RWDC INDUSTRIES: TACKLING GLOBAL PLASTIC WASTE THROUGH STRATEGIC CAPITAL AND CLIENT PARTNERSHIPS

SCALING IMPACT IN ASIA: ACHIEVING PURPOSE AND PROFIT

Photo provided by RWDC Industries – 3D rendering for RWDC's proposed 50,000 ton/year PHA production plant in Singapore.

CIIP Centre for Impact Investing and Practices

SMU Singapore Management University | Sim Kee Boon Institute for Financial Economics

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CIIP is a non-profit centre established by Temasek Trust

INTRODUCTION

This case study was developed in conjunction with the report "Scaling Impact in Asia: Achieving Purpose and Profit". It is part of a collection of stories that aims to illuminate and provide insights into the impact journey of investors and businesses in Asia.

The report and case studies are jointly developed by the Centre for Impact Investing and Practices (CIIP), Singapore Management University (SMU), and Accenture. In producing this study, our aim is to inspire and encourage more to make every dollar invested in Asia deliver positive, measurable impact. Through these in-depth case studies, we hope to extend the scope of existing research in Asia by providing tangible, real life examples from practitioners on the ground.

As part of our efforts to broaden the impact universe, we sought to speak with and showcase a range of organisations, from traditional impact investors and companies, to those who are not typically recognised as agents of impact. These diverse types of organisations are reflective of the broad commercial landscape within which the private sector operates, and we hope they serve as relatable examples for readers on various parts of the impact journey.

The rich and nuanced story told in the ensuing pages is the product of several deep conversations with leaders of the organisation(s) featured. We dug deep into how decisions are made, probed at dilemmas faced, dissected challenges and setbacks, and identified key actions that maximise impact. Thank you to those who participated for your time, insights, candid responses, and above all, your willingness to share about your journey, so that others may learn and be inspired.

You can find our report "Scaling Impact in Asia: Achieving Purpose and Profit" here.

