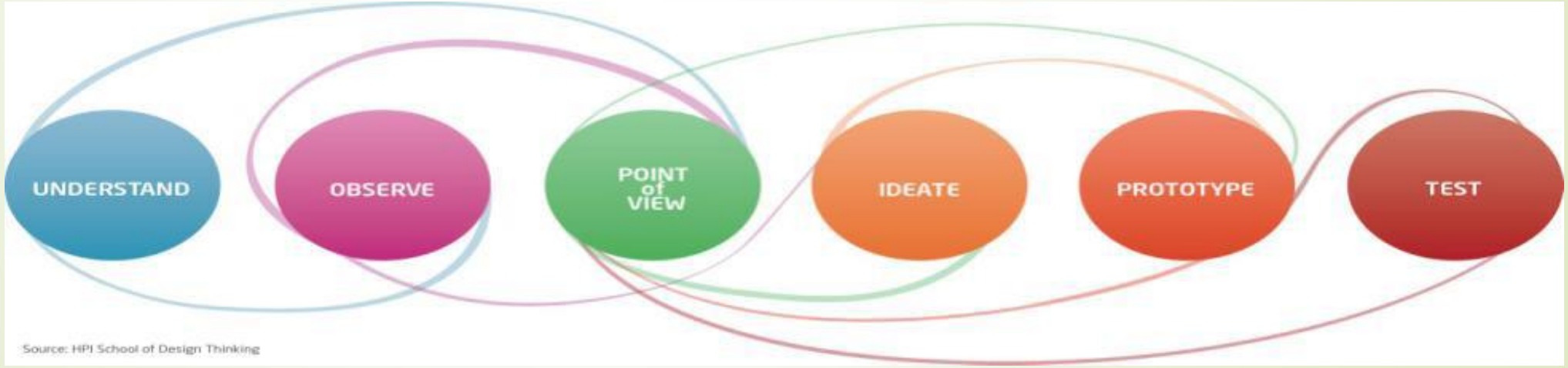
Design thinking merged with design for sustainability combines insights to provide a means whereby users of products, services and systems become inseparable partners in ensuring the longevity of our natural, social, and economic environments (Munyai, 2016).



- Framework juxtaposing design thinking on the sustainability development (Munyai, 2016)

Design Thinking Methodology

- Uses designer's sensibility and methods for problem solving (Brown, 2009).
- The methodology brings a process towards building sustainable systems, services, and products.
- Uses abductive reasoning, which is associated with problem solving (Dorst 2006).



- Design thinking process (Munyai, 2016)

Design Thinking Methodology

The methodology is about using design tools to tackle more complex problems, rather than focusing on enhancing the look and functionality of products, it is about designing user experiences, instead of consumer products

Broader Principles of Design Thinking

Human-centered approach

- Shifts perspective from technical to one in which human biases and heuristics play a role
- Personal values, attitudes, beliefs, and cultural settings are considered when designing solutions

Research-based

- Applies qualitative techniques of information gathering such as ethnographic, interviews, observations and immersion into the context (Korn and Silverman, 2012).

Broader Principles of Design Thinking

Design thinking looks at a broader contextual view

- Design thinking methodology forces participants to unpack and understand that any system operates by interacting with its environment.
- The contextual view clarifies the boundary of the system and its interface with the environment in which it operates (Beckman & Barry, 2007).

Broader Principles of Design Thinking

Collaborative and multi-disciplinary

- Encourages the understanding of social interactions
- With a multidisciplinary team, the solution that is developed is relatable to more people
- Design thinking is a multidisciplinary mindset regardless of whether design is directly involved or not (Buchanan, 1998).

Design Thinking

- Design thinking methodology is a valuable process toward sustainably tackling the higher education challenge of training graduates are expert in their disciplines
- Explores creative ways of problem solving which critical to dealing with some of the social challenges in society
- The methodology gives none designers the confidence that the can be part of crating a more desirable future, and a process to take action when faced with a difficult challenge

Broader Principles of Design Thinking

Iterative deliveries and prototyping

- Design Thinking is a creative human-centered discovery process followed by iterative cycles of prototyping, testing and refinement.
- Promotes the production of provisional outputs that can be tested with the user in order to develop understanding of both design problems and alternative solutions (Lawson, 1997).

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