Innovation for Circular Economy

Jovan Tan and Virginia Cha

Abstract Innovation can be magical. It has the potential to reduce the unprecedented resource stress on our planet while creating vast new economic opportunities for businesses to capitalize and prosper. With this promising proposition, business leaders are encouraged to design innovations that contributes to the betterment of society. This includes designing innovations for the circular economy, which is the centerpiece of discussion for this chapter. This chapter explores the dynamics of a successful innovation and discusses the current state of innovation for the circular economy. It further introduces the concept of Restorative Innovation—an innovation economic model that explains a pattern of innovation-driven growth for innovative solutions designed to restore our health, humanity, and environment. By the end of this chapter, readers will have a baseline understanding of innovation and the importance of designing innovation for the circular economy. Above all, readers will also appreciate the possibilities of creating and capturing positive value for both our economy and our society through Restorative Innovation.

Keywords Restorative Innovation · Innovation · Circular Economy · Impact · Outcome

Learning Objectives

- To understand the fundamentals of innovation.
- To learn about the current state of innovation designed for the circular economy, its challenges, and examples.
- To be introduced to the Restorative Innovation framework.

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1 Introduction

The advent of technology has ushered in a state of society that is constantly evolving at an unprecedented rate. This state of flux has introduced a lot of uncertainty in the global business climate. As a result, many businesses—including industry incumbents, are finding it increasingly harder to keep pace with the rate of change and to compete effectively in their respective domains. The competitive advantages that once gave these businesses a defensible position is also no longer as impregnable as they were. In addition, businesses are also starting to realize that they simply cannot cost cut their way to profitability.

Therefore, for businesses to continue thriving in this fast-changing environment, and to guard against potential disruptors, businesses must be forward-looking and be different. They must commit to strengthening their existing capabilities, while relentlessly identifying new growth opportunities and developing them into key strategic levers of growth. That is the intrinsic motivation of why business leaders innovate, and why innovation—the process of commercializing and exploiting inventions [1]—is imperative in our contemporary business environment.

Innovation revolves around value creation—where the value created is what consumers are willing to use and pay for. Hence, the precursor to innovation entails upon businesses to accurately spot the shifts in consumer behaviors and demands. In general, these shifts are gradual and are either geographic or industry specific. However, every once in a while, there will be a new eye-catching catastrophe that grabs our attention and consciousness. In recent years, it was the stark wake-up call from a special report released by the Intergovernmental Panel on Climate Change (IPCC). This special report denotes the impacts of global warming of 1.5 °C and stresses on the limited time we have on taking action to minimize extreme weather events, species loss, water scarcity and many other climate impacts that endanger lives, economies, and livelihoods [2].

This incident drove a monumental shift in global consumer behavior and demand towards green and responsible consumerism. Consumers are starting to feel most responsible for the future of the planet and are willing to play their part by rejecting goods that are detrimental to either health, humanity or the environment. Instead, conscientious consumers are now seeking alternatives to live a greener, cleaner and more equitable lifestyle. Therefore, for businesses to continue providing value and establishing a long-term relationship with their consumers, they will have to re-look at their current product offerings and introduce improvements or new solutions that are more sustainable.

As the rise of green and responsible consumerism is becoming ubiquitous, the question arises of—"How should businesses ride on this wave?" and taking a step further, "How does one innovate responsibly and introduce innovations that contribute to the betterment of society?"

There is no singular answer to this question as each approach to create and deliver value through innovation is unique. As such, this chapter sets out to guide and introduce the latest thinking on how we can innovate for circularity. To achieve our objective, we have divided this chapter into 2 parts.

Part One (Sects. 2, 3, 4, 5) aims to establish a baseline understanding of innovation through a short case study from one of Apple's most successful innovation story. Building on the learnings from Apple's case study, we will extend our discussion and apply it towards understanding the current state of innovation for the circular economy.

Part Two (Sects. 6, 7, 8, 9, 10) introduces the Restorative Innovation framework that explains a pattern of growth for innovative solutions that are designed to do good for our health, humanity, and environment. In this part of the chapter, we will establish the theoretical depth of Restorative Innovation while encapsulating the breadth of its usefulness and applicability through a short case study on TRIA, a Singapore-based company that is trying to "close-the-loop" for the global food services industry.

2 Case Study: Lessons from Apple's iPod Success

Examples of music players before the first iPod was introduced in 2001

Even though Apple's iPod may be the most iconic and successful digital music player in the world today, it was not the first to be introduced to the market. By the launch of the first iPod, there were at least 50 other portable music players for sale [3].

Yet, none of iPod's existing competitors were able to effectively drive product adoption and dominate the market. The primary reason was with the user experience and in particular, the downloading and transferring of digital music. Consumers were turned off by the process of doing so—legally or not—as it was extremely time-consuming and tedious.

Hence, Apple knew that introducing another digital music player by itself would not work. For the iPod to appeal to the masses, Apple would have to create a platform that facilitates a fast, intuitive, and seamless process for iPod users to purchase and manage their music. Apple also took an ecosystem approach towards delivering the benefits of digital music on the go, with a staged approach towards building this ecosystem.

The first release of the iconic digital MP3 player solved the problem of fast download of music with the integration of Apple's FireWire and Toshiba's ultra-slim 1.8", 5 GB hard disk, coupled with the superior UI/UX and design. Apple was able to release the first iPod with a value proposition of "1000 Songs in Your Pocket." The iPod became a smashing success 3 years later, when the iTunes and the ability for users to purchase individual music scores enables the delivery of exponential benefit to music lovers. The strategic iPod and iTunes combination would later be acknowledged as the pivotal moment in Apple's successful attempt to revolutionize the portable entertainment market.

Apple took a step beyond mere product innovation and significantly innovated on the iPod's business model too. By allowing their users to effortlessly purchase music directly from the iTunes music store, Apple was able to take a commission off each piece of purchased music and this approach brought in additional service revenue for Apple. This model is an improvement to Gillette's famous blades-and-razor model. In this instance, Apple created the ecosystem where they were the only ones offering low cost "blades" (low-margin iTunes music) to lock in purchase of the "razor" (the high-margin iPod) [4].

To achieve this feat, Apple had to develop a synergistic business model that incorporates its hardware (iPod), software and services (iTunes). By perfectly synchronizing the various elements, Apple was able to tap into new revenue sources while addressing the users' biggest pain point in using a digital music player. In just three years, the iPod became a near $10 billion product and contributed to almost half of Apple's revenue.

In a nutshell, iPod's success is largely attributed to the fact that Apple was able to accurately diagnose their users' pain point in using a digital music player and applied the right treatment, which is also commercially viable. Instead of introducing another iPod that is better and faster (product innovation), Apple introduced a business ecosystem around digital music consumption (business model innovation) that seamlessly integrates and uplifted the entire product experience to a point where consumers are willing to use and pay for.