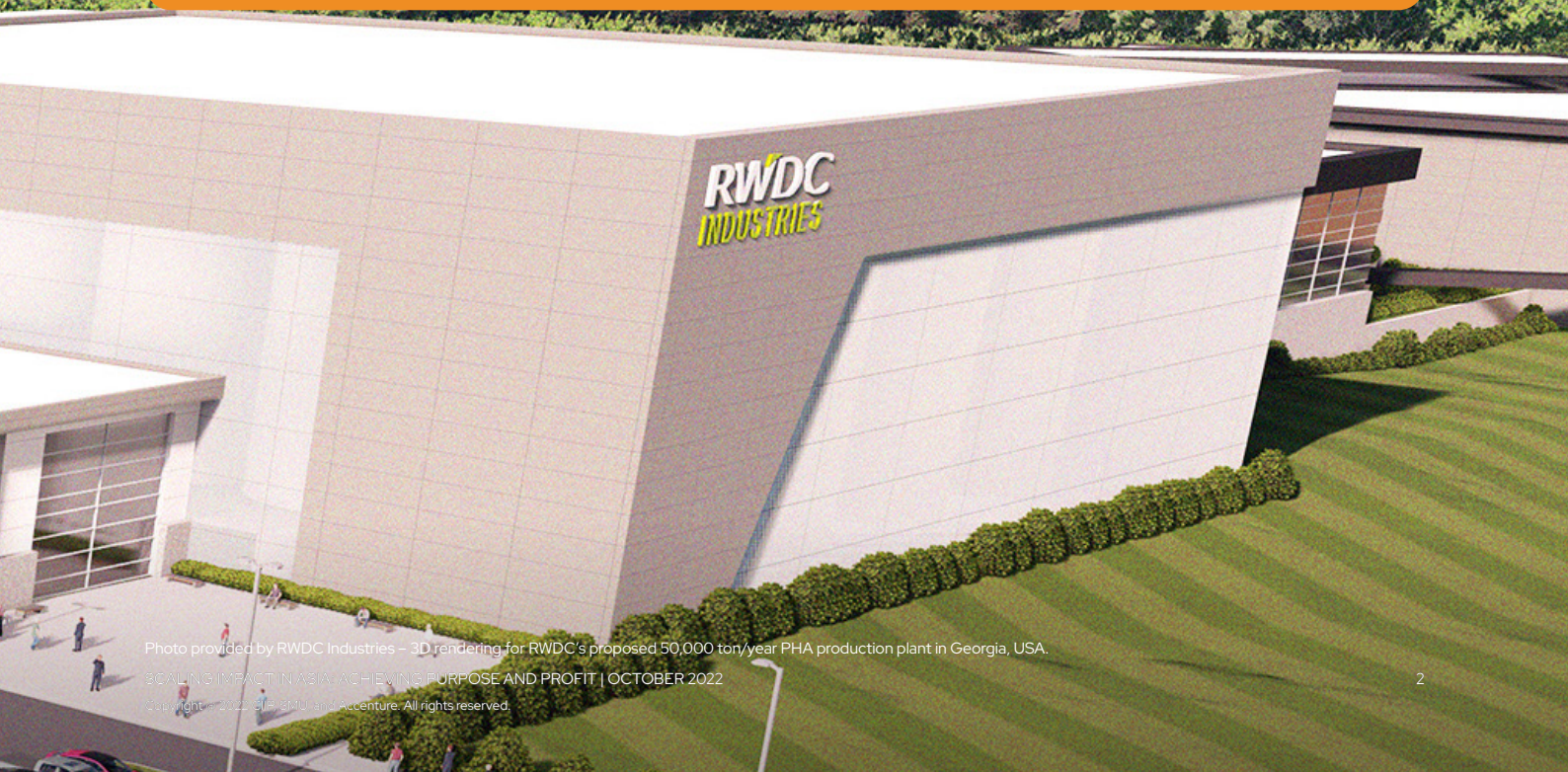

Photo provided by RWDC Industries – 3D rendering for RWDC's proposed 50,000 ton/year PHA production plant in Georgia, USA.

RWDC INDUSTRIES

RWDC INDUSTRIES

HEADQUARTERS

United States and Singapore

GEOGRAPHY FOCUS

Global

SECTORS

Biotechnology, Environment

FOUNDING YEAR

2015

TOTAL FUNDING

US$208M (Series B2)

MISSION

To replace petroleum-derived materials with safe, sustainable alternatives

GROWTH MILESTONES

July 2018:
Won Temasek's Liveability challenge

May 2021:
Exclusive agreement with Cove for >350M pounds of polyhydroxyalkanoate (PHA) to produce the first water bottles made out of biodegradable material

June 2021:
Partnership with Kimberly-Clark to advance sustainable technology for consumer products

Photo provided by RWDC Industries – Storage tanks at RWDC's Athens, Georgia, plant.

ADDRESSING PLASTIC WASTE AT THE SOURCE

IMPACT OF PLASTIC ON THE ENVIRONMENT

Each year, several hundred million tonnes of petroleum-derived plastics are produced around the world, adding to the 8.3 billion tonnes of plastic waste that have been generated since commercial use began in the 1950s[1,2].

Plastic waste generation is becoming an increasingly large problem. In early 2022, the Organisation for Economic Co-operation and Development (OECD) reported that the world is producing twice as much plastic waste as it did 20 years ago.[3] Half of all plastics are discarded after a single use, and some of these plastics can take up to 1,000 years to disintegrate.[4] This generational spike, as well as plastic's inherent resilience, have made plastic ubiquitous, such that it has been found in every ocean basin around the world. It has also been proposed as the geological indicator for the Anthropocene Era, the epoch during which human activity began to have a geological impact on the earth.[2,5]

There are three broad stages in the plastics lifecycle, each with associated strategies to manage the negative impacts of plastic disposal.

Photo provided by RWDC Industries
– Samples of bottles produced using RWDC PHA.

[1] DW (2017). There are 8.2 billion tons of plastic in the world
[2] Science (2017). Production, use, and fate of all plastics ever made
[3] OECD (2022). Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD
[4] Public Health Post (2018). The Problems with Plastics
[5] RWDC Industries (2021). RWDC Industries' CEO talks with Robert Downey Jr.

PLASTIC VALUE STREAM: LIFECYCLE STAGE	STAGE DESCRIPTION	STRATEGIES FOR MANAGING NEGATIVE IMPACT
Upstream: Design & Production	Product and packaging design - including colour, recyclability, and polymer mix - and production	Materials science innovations intending to pivot toward recyclable or non-petroleum-derived materials Packaging design to use recycled or non-toxic plastic, or limit the volume of plastic used Design for longer-term use
Midstream: Consumption	Demand, use of plastic, and disposal of plastic products	Education focused on influencing consumer behaviours related to sustainable product selection, reducing consumption, extended use, and proper disposal
Downstream: Disposal & End of Life	Collection, sorting, recycling, and destruction of waste	Waste disposal infrastructure capacity and effectiveness Chemical and mechanical recycling technologies Environmental clean-up efforts Regulation