Apple changed the economics of purchasing digital music for the consumers, and in doing so, has created a business fortune for the company. To effect this change, Apple had to convince music publishers that they would make more revenue from a small unit sale (each individual score), but with an exponentially growth, versus the then-existing paradigm of charging a large sum for an entire (CD) album.

To effect the fundamental economics of how consumers pay for music, Apple had to (1) create a ready consumer base with the initial releases of iPod, (2) change the supply chain economics of selling music so it is efficient and low-cost to distribute music, and (3) change the availability of music choices to meet the demand of consumers. We will return to these three fundamental and inter-related economic actions later in this chapter.

3 Understanding Innovation

So, what have we learned from this case study? Firstly, we learnt that innovation can be perceived as an outcome that an organization seeks to achieve [5], and good innovations solve problems that currently only had poor solutions or none. In Apple's case, the desired outcome was to eradicate the time-consuming hassle and complexity of downloading and transferring digital music to the iPod. The exponential benefit of digital music cannot be fully realized without a full ecosystem approach, with breaking apart the economic constraints for wide-spread music consumption.

A good innovation is capable of addressing a persons' need and it is critical to understand that people do not just buy a product or service, they "hire" a product to do a job [6]—or in the words of the renowned Harvard Business School marketing professor Theodore Levitt, "People don't want to buy a quarter-inch drill. They want a quarter-inch hole!". This perspective places strong emphasis on the need for innovators to deeply understand the "human needs" they are trying to fulfil and recognize that these "human needs" changes across the time horizon.

As organizations and individuals possess different needs at different points in time, there is no universal answer or a singular approach to innovation. Innovation,

by nature, is contextual to the problem these organizations are trying to solve. To innovate effectively, one must have a clear and complete understanding of the problem and situation at hand before devising the treatment.

A great technique to obtain clarity of the higher purpose for which customers "hire" a product or service is to understand what's the "Job to Be Done". iPod served their users with a clear "Job to Be Done". Users were seeking a fast, intuitive and seamless process to purchase and manage their music library. Hence, they "hired" the iTunes music store to get the job done.

As we shall see, there are a diversity of innovation types and methods to help innovators formulate a strategy to get the "Job" done. We have detailed a few common types of innovation in Table 1 below. The list in non-exhaustive and the examples provided can overlap with other types of innovations too.

As we can see from this table, innovations can be applied across multiple dimensions (Product, Business Model, Market Demand, Process), and can be Radical or Incremental. We also must remember that not all innovations have to be groundbreaking and radical. Many innovators and technologies dismiss the potential market impact from minor incremental innovations.

As with Apple's case, Apple did not introduce the first-generation iPod with iTunes. It was an incrementally better MP3 player than others in the marketplace—with increased storage capacity to store up to 1,000 CD-quality songs, ultra-portability at only a fifth of the volume of then-hard drive-based players, and faster transfer speed with FireWire® [7]. The iPod entered the market on the single focused benefit, combined with an easier user-interface, for which Apple users have come to expect as hygiene factor. By the third-generation iPod, each successive model had mere incremental hardware improvements from its predecessors, and it was not the key enabler for its massive breakthrough in 2003. The breakthrough came from the minor yet significant software changes to the iPod operating system to enable it to work flawlessly with the iTunes music store.

The third-generation iPod was not an outlier. It is natural for successful organizations to pursue incremental innovation more frequently than radical innovation. The problem with radical innovation is that it often involves translation of breakthrough

Table 1 Types of innovation

Types of Innovation		Definition and characteristics	Example(s)
Product; service; technology	Incremental	Slight Improvements and/or minor differences from existing competitors in the market (i.e. additional 1 or 2 features) with a little or no change in consumer behavior and habits	Each successive iterations of smart phones
	Radical	Profound/Breakthrough changes and approach to the product, its overall experience and consumer usage behavior, without altering the value proposition & problem it intends to solve	3D Printers; LASIK; CRISPR
Business model	Incremental	Known and/or proven business model but applied to a different solution and/or industry	Selling solar energy to state-own utilities
	Radical	Untested and Unproven business model (how customer purchases and/or access the product)	Rolls Royce's 'Power-by-the-Hour'; power purchase agreements as financial products
Market demand	Incremental	Proven market demand from same (or more) target group(s) of customers as the competitors.	E-payments platforms; Online games
	Radical	Targeting an untested market demand with no known direct or close proximity competitors with similar value proposition	Cryptocurrency; second life
Process	Incremental	Incremental changes and/or tweaks to existing methodology or process to improve and achieve greater overall efficiency of a process	Adding robotics to an automated factory line
	Radical	Implementation of a new or significantly improved methodology or process to improve and achieve greater overall efficiency through a change in user's behaviors and habits	Toyota production system (lean manufacturing) or ford's assembly line process

Source Cha et al. [8]. Innovation risk cube

research that comes with heavy resource commitments—largely capital and labor—and use of special resources which are not easily attainable. Besides, there are also considerable regulatory hurdles to cross, substantial risks in the ability to deliver the expected product with stable performance and the unpredictable market receptivity to the innovation. Above all, a separate empirical research by the authors have suggested that the pursuit of radical innovations does not guarantee nor necessarily increase the chances of a venture success [8].

Successful innovations are built on other innovations. It is not a zero-sum game as successful innovations are often found by recombining ideas across boundaries [9]. Likewise, in the iPod case study, we discovered that improving the product's performance alone was not the panacea that cemented iPod's success. It was the fusion of the incremental product improvements and an integral business model—with a deeply-embedded and robust profit formula—that really propelled the iPod to be widely accepted and adopted by the mass consumers.

To innovate effectively, innovators should follow a layered and structured formula of introducing the specific innovation dimension into the marketplace, gauging, and learning from the customer reactions, and subsequently integrating the market insights into iterations of innovations. This serves to eliminate uncertainty and minimize risks while naturally building in evidence-based decision making in the process. Another successful formula is for organizations to pursue incremental innovation, alongside radical innovation, to balance their innovation effort by allowing small wins in pursuit of big wins [5].

4 State of Innovations Designed for Circular Economy

While innovation brings growth, the motivation behind this pursuit of growth has always been couched in an economic model. This economic model follows a well-defined set of performance indicators that can be optimized. In individual businesses, typical performance indicators are sales revenue, profit generation and growth in market capitalization. At face value, these performance indicators may seem harmless. However, organizations across the past few decades are fanatically obsessed in achieving stellar performance across these indicators. So much so that they are relentlessly innovating for the sake of producing and delivering products and services that are faster, cheaper and with little to no consideration to the ecological aspects of their actions.

Here we cite the example of China's now defunct bike sharing companies, because you can see the paradigms magnified and amplified due to the sheer size and speed of the Chinese market. Bike-sharing started as an innovative business concept with good intentions. The idea of crowd-sharing assets can lead to a reduction of material usage while fulfilling the needs of consumers. However, with the execution of the innovation, the exact reverse happened. These companies were blinded by the desire to achieve unicorn status and the need to seize market share as fast as they could. Consequently, these companies invested huge amounts of capital into the

sector regardless of the actual demand [10], which led to excessive overcapacity and damaged bikes, forcing many of the companies to declare bankruptcy and leaving massive number of bicycles being strewn haphazardly.