The challenge of addressing plastic waste requires urgent solutions across the value chain. The ubiquity of environmental plastic has led to the presence of plastic particles in human food and water sources, which, due to their high concentration of toxins, can have adverse health effects.[6]

With the current lack of scaled plastic alternatives and growing annual consumption, countries are increasingly dependent on disposal infrastructure. In lower-income countries, including those in Southeast Asia, poor infrastructure can lead to significant amounts of plastic waste entering the environment through poor collection or illegal dumping. In fact, Southeast Asia contributes as much as 40% of mismanaged plastic waste in the ocean, though some of this waste is imported from countries such as Japan, the United States, and France.[7,8]

Although solutions are required across the value chain, addressing the problem at the upstream stage, particularly in materials design, can have an outsize impact as it prevents problematic plastic waste from entering the value chain. Among the present most widely used plastic polymers such as Polypropylene (PP) and Polyethylene Terephthalate (PET), none are biodegradable. As such, companies focused on engineering safe-for-nature alternatives have the potential to make a significant positive impact. RWDC Industries ("RWDC") is one such company focused on replacing plastic consumption at the source.

[6] University of Nottingham Connect. The big problem of microplastics
[7] The Incubation Network (2022). Plastic Waste to Value Challenge
[8] Statista (2022). Which Countries Export & Import Plastic Waste?

Photo provided by RWDC Industries
– Samples being taking during PHA production for lab analysis.

RWDC – INNOVATIONS IN MATERIAL SCIENCE TO FIND A PLASTIC ALTERNATIVE

RWDC was founded in 2015 by Roland Wee and Dr Daniel Carraway. The two set out to address the problem of disposable, petroleum-derived products – primarily single-use plastics – by designing an alternative that degrades safely in water. Carraway believes upstream solutions are essential for reducing the impact of plastic waste as "less than 5% of the plastics made every year actually get recycled." The seed of inspiration for RWDC was planted by Carraway's lifelong passion for and fascination with the environment. As a leading authority on biopolymer development and commercialisation, he has dedicated his life to investigating how materials can be used in new ways to solve problems in harmony with nature. He acknowledges that plastics have enabled many advances in technology, innovation, and quality of life, but notes that their production and disposal can be a burden on the environment. He believes humans should be "good stewards of the natural resources that we have," and ensure we "do not diminish [nature] for following generations."Hence, he is keen to enable consumers to be more conscious, and to "use materials that have broader end-of-life options."

> "[Humans should be] good stewards of the natural resources that we have... [and] not diminish it for following generations."
>
> **DR. DANIEL CARRAWAY, CEO AND CO-FOUNDER OF RWDC**

Roland Wee, the other half of RWDC's founding team and its Executive Chairman, has extensive experience designing cost-effective and efficient production processes. Together, they had complementary skill sets and shared a common dream of reducing the production and consumption of petroleum-derived single-use plastics. To this end, they developed and commercialised RWDC's biodegradable product, Solon.

Solon is a polyhydroxyalkanoate (PHA)-based, environmentally friendly alternative to traditional petroleum-derived single-use plastics. It is produced by fermenting a range of feedstocks, including waste, and biodegrades safely into carbon dioxide and water in all end-of-life situations, leaving no harmful traces or by-products. Solon has the potential to be used to make thousands of single-use products, such as drinking straws, coffee cups and lids, utensils, plastic bags, and even textiles. RWDC estimates the total addressable market for replacing single-use plastics to be 120m-150m tonnes per year. With less than 1% of the total addressable market currently fulfilled, there is an outsized demand relative to available capacity.

Given the significant market opportunity, and Solon's ability to replace harmful petroleum-derived plastics, RWDC's leadership views commercial growth as tightly aligned with its impact mission, which is to reduce plastic waste in the world. Wei Luo, Director at Vickers Venture Partners – a venture capital fund and investor in RWDC – who is on secondment to RWDC, aptly explains that "every gram of PHA produced to replace single-use plastics [drives] impact, and at the same time, drives returns."

> "RWDC's founders have the dream and the mission, and also the expertise and experience to bring it together."
>
> **WEI LUO,**
> **DIRECTOR AT VICKERS VENTURES,**
> **ON SECONDMENT TO RWDC**

DRIVING SCALE THROUGH FINANCIAL AND COMMERCIAL PARTNERSHIPS

VENTURE PHILANTHROPY LAID THE FOUNDATION FOR IMPACT

Early in its product and corporate growth cycle, RWDC sought both philanthropic and commercial capital to facilitate growth. Given the dual nature of its business model – capable of delivering both tangible impact and commercial returns – it was attractive to a broad pool of investors. Each investor type provided a different blend of benefits and requirements, in addition to requisite injections of capital funding.

> "Capital wasn't the only intent. The opportunity to share our message and engage with thought leaders allowed us to focus our efforts and chart our direction in a short span of time."
>
> **ANDREW WEE,**
> **SENIOR VP APAC AT RWDC**

A notable growth milestone came in July 2018, when RWDC was selected as the winner for the first annual The Liveability Challenge (TLC). TLC is an opportunity for businesses to showcase disruptive and viable solutions to the greatest problems tropical cities face in the 21st century. The challenge is hosted by Temasek Foundation and features a grand prize of up to S$1 million.

TLC proved to be a key inflection point for several reasons. First, to create an impactful application, the team was forced to prioritise its product focus from 10 potential use cases down to one. By applying theory of change principles and carefully considering impact potential and broad market visibility, RWDC selected a single tangible use case: bio-degradable straws.

Second, the TLC grant provided the necessary funding to increase production for RWDC's Solon-based straw. In just a few months, 100,000 straws were produced for Ecosperity Week 2019, where business leaders, policy makers, and investors gathered to discuss solutions for financing and executing Asia's green transition. After the public launch, the bio-degradable straws were made available at F&B outlets across Singapore.[9] This period proved to be a significant step in driving market awareness for Solon - it provided exposure to an interested investor community and global brands, laying the foundation for future collaboration and the scaling of its operations.

Finally, securing the grand prize at TLC validated RWDC's initial business model, boosting its visibility and attractiveness to subsequent commercial investors. One such investor was Singapore-based investment company Temasek. Temasek takes a muti-generational approach to investing, and as such, the resilience and sustainability of their portfolio are primary considerations.

As Andrew Wee says of TLC, "Capital wasn't the only intent. The opportunity to share our message and engage with thought leaders allowed us to focus our efforts and chart our direction in a short span of time."

[9] RWDC Industries (2019). Solon – Revolutionary, Biodegradable and Commercially Viable Single-Use Plastic Alternative

INSTITUTIONAL INVESTORS DRIVING SCALE AND IMPLEMENTING BUSINESS STRUCTURES

With its market fit and product potential validated by TLC, RWDC has been able to attract a total of US$208M in funding from commercial venture capital and private equity partners, including Vickers Venture Partners and Temasek, most recently completing their Series B2. The ability to raise funding from these mainstream investors demonstrates the commercial viability and appeal of RWDC's strong business model, along with its core focus on impact. These investments accelerated product maturity and increased its production capacity in the United States, with another facility planned for Singapore.[10] These investors also implemented essential business structures, such as by setting up targeted executive committees to drive more robust decision-making governance and set the foundation for healthy, sustainable growth. More recent efforts have sought to optimise the board of directors with a focus on gender diversity and expertise across priority financial and non-financial areas, such as sustainability.

As RWDC grew, it quickly learned the importance of selecting investors with a long-term mindset. These investors provide guidance at each stage of growth, the capacity to help scale investments based on need, and the connections necessary to open doors. In addition, long-term investors allow founders to raise funds less frequently, freeing executive capacity to focus on mission critical work, such as product development. Luo says, "The most important consideration is to have a larger investor who believes in you and has the ability to increase funding as you grow."

> "Impact measurement really helps. It is a key consideration for private equity funds. They increasingly ask, 'what impact do you have' and 'what reporting do you publish.'"
>
> **WEI LUO,**
> **DIRECTOR AT VICKERS VENTURES,**
> **ON SECONDMENT TO RWDC**

For founders seeking these relationships, a robust business model is table stakes, but a strong impact mission and measurement capability can be a differentiator. Institutional investors, which have historically focused purely on commercial returns, are increasingly looking to quantify the impact their funds drive and how they align with environmental, social, and corporate governance (ESG) principles. Luo says, "Impact measurement really helps. It is a key consideration for many private equity funds. They increasingly ask, 'what impact do you have' and 'what reporting do you publish.' Similarly, as investors court entrepreneurs seeking growth capital, a clear impact mission and quantification methods across the portfolio can help to differentiate them from their institutional peers.