A worker rides a shared bicycle past a huge pile of unused shared bikes in a vacant lot in Xiamen, Fujian province, China, on December 13, 2017. (Source: Reuters and The Atlantic)

This is a recent prime example of a hazard that arise from our relentless pursuit of economic growth. While it is still fundamentally important for organizations to pursue economic growth, we need to also remember that organizational growth must be ecologically sustainable for our ecosystem too.

In the same vein, we must also not forget that the world's population is continuing to grow, and it is projected to reach 8.5 billion in 2030 and 9.7 billion in 2050 [11]. A growing population will also proportionately increase the use of resources to satisfy our basic needs. However, as we reiterate, Earth's resources are limited. Without a regenerative timescale, the continued depletion of Earth's resource will further threaten the survivability of our planetary ecosystem. Therefore, circular economy has become such an appealing concept because it advocates for an innovative process of rethinking and redesigning products to a state where the materials required to construct it can be recycled indefinitely without degradation of its properties.

The transition to a circular economy is a logical proposition. It will do more than saving the planet. It will also create vast new economic opportunities [12]. Despite the potential upsides, we have a strong sentiment that innovation for the circular economy today are still largely driven by the rising pressure for organizations to behave more sustainably and responsibly. As a result, organizations tend to react with haste by delivering quick-fix solutions as opposed to developing one that is holistic and can maximize the impact translation to society.

Many organizations also relegate innovations around sustainability to be a Corporate Social Responsibility (CSR) initiative, and do not invest into creating a long-term, economically robust model for these projects. Not surprisingly, the projects would subsequently be side lined due to conflicting, higher priority, and/or short-term profit-driven demands. Only when circular economy innovations can generate true economic impact to the project sponsor, and can be measured, that we will see sustained efforts and outcomes to the betterment of our environment. Similarly, perhaps due to the lack of corporate attention, many models of innovations (as

summarized in Table 1 above) do not emphasize the unique characteristics of circular economy needs.

Therefore, as we extend our discussion towards understanding the current state of innovation designed for the circular economy today, we would also want to take this opportunity to inspire more innovators to introduce holistic innovations in our society. We aim to do that by highlighting some commendable initiatives and sharing our thoughts on how we feel they can take a step further with their circularity efforts.

5 Examples of Innovations Designed for the Circular Economy

A remarkable product innovation designed for the circular economy is BASF's ecovio®. It is a high-quality and versatile bioplastic that is certified compostable and bio-based. As a material, it has a wide range of applications. It can be used for injection molding to produce hard plastic goods or used as flexible plastics for shopping bags, waste bags and food packaging. With reference to its technical specifications, ecovio® possess superior attributes and is undeniably an eco-friendlier alternative to petroleum-based plastics [13]. With its compostable properties, ecovio® can also be converted into compost in specially designed and operated facilities.

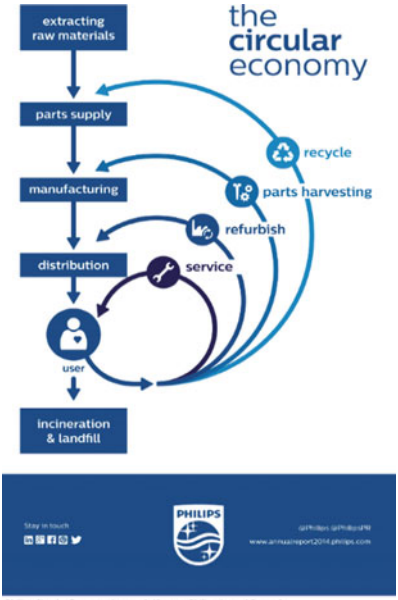
BASF ecovio® Organic Waste Bag (Source: BASF)

Despite its product superiority and capabilities, BASF does not provide any end-of-life options for their customers to properly dispose and reap the benefits of using ecovio®. As such, for customers who lacks access to a composting facility, they will presumably dispose their waste in a general waste stream, which will likely end up being incinerated or landfilled, and defeats the good intentions of adopting ecovio®.

Though it may be beyond BASF's scope and position as an organization, in our opinion, BASF can take a step further to ensure that their customers' waste loop is truly circular. They can form key partnerships with organizations that has an established waste collection system for compostable products. This will reduce the leakage of post-consumption ecovio® products into the environment on land, into waterways, and the ocean. It will also ensure that these post-consumption products

are sent to the appropriate facilities and returned to Earth as compost and hence, serving its purpose.

Another notable example is Philips' commercial lighting services. For commercial premises, Philips installs, maintains, and manages the lighting throughout its lifecycle. This makes it possible for their customers to purchase light as a service rather than invest in new hardware upfront [14]. By innovating on the business model and modelling it after a managed service business instead of direct sale, Philips was able to unlock a new revenue stream.



Philips Circular Economy Approach (Source: Philips Annual Report)

Coupled with a strong and grounded profit formula, this business model innovation allows Philips to generate recurring revenue while being able to collect its lighting equipment back for reuse or recycling. This approach has enabled Philips to achieve circularity in their commercial lighting business.

Furthermore, Philips has also placed considerable thoughts on the ecological aspects of their products as they innovate to improve its performance. Some of their efforts include modularizing the connectors of their new lighting product and making them more energy-efficient and more durable. Taking a step further, Philips can explore ways to modify this successful commercial offering and cater it towards the consumer retail market.

Another interesting example is a young Singapore-based startup Insectta. Insectta is an urban insect farm that breeds black soldier fly larvae by feeding it with discarded food waste. It then takes these black soldier fly larvae and convert it into biomaterials, including one known as chitosan—a biodegradable polymer typically derived from crustacean shells [15]. Insectta claims that these biomaterials can be repurposed as

semiconductors in devices such as phones and computers, or as protein and probiotics in animal feed additives.

Insectta's black soldier fly larvae feeding on spent brewery grains and soybean pulp. (Photo source: Teng Yong Ping/Yahoo Lifestyle Singapore)

Insectta has also innovated on their business model. While their competitors harvest and sell their insects whole to customers, Insectta created a mechanism that allows it to separate their black soldier fly larvae into different parts through a biorefinery processes to produce its chitosan, organic semiconductors, and protein and probiotic products. This differentiation allows Insectta to triple the larvae's final product value.

In summary, to effectively design innovations for the circular economy, it would be beneficial for both organizations and innovators to have a holistic understanding of innovation, especially the dynamics of a successful innovation. As a brief recap and summary, we learnt that good innovations could create and capture new value. Further, we learnt that these innovations can either be incremental or radical, and they come in all shapes and sizes. Above all, we learnt that innovations build on other innovations. For organizations to affect a real positive impact to the stakeholders they serve, they would first need to have a clear understanding of what's the "Job-to-be-Done". After which, they must also be bold in experimenting with numerous types of innovations until they are able to develop and introduce an all-rounded solution that customers are willing to "hire" to get the job done.