RWDC is selective with who they bring onto their capitalisation table. It prioritises investors who are aligned with its core values and mission. The wrong investor could derail the company's growth, autonomy, and strategic direction.

[10] Business Times (2021). Biotech startup RWDC Industries raises US$95.1m in Series B2 funding

CORPORATE PARTNERSHIPS TO ACCELERATE GROWTH AND ENABLE SYNERGIES

While RWDC has received requests from almost every country and profile of partner across Asia, North America, and Europe, RWDC has been selective in inking formal collaborations. Given its limited production capability, partner selection has been critical to RWDC's growth.

As a business-to-business (B2B) raw materials provider, RWDC knew achieving scale would require reliance on corporate partnerships. To this end, they invested in research and new product development for Solon, including conducting trials with potential partners. Over time, this investment yielded flourishing relationships with global brands such as Kimberly-Clark, where fabricating existing products using environmentally friendly Solon soon became a key pillar of their zero waste strategies. Beyond satisfying growth ambitions, which could be viewed as table stakes, the intentionality and shared principles helped separate selected partner companies from other suiters.

Photo provided by RWDC Industries – Samples of non-woven fibers.

There are several factors RWDC considers when evaluating potential corporate partners.

(1) **Shared impact intent** – RWDC partners with companies that not only have a real desire to protect the environment, but are also ready to act. Often, these companies face consumer or regulatory pressure, and are incentivised to move quickly to find sustainable solutions.

For example, RWDC will supply Kimberly-Clark with a Solon-based alternative to develop selected biodegradable products. Over time they plan to scale this across Kimberly-Clark's relevant product suite to help it progress towards its goal of halving its use of fossil fuel-based plastic by 2030.[11] The partnership with RWDC is a key tenet in ensuring Kimberly-Clark make good on their sustainability goals.

Building partnerships based on shared core principles can ensure continued alignment on impact even through periods of heady business growth.

(2) **Commitment to impact accountability** – RWDC is at the start of its impact measurement and reporting journey. As such, partners with robust ESG data and measurement capabilities can be helpful in designing their impact and sustainability strategy.

For example, in seeking to achieve its public commitment to reduce its plastics footprint through halving its use of fossil fuel-based plastics, Kimberly-Clark will be able to provide detailed, data-based understanding of how Solon contributes toward this goal.[12] Consolidating this data across the RWDC partner portfolio is one approach to building its environmental impact story.

(3) **Potential for scale** – As can be seen from their dual headquarters in Singapore and the United States, addressing plastic waste globally is a priority for RWDC. This focus on scale is also a consideration during partner selection, as global distribution networks enable broad reach and impact.

RWDC's partnership with Kimberly-Clark is a good example for its ability to provide two types of scale. First, Kimberly-Clark has been able to provide geographic scale, as their products are consumed around the world, enabling Solon to reach a broad audience across Europe, Asia, and North America. Second, Kimberly-Clark has also been able to provide application scale, as its broad product suite creates potential for a variety of non-woven fibre use cases.

RWDC prioritises partners who are committed to use case co-creation, motivated to adopt creative solutions, and have the ability to fund product development.

(4) **Branding to drive mission awareness** – As a B2B company, RWDC has almost entirely functioned outside the realm of traditional media. Andrew Wee shares that, "as a small company, [RWDC does not] have the resources to do big marketing and awareness." To fill this gap, it relies on partners. RWDC prioritises partners would share and amplify Solon's attributes and mission.

For example, through a partnership with Cove, a materials innovation company, RWDC will be developing the first completely biodegradable water bottle. Cove has since made this a central pillar for its branding strategy. Given Cove's location in Los Angeles, celebrity endorsements and music festival sponsorships are being explored as unique marketing and branding initiatives. Participating influencers and events have a global following, driving massive global reach and popular interest.

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[11] RWDC Industries (2021). Kimberly-Clark Partners with Biotech Innovator RWDC to Design Sustainable Alternatives to Traditional Plastics
[12] Kimberly-Clark (2022). Plastics Footprint

LOOKING AHEAD TO A SUSTAINABLE FUTURE

THE JOURNEY TO IMPACT: GOING BEYOND INTENTION TO MEASUREMENT

RWDC has focused on addressing upstream plastic pollution from its inception. It has built a strong business model that has provided a pathway to scale and funding. During its ensuing growth, it allowed its impact mission to guide its journey.