Lastly, we must not forget that the fundamental reason for a monumental shift in global consumer behavior and demand towards green and responsible consumerism, is climate change. To combat climate change, we need substantial innovations to be built, deployed, and scaled at a massively fast pace.

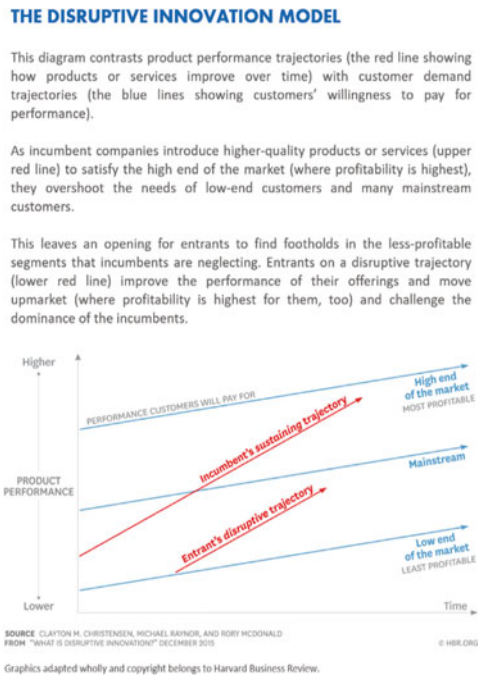
Therefore, in the following part of this chapter, we will be exploring what happens if we attempt to build, deploy and scale innovations that are designed to do good for our health, humanity and the environment at a massively fast pace. How would they grow? and what are the implications? For that, we turn towards understanding the concept of Restorative Innovation, which is co-created by the authors of this chapter.

6 Introduction to Restorative Innovation

Restorative Innovation is an innovation model that aims to accelerate the adoption of innovative solutions designed to restore our health, humanity, and environment, with interventions aimed to drive down the economic costs.

With more organizations and individuals starting to understand that making a profit and doing good do not have to be mutually exclusive, we are starting to see a surge of nascent entrepreneurs launching new ventures aimed at trying to make the world a better place. However, it is empirically observed that these impact-driven enterprises would have very diminished impact or become social enterprises or charitable organizations. We believe this is due to the lack of a robust and predictable economic model to justify and anticipate returns from continued investments into the innovation development. It is universally acknowledged that introducing innovative products and services is an expensive undertaking, an undertaking that is fraught with very high risks and uncertainty.

Typically, the beginning of the innovation adoption curve is flat or erratic. Hence, a model to project the growth curve under certain conditions and parameters can offer a guide to the potential future growth if the hypothesized conditions are met. Disruptive Innovation, a model developed by the late Clayton Christensen, enjoys widespread support and adoption by innovators and entrepreneurs because it offers a predictable model for the switchover effect.



In a nutshell, Disruptive Innovation offers innovators a predictive model of how innovations from the low-end, typically with an initial sub-par performance but satisfies a niche market demand, can replace its mainstream counterpart, in part due to the mainstream technology overshooting its performance to customers' needs [16].

Such a model does not exist for innovations designed to restore our health, humanity, and the environment. Therefore, even with all the best intentions, the lack of a good profit formula or visibility on expected returns would produce an enterprise that is either economically unsustainable or it will lack the ability to scale beyond its initial, evangelists-led market.

We also believe that innovations can be the key to solve the critical issues facing our earth. It is well established that innovations, when applied correctly, have the ability to enable organizations to achieve continued economic growth. However, there is minimal research and evidence to support the fact that innovations can also empower these impact-driven enterprises to simultaneously do good for the society and thrive economically.

We also observe that innovations which are restorative or for the betterment for our health, humanity and the environment tend to be priced at a substantially higher level than its mass market alternatives at launch—at a price point that prohibits widespread adoption—and remains at a niche level, often relying on corporate social responsibility (CSR) or other social innovation initiatives to drive adoption. Thus, how do we offer a model to enable a predictable path towards a business-sustainable growth? The Disruptive Innovation paradigm addresses the switch-over effect from new entrants when the performance of the Disruptive Innovation reaches on-par with the mainstream needs [16].

Therefore, it is imperative to develop a new innovation model and framework that can accurately expound on the growth pattern of innovations that are restorative and contribute to the betterment of society. The authors thus embarked on a research project which culminated into the Restorative Innovation framework, a framework to illustrate how innovators can develop solutions for the betterment of society, amass profits, and achieve scalable growth, all at the same time.

We offer this framework to pave the way for a whole new set of possibilities as Restorative Innovation changes the global narrative of innovation for the good. This new narrative offers entrepreneurs and innovators the way to explain how their innovative solution can bring profits and returns to investors, paving the way for capital injection to develop the restorative solution. Moreover, Restorative Innovation can also be used as the innovation model to explain how we can use innovation to accelerate our societal progress towards achieving the United Nations Sustainable Development Goals (SDGs), where the goals are largely connected with positively improving our health, humanity and the environment.

7 The Theory of the Latent Conscientious Consumer

To explain Restorative Innovation, let us first establish that we all want to be a conscientious consumer. We all have an inner desire to live a healthier lifestyle, be more humane, and to protect the environment. These needs, we shall label them as latent needs as they tend to be subconscious, omnipresent, and intrinsic in all of us. Even though we possess these latent needs, our decisions to pursue and satisfy them are often overridden by explicit counter signals from our fast-moving consumptive environment.

Let us use grocery shopping as an example to illustrate such counter signals. When we think about healthy eating, the first thought that naturally comes to our mind is to consume organic products. However, when we start shopping for these organic products, we would discover that there is a staggering price difference between the organics and non-organic products. Using cow's milk as an example, a study by Nielsen in 2018 [17] states that the average unit price of organic cow's milk is 84% higher than the average unit price of its non-organic alternative, and moreover, depending on where you purchase groceries, the premium you pay for organic produce can even go as high as 300% more [18]. This exceeds the upper-bound estimate of 50% more price premium that consumers are willing to pay for a commodity organic food item [19], which correlates to our own research by way of qualitative interviews that a switch-over effect occurs between 30 and 50% premium over mass goods. Unless the conscientious good is within this premium range, many consumers end up suppressing the desire to satisfy their latent needs and instead, anchor to what is mass produced and widely available.

Here we can clearly see the psychology of price anchoring as having an effect to suppress our latent needs. Due to our highly optimized supply chain for mass production, the parallel, not-yet-optimized supply chain is used only to serve niche market segments like organic produce. While we inherently know that organic produce is healthier for ourselves and our families, we are unwilling to pay the higher price, thus creating an ever-increasing price gaps between the two supply chains. Note that we use the word 'unwilling', and not 'unable' because we submit to you that for many of our households in developed countries, we can absolutely afford the healthier option. However, due to the price anchoring, our latent needs are suppressed from the choice dilemma, often not even entering our conscious decision-making. Thus, how do we break this cycle of ever-increasing price gaps?

8 How Restorative Innovation Works

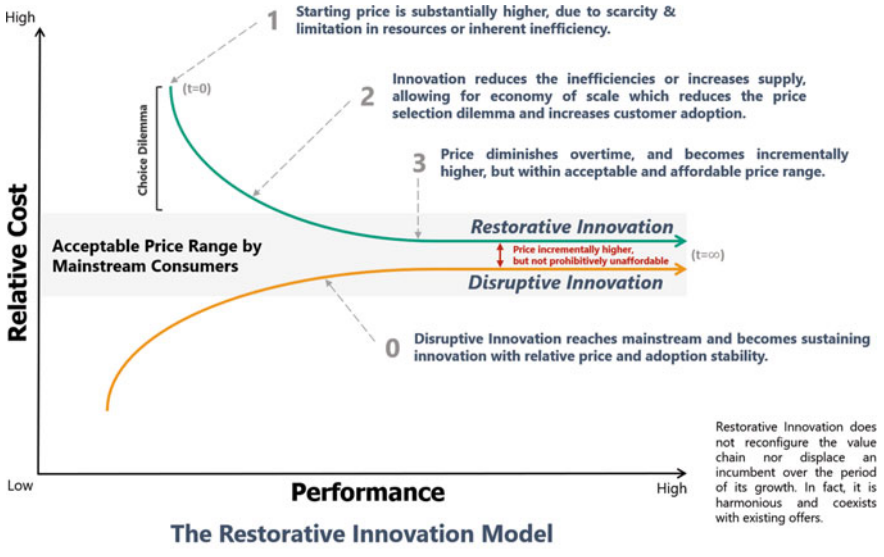
Given that deep within us, we all desire to be a conscientious consumer and are willing to pay a slight premium for goods that cater to our latent needs. Our proposition is, we can close the price gap and eliminate the inherent complication of price anchoring with innovation and technology.

To do so, we need impact-driven leaders to not only introduce more innovative solutions that cater to our latent needs, we also need them to actively problem solve on the following dimensions: (1) increase the production availability and capacity, (2) improve the efficiency of their supply chain, and (3) drive the adoption of the innovation with targeted go-to-market strategies.

By improving on these dimensions, either singly or collectively, the price premium will be reduced. This drives the innovation into a downward price cycle due to the cost savings. The savings can then be passed on to increase the convenience and accessibility for consumers to adopt these new innovative solutions. More importantly, the savings can also be used to reduce the overall cost of production and the selling price. This will greatly strengthen the product's appeal and attract more mainstream consumers to adopt it over existing mass-market alternatives.

The increased product adoption will further accelerate the reduction of its respective production cost. This will pave the way for these innovative solutions to gradually enter the acceptable price zone. As a result, mainstream consumers will make the switch and adopt these innovative solutions that cater to their latent needs and allow the restorative effect to proliferate.

The illustration on the Restorative Innovation Model below will help readers visualize the growth pattern of these innovative solutions that are designed for our latent needs.



The Restorative Innovation Model

9 The Principles of Restorative Innovation

Impact-driven leaders play an instrumental role in enabling the above growth pattern for their innovative solutions. These leaders are passionate and intrinsically driven by their altruistic vision. They prioritize the potential impact translation of their innovative solution more than the scale of potential earnings. Therefore, these leaders possessed a radically different decision-making mindset as opposed to the profit-driven leaders.

It is empirically observed that these leaders want the best for their consumers and will not compromise on the product quality. They will take a solution-based approach to ensure that their innovative solution is holistic and is able to maximize the impact translation to society. In addition, they will also carefully consider all aspects of the product and ensure that only the best and most appropriate materials are incorporated into the finished product. This ensures that their newly introduced innovation achieves its functional purpose without harming our health, humanity, or the environment.

These innovative solutions would often possess superior product attributes and capabilities as compared to their mass market alternatives, which would then result in a higher initial true cost of production. In most instances, the higher true cost of producing the innovative solution will be directly translated to a higher starting price point. This explains our natural interactions with the explicit counter signals against our desire to satisfy our latent needs. An example of a product with superior attribute and a higher starting price point would be ecovio®, the bioplastic material that BASF has created. As we have discussed earlier, unlike its petroleum-based plastics alternatives, ecovio® is able to be composted and return to Earth as compost.

Nevertheless, some impact-driven leaders may choose to introduce their innovative solutions at a lower price point in efforts to hasten consumer adoption. In most cases, these leaders will use their resources to artificially lower the selling price and make it as competitive as the existing mass market alternatives. Gradually, with greater consumer adoption, the efficiency of the production and supply chain will improve and that would translate to a lower true production cost.

Below is a table summary to encapsulate what we have learned on Restorative Innovation.

Table Summary of Restorative Innovation

Pre-conditions	1. We possess a latent need to be a conscientious consumer and we want the best for their health, humanity and the environment 2. Products with impact to these 3 dimensions are multi-stratified. They can be catered for the low-end, mass or high-end market 3. Restorative Innovation are always enabled and championed by impact-driven leaders, who often possess a decision-making mindset that is more inclined towards impact translation than profit generation

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Principles and characteristics	1. As compared to its existing mass market alternative, Restorative Innovation solutions often possess superior attributes, especially on the latent need attributes that customers value 2. Restorative Innovation always come with a higher initial true cost even though it contains new value propositions to attract a new (and often) niche customer segment who is willing to pay a price-premium for the attributes 3. Restorative Innovation inherently spreads socially and can influence and co-opt more adopters as the choice dilemma reduces (degree of latent needs vs. willingness to pay) 4. Restorative Innovation can co-exist with mainstream products for an extended (even indefinite) period and create a parallel and duo consumption pattern

10 Case Study: Closing the Loop with TRIA Bio24

TRIA is a Restorative Innovation champion and an aspiring leader in designing and implementing innovation for the circular economy. TRIA is a sustainable food packaging company based in Singapore.

As a food packaging company, TRIA is not a new kid on the block. Today, they are manufacturing and supplying disposable food packaging and food service wares (collectively known as foodware) to some of the largest food services player in Asia.

Founded by impact-driven leaders Ng Pei Kang and Tan Meng Chong, TRIA's mission is to enable and empower the global food services industry to move towards more sustainable patterns of consumption and eventually emerge as a truly zero waste service provider.

To accomplish this feat, TRIA has invested heavily to innovate on multiple fronts and has translated its Research and Development efforts to create and launch

Bio24, a breakthrough zero waste system that is perfectly aligned with the 12th Goal of the United Nations Sustainable Development Goals (UN SDGs)—Responsible Consumption and Production. Tout as the world's first holistic "table-to-farm" system, the Bio24 system is a marvel to behold. The entire system is capable of converting foodware, together with food waste, into good-quality compost within 24 h. This integrated approach provides an elegant solution to recycle single-use food-ware & food waste without the need for segregation nor any changes to the client's existing operations.