As RWDC looks to the future, with demand outpacing supply, business expansion will continue to be a key driver to increase impact. The quantification of this impact will in turn ensure RWDC stays aligned with their mission as they scale.

Driven by public commitments, consumer pressures, and regulation, companies around the world are searching for solutions to reduce their corporate contribution to plastic waste. RWDC is well placed to capitalise on this urgency. Impact quantification will increasingly become a critical component of fundraising, partnerships, and public branding. To take advantage of this, as one of RWDC's investors, Temasek continues to push for more thorough impact measurement, both positive and negative, and considers it an important tenet for RWDC's growth potential.

To date, RWDC has commissioned studies on greenhouse gas emissions modelling and plastic pollution avoidance. Moving forward, it will deepen its comprehension of Solon's environmental impact through a Life Cycle Assessment. Additionally, as it reaches a baseline manufacturing capacity, it will begin to track and operational report metrics such as Solon produced, emissions resulting from heating fermentation tanks, and emissions related to shipping and transport.

SCALING RWDC'S BUSINESS AND IMPACT

While RWDC has expansion into the United States as a path toward global partnerships and market access, they are committed to retaining close ties to Southeast Asia by opening a new facility in Singapore. From Singapore, they plan to engage Asia-based corporate partners and investors in a bid to directly reduce plastic waste in the region. Co-founder Roland Wee has explained that Singapore is "home to many of the fast-moving consumer goods brands that rely on packaging to keep their products fresh and safe", and RWDC's solution can be a crucial element to "take sustainable packaging to a whole new level."[13] In addition to servicing demand in the region, a presence in Singapore will provide the opportunity to engage with research and development organisations such as the Agency for Science, Technology and Research (A*Star), who can support product growth and impact quantification.

RWDC believes its dual focus between the United States and Singapore will continue to pay strategic dividends. It enables it to have global footprint, from which broader expansion is planned, but it also provides visibility to parts of the world where the effect of plastic waste is most acutely felt. Not only does this reinforce the importance of RWDC's mission, but ensures that it will remain accountable to its impact goals in the year ahead.

[13] RWDC Industries (2021). RWDC Industries raises US$95.1m in Series B2 funding

DAWN CHAN
CEO
Centre for Impact Investing and Practices (CIIP)
info@ciip.com.sg

RAJIV LALL
Professional Research Fellow
Sim Kee Boon Institute for Financial Economics at SMU
rajivblall@smu.edu.sg

ALISON KENNEDY
Strategy & Consulting Lead and Sustainability Services Lead
Accenture Southeast Asia
alison.kennedy@accenture.com

ABOUT THE CENTRE FOR IMPACT INVESTING AND PRACTICES (CIIP)

The Centre for Impact Investing and Practices ("CIIP") fosters the growth of impact investing and practices in Asia and beyond by building and sharing knowledge, bringing together stakeholders in the community, and bringing about positive action that accelerates the adoption of impact investing. Based in Singapore, CIIP was established in 2022 as a non-profit centre by Temasek Trust, a steward of philanthropic endowments and gifts. Temasek and ABC Impact are our strategic partners.

To achieve a sustainable future for all mankind, the world needs companies that can drive positive changes at scale through products and services. Impact investing can spur the growth of such companies and help advance solutions to address the challenges that the world faces today. We believe that sustainable companies are those who pursue social and environmental impact as avidly as they pursue profits and shareholder value. By striving to generate positive and measurable social and environmental returns alongside a financial return, both impact investors and companies can achieve returns with purpose.

We are SDG Impact's anchor partner for Asia. SDG Impact is the United Nations Development Programme initiative tasked to develop resources that accelerate investments towards achieving the United Nations Sustainable Development Goals by 2030.

For more information, please visit www.ciip.com.sg

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The Sim Kee Boon Institute for Financial Economics (SKBI) at Singapore Management University (SMU) is the premier Asian institute for applied financial economics research and training. This is done through multidisciplinary collaborations involving research talent from the SMU community, around the world as well as industry. The institute's focus is in the area of financial education and inclusion, sustainable finance, financial technology, and macro markets.

Besides conducting fundamental and applied research which aims at solving real-world issues, SKBI also actively engages in outreach, executive training and research dissemination through organising courses, seminars and conferences. Our purpose-oriented activities are designed to bridge the gap between theory and practice, and to act as accelerators with regard to financial policies and regulations. To maintain our relevance to finance practitioners and policy-makers, SKBI adopts a view on Asian and global economic trends.

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