For this closed-loop system to work, it requires several components to work in unison. Firstly, TRIA's foodware must be constructed using their proprietary material, NEUTRIA®—a bioactive polyester derived from plant-based sources—which allows it to be fully compostable. In every aspect, NEUTRIA® is superior in product performance over its petroleum-based plastic counterpart and it does not compromise on its functionalities.

When thrown into TRIA's Bio24 digester—which is the second component to this equation—the NEUTRIA® material ages and breaks down rapidly. Fed with natural enzyme, NEUTRIA®, together with the food waste will undergo a chemical-free catalytic degradation process and be converted to compost within 24 hours. TRIA will retrieve and enrich the quality of compost to make it suitable for commercial agricultural use. Ideally, TRIA aims to sell the commercial organic compost back to their own clientele base for use in their own farms, and hence, truly closing the loop.

To ensure this outcome is achieved, TRIA has also orchestrated and established a landmark cross-industry partnership, known as the Bio24 Alliance. The Bio24 alliance includes a waste management company, who is responsible for collecting and transporting the waste to the digester plant, and an impact-driven outcome-based certification body who will independently quantify, analyze and publish the performance of the Bio24 ecosystem and their respective participating clients in achieving zero waste. These key partners will contribute their expertise and pool their resources to enable and ensure that TRIA is able to consistently close the loop for their clients and contribute to the betterment of society.

(TRIA's Digester Plant in Singapore)

Bio24 is TRIA's answer to the commonly faced challenges in the recycling industry. Before the inception of Bio24 as a closed-loop system, there was no sustainable solution (from both environment and economic aspects) in managing single-use foodware. Even if the foodware is constructed with eco-friendlier options like renewable, biodegradable, or compostable materials, most of it will still be burnt down in the incinerator or disposed in the landfills creating negative environmental impact.

Among all the eco-friendlier options, composting offers the most attractive proposition as it has the potential to turn waste materials into resource. Even so, a report by the Food and Agriculture Organization (FAO) of the United Nations found that depending on the methods used to carry out the composting process, the active composting period ranges from 3 weeks to 2 years [20] in an industrial composting site. If left to compost in an open environment, it can take decades for it to degrade. As the active composting process is carried out in an industrial composting site, the entire composting process would require storage space and resources to manage, thus making it economically non-viable to operate and consequently, it creates a situation where most composting sites are rejecting bioplastics. Existing food waste digestors and infrastructures are also a contributing factor. As they are incapable of simultaneously managing both foodware and food waste, food waste recyclers are required to segregate and remove inorganic contents from their collected waste before sending it to be composted. This introduces additional operational costs and complicates the entire composting process. Similarly, for recycling bioplastics, there are solvent solutions that can chemically degrade the bioplastic material. While effective, it also relies heavily on the purity of the feedstock and thus, waste will still need to be separated before the bioplastics can be recycled.

Holistically, the Bio24 system is a state-of-the-art ecosystem approach to simultaneously and sustainably manage and treat both single use foodware and food waste. By synergistically adding and blending layers of innovation together, TRIA was able to create a breakthrough experience that alleviates the most faced challenges in the recycling industry. Following the footsteps of Apple's successful iPod and iTunes combination, TRIA tailored its NEUTRIA® material composition to work seamlessly with its complementary catalytic digester. This deliberate optimization allows

for the Bio24 to achieve peak degradation performance of at least 20 times faster than the current top of the line composting method (24 hours vs 3 weeks).

On top of this product innovation, TRIA has also implemented process innovation. TRIA has streamlined Bio24's operations and deployment process to allow for their participating clients to conduct their "business as usual". With this current deployment process, TRIA is confident in onboarding and enabling their clients to go zero waste within a month or two. TRIA will work closely with their client to design and manufacture their foodware according to their functional requirements. Afterwards, all that is left is for the participating clients to replace their existing foodware with the NEUTRIA® foodware. Everything else stays the same and this means there are no further changes to their current modus operandi. The participating clients will not need to sort and separate their waste before recycling, neither do they need to be trained on any new processes and procedures before utilizing Bio24. This enables an effortless recycling process and it further eliminates the need for incurring additional time and manpower cost.

In addition, TRIA has also placed considerable effort on innovating and extending its business model. Apart from generating revenue through the sale of its NEUTRIA® foodware, TRIA has also paved the way for a new revenue source by ingeniously conceiving a cost-effective method to enrich and sell the by-product of the Bio24 system—which are organic compost—to members of the agricultural community.

Bio24 may seem to be the perfect formula to accelerate societal progress towards a greener, cleaner, and more equitable world. However, the implementation of the Bio24 system comes with its own set of challenges and resistances too. Evidently, TRIA's Bio24 has met all the conditions to be classified as a Restorative Innovation. It is led by passionate impact-driven leaders and its innovation has superior performance and attributes, especially on the latent need attributes that customers value—which in this case is environmental consciousness. As a result, TRIA's Bio24 system follows the Restorative Innovation growth pattern and started off with a higher initial true cost due to scarcity and limitations in resources and/or inherent inefficiencies.

For a 12oz Cold Cup		
Material	**Degradation**	**Cost**
PP Plastic	Incineration or Landfilling (up to 1000 years)	≈SGD$0.07
Styrofoam		
Paper (Lined)		≈SGD$0.08
PLA Plastic	Biodegradation (3-6 months)	≈SGD$0.12
NEUTRIA®	Composting (24 Hours)	≈SGD$0.13

Adopting Bio24 creates a choice dilemma. In TRIA's case, this choice is made on the consumer's behalf by TRIA's clients. In the food services business, each unit of sale yield a tiny profit margin. In most cases, a percentage of this profit has been pre-allocated to cover the cost of foodware. Hence, the additional premium to adopt NEUTRIA® proves to be the greatest resistance as these food services businesses will opt for foodware that fulfils their functional requirement and within their budget.

Exceeding their budget will correspondingly reduce their profit. As such, even if they are environmentally conscious, it is not easy for them to readily make the switch.

Nonetheless, TRIA believes that the sustainability uptake for the food service providers can be a zero-sum game and they have creatively experimented with various strategies to encourage adoption. With their vast experiences in the food packaging sector, TRIA has observed that their brand-savvy clients have the strongest inclination towards sustainability. As these brand-savvy clients leverage heavily on the use of marketing and branding as their competitive advantage, they tend to be constantly on a lookout to stay relevant with the latest trends by re-positioning and re-aligning themselves to it.

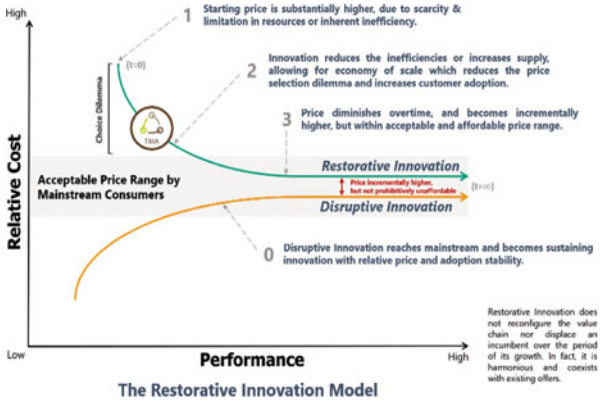
Fortunately, today, there is a monumental shift in consumer's behavior towards green and responsible consumerism. As such, TRIA capitalized on this opportunity and offered these prospective clients an attractive proposition where TRIA will render their award-winning design expertise to help them design and develop foodware that are appealing, distinctive, and can be incorporated as part of their overall brand experience, should they choose to adopt NEUTRIA® foodware and be part of the Bio24 ecosystem.

The strategy to bundle in award-winning designs as part of the NEUTRIA® foodware is the critical first step towards increasing availability of the Restorative Innovation goods. The early customers would not be willing to pay a premium for a circular economy innovation when it is not yet in the mainstream, but they are willing to pay for a more beautiful foodware package, as typically, this budget is parked under marketing and branding. We think this early strategy of offering a value proposition that customers are willing to pay for, in the early stage of Restorative Innovation, is a critical factor to start the downward cost curve.

Prior to mainstream adoption, few customers would be willing to pay more for a 'sustainability' or 'do-good' value proposition. We dub this the 'Fancy Horse' strategy and offers a win-win arrangement for both the Restorative Innovation champions and their customers.

This approach is proving to work and as a result, TRIA has been able to convince larger industry players to jump on the bandwagon and go green. Following the Restorative Innovation growth pattern, the authors firmly believe this product adoption strategy will gradually improve TRIA's operational efficiencies and consequently, eliminate unnecessary cost and reduce their overall cost of production.

With time, the Bio24 ecosystem will progressively enter the acceptable price zone and this will encourage more food service providers to make the switch and adopt these innovative solutions that cater to their latent needs.



The Restorative Innovation Model

For now, the authors have determined that TRIA is close to the second point and is progressing well to be a successful Restorative Innovation.

11 Conclusion

To conclude this book chapter, let us remind ourselves that the world's population is soon reaching 10 billion, which will create unprecedented resource stress on our planet. If we continue to singularly focus on innovation as a relentless pursuit of economic growth, we may find ourselves depleting what nature intends for us, in terms of positive growth and change. We believe the time has come to encourage more innovators and business leaders to reimagine value creation in terms of how we can restore health, humanity, and the environment. The changes that are causing negative effects to our health, our societal values, and our environment have been adding up gradually, and if we are blinded by the gradualness of changes and evolution in our Darwinian world view, we may not be ready when a bifurcation event happens, suddenly and on a large-scale, as such changes almost always do in a complex system.

We explored the various models of innovations and provided an in-depth analysis of Apple's iPod, in how Apple is able to create an ecosystem to deliver the exponential benefit of music-on-the-go of own preference to mass consumers, at an affordable cost, with speed, fidelity, and convenience. This required Apple to build this ecosystem in stages—first by attracting an initial group of iPod consumers with fast file transfers with a superior UI/UX—then by adding in the ability to purchase individual music scores at an affordable unit-price. To accomplish this, required a reconfiguration of the music supply chain to offer a lower cost distribution and the willingness of music publishers to forego a larger unit sales revenue in exchange of a promise of a larger total revenue from an exponentially larger audience. This promise is amply realized by Apple, to the delight of her shareholders.

We believe this model is instructive for how to drive larger adoption of Restorative Innovations. Instead of relying on the do-good contributions from various stakeholders under the "Corporate Social Responsibility" umbrella, Restorative Innovation champions should take aim at intervening at any or all three critical points: (1) Increase supply availability, (2) Increase efficiency of supply chain, (3) Increase demand to arrive at a price premium that is not greater than 30% to existing, mass-consumer equivalent.

We then looked at TRIA, a restorative champion in the initial stages of implementing such interventions. One tactic to accomplish these interventions may involve use of a 'fancy horse' offer where the buyer is paying the premium for a non-restorative feature. We look forward to contributors to add to this body of knowledge in offering other tactics to achieve the success that all restorative innovations deserve, for the sake of our planet. We hope this book chapter, and especially Restorative Innovation, will serve as an inspiration to ignite our collective imagination on what is possible and change the innovation narrative from relentless pursuit of economic growth to pursuit of value from a more balanced view on what is good for economy and what is good for us. Innovation should serve a purpose for society and should not be a solely monetary pursuit.

Questions

1. Why do most innovations and initiatives around sustainability ends up becoming a Corporate Social Responsibility initiative or equivalent?
2. Why do organisations pursue incremental innovation more frequently than radical innovation?
3. What is Restorative Innovation?
4. Why is it important to learn and understand Restorative Innovation?
5. What are the key interventions impact-driven leaders need to introduce to drive their restorative innovations into a downward price cycle and increase adoption?

Further Discussion Questions

1. What example(s) can you think of, a conscientious product that was introduced in recent years but have not reached mass adoption, and hypothesize on the reason(s)?
2. Can this product innovation benefit from a Restorative Innovation framework?
3. What intervention point(s) would you consider to be the most effective? and why?

Answers

1. Organizations tend not to invest into creating a long-term, economically robust model for innovations and initiatives around sustainability. As a result, these efforts often get side lined due to conflicting, higher priority, and/or short-term profit-driven demands. To resolve this issue, the organization must consider embedding a mechanism that delivers a quantifiable economic benefit back to the organization.

2. As radical innovation often involves the translation of breakthrough research, it often comes with heavy resource commitments, including capital and labor, and the use of special resources which are not easily attainable. In addition, radical innovation also involves considerable regulatory hurdles to cross, substantial risks in the ability to deliver the expected product with stable performance and the unpredictable market receptivity to the innovation.
3. Restorative Innovation is an innovation model that aims to accelerate the adoption of innovative solutions designed to restore our health, humanity, and environment, with interventions aimed to drive down the economic costs. It explains how innovations that contribute to the betterment of our society goes to market and scale.
4. It is important for us to learn and understand Restorative Innovation as it illustrates the possibility of creating and delivering innovations that are capable of achieving continued economic growth while simultaneously contributing to the betterment of society.
5. Impact-driven leaders needs to work on (1) increasing the production availability and capacity, (2) improving the efficiency of their supply chain, and (3) driving the adoption of the innovation with targeted go-to-market strategies.

Suggested Reading

1. Christensen, C. M. (1997). The innovator's dilemma: When new technologies cause great firms to fail. *Harvard Business School Press*, Boston, MA.
2. Casadesus-Masanell, R., Kim, H., Reinhardt, F. L. (August 2010). Patagonia. *Harvard Business School Case*, 711–020, (Revised October 2010).

[Readers are highly encouraged to read up on various business case studies—like Patagonia—that involves companies pursuing both economic growth while simultaneously contributing to the betterment of society.].

References

1. Roberts, E. (1988). What we've learned: Managing invention and innovation. *Research-Technology Management, 31*(1), 11–29.
2. Intergovernmental Panel on Climate Change (2018). Global warming of 1.5 °C. Summary for policymakers. *World Meteorological Organisation & UN Environment*. Retrieved Sep 17, 2019, from https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf.
3. Adner, R. (2012). Innovation success: How the Apple iPod broke all Sony's walkman rules. *[Blog] INSEAD Knowledge.* Retrieved Sep 23, 2019, from https://knowledge.insead.edu/blog/insead-blog/innovation-success-how-the-apple-ipod-broke-all-sonys-walkman-rules-2791.
4. Johnson, M., Christensen, C., & Kagermann, H. (2008). Reinventing your business model. *Harvard Business Review*.
5. Kahn, K. (2018). Understanding innovation. *Business Horizons, 61*(3), 453–460.
6. Christensen, C. et al. (2016). Know your customers' "Jobs to Be Done". *Harvard Business Review*.

7. Apple Inc. (2001). *Apple presents iPod*. Retrieved Oct 23, 2019, from https://www.apple.com/newsroom/2001/10/23Apple-Presents-iPod/.
8. Cha, V., Cai, Y., & Tan, J. (2019, In Publication). *Innovation risk cube*.
9. Anderson, P. (2018). How do you spot a restorative innovation opportunity. *INSEAD*.
10. Yao, Y. (2019). How to clean up bike-sharing firms' mess. *China Daily*. Retrieved Oct 18, 2019, from http://www.chinadaily.com.cn/cndy/2018-08/27/content_36828744.htm.
11. United Nations, Department of Economic and Social Affairs, Population Division (2019). *World population prospects 2019: Ten key findings*.
12. Ghosh, A. (2019). The circular economy is a golden opportunity. Don't let it go to waste. *World Economic Forum*. Retrieved Oct 9, 2019, from https://www.weforum.org/agenda/2019/01/the-circular-economy-turns-waste-into-gold-so-lets-get-on-with-it/.
13. BASF. (2019). ecovio®. Retrieved Oct 19, 2019, from https://products.basf.com/en/ecovio.html.
14. Smart Cities World. (2016). *Philips' light-as-a-service offering*. Retrieved Oct 19, 2019, from https://www.smartcitiesworld.net/news/news/philips-light-as-a-service-offering.
15. Wee, R. (2020). Insectta sees a big future from small insects. *Garage powered by the business times*. Retrieved March 29, 2020, from https://www.businesstimes.com.sg/garage/insectta-sees-a-big-future-from-small-insects.
16. Christensen, C. (1997). Innovator's dilemma: When new technologies cause great firms to fail (management of innovation and change series). *Harvard Business Review*, 174.
17. Nielsen Insights. (2018). *Tops of 2018: Organic*. Retrieved Oct 20, 2019, from https://www.nielsen.com/us/en/insights/article/2018/tops-of-2018-organic/.
18. Consumer Reports. (2015). *Cost of Organic Food—Consumer Reports*. Retrieved Oct 20, 2019, from https://www.consumerreports.org/cro/news/2015/03/cost-of-organic-food/index.htm.
19. Strzok, J., & Huffman, W. (2016). Willingness to pay for organic food products and organic purity: Experimental evidence. *Journal of Agrobiotechnology Management & Economics*, *18*(3), 13. Retrieved Oct 20, 2019, from http://www.agbioforum.org/v18n3/v18n3a13-huffman.htm.
20. Food and Agriculture Organization of the United Nations. (2003). *On-farm composting methods*. Land and Water Discussion Paper.

Jovan Tan has vast experiences in launching & consulting for both for-profit and non-profit enterprises. He is the co-creator of Restorative Innovation and the Founder of RIGHT Foundation, a non-profit think tank dedicated to advance and proliferate the body of knowledge of Restorative Innovation. In addition, he is also the Co-Founder of REAL IMPACT, an impact consultancy firm, and the Chief Evangelist of TRIA where he fervently champions the company's cause, support its growth efforts, and advise the senior leadership team on key strategic issues.

Previously, he has led special projects and built business units from scratch to profitability. More recently, he was also involved in venture capital, teaching, and research. Today, Jovan is an active researcher pursuing his degree of Doctor of Philosophy (Ph.D.) with the National University of Singapore. His research interest is in the areas of applied innovation and sustainable development, where Restorative Innovation is his most notable work. He has also been featured on Channel News Asia's Money Mind and CNA938 for his expertise in sustainability and the circular economy.

Jovan actively gives back to the community by serving as the Chairman of the SAFRA Entrepreneurs' Club and is

also an advisor to King Mongkut's University of Technology Thonburi's (KMUTT) STEAM Platform of Transformation. He is also represented in the Technical Committee on Food Services, under the Food Standards Committee of Singapore Standards Council. Jovan earned his first degree in Innovation and Entrepreneurship from the University of Adelaide, and his Master of Science in Management from the National University of Singapore.

Virginia Cha is a leading educator of Innovation & Entrepreneurship in Singapore with multiple appointments at Singapore's leading tertiary education institutions: Adjunct Professor at NUS Business School and at INSEAD; Adjunct appointments at SMART (Singapore MIT Alliance for Research and Technology) and Lean LaunchPad @Singapore. She has conducted numerous executive programs, with special original content on Entrepreneurial Mindset with emphasis on action-planning for Corporate Innovation Programs. Her research work in entrepreneurial logic has been published as a chapter in "The Entrepreneurial Behaviour. Unveiling the cognitive and emotional aspect of entrepreneurship", published by Emerald.

In her multi-faceted 40 year-long industry and academic career which spanned multiple countries, Virginia co-founded or was the sole-founder and CEO of multiple venture-funded, hi-tech companies in Singapore and China, with listings on NASDAQ and HKSE. She has co-authored a book "Asia's Entrepreneurs: Dilemmas, Risks and Opportunities" which captured Singapore's technology entrepreneurial history from 1995–2005. Additionally, Virginia is a member of the Future Council of World Economic Forum. In addition to teaching entrepreneurship, Virginia is also an active researcher, mentor, and angel investor in Singapore's entrepreneur ecosystem. Virginia has 16 companies in her angel investment portfolio, supporting start-up entrepreneurs with operations in Singapore, Vietnam, Indonesia, USA, Finland, and the UK.

Virginia's latest research into innovation is on the subject of restorative innovation (www.restorativeinnovation.com). This emergent framework uses an economic model on how sustainable goods can reach mass consumption through innovation along three dimensions: increased supply, supply chain efficiency, and increased adoption. This framework is now taught in leading Singapore tertiary institutions.

Virginia earned her Bachelor of Science in Information Computer Science, University of Hawaii, in 1980, and her PhD from National University of Singapore. She has lived in Hong Kong, Thailand, multiple cities in the U. S. and P. R. C., and continues to be based in Singapore.