Fab Island Challenge Publication

Bali, 2022

FAB Island Challenge

FAB CITY

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About the Fab Island Challenge

The Fab Island Challenge brought together local and global innovation communities to propose meaningful interventions to enrich, empower and scale emerging realities. For ten days, global networks and the local Indonesian ecosystem converged to propose and prototype design outputs that address local problems.

The Challenge was organised during the Bali Fab Fest - a unique event that brought together the 17th annual Fab Lab conference and the Fab City Summit. The Bali Fab Fest was held from the 12th to the 22nd of October, 2022. The theme ‘Designing Emergent Realities’ aimed to accelerate the island's transition toward a more regenerative economy.

The Fab Island Challenge was hosted by the Fab City Foundation and Meaningful Design Group, along with local and global partners.

The Fab Island Challenge in numbers

10
international curated teams

+10
hrs of Project Demonstrations

10
local challenges

92
participants (71 international and 21 Indonesian)

23
nationalities

+12
field trips in and around Bali

32
challenge leaders

10
hosting innovation initiatives of Bali

10
days during the BaliFabFest

256
public and expert votes cast

12K
USD in winner funding

3
winning teams:

- Supporting smallholder farmers with Kopernik
- Empowering sustainability with Plastic Exchange
- Water for fife with IDEP Foundation
- Special mention: Floating solar hydrogen pods with Cesar Jung-Harada

1 Goal

Accelerate the Transition to a Regenerative Economy in Bali

Why was the Challenge organised?

Mass tourism threatens Bali's environment, culture, religion, and economy. This suffering can be characterised by water shortage, environmental degradation, sanitation issues, over-crowded destinations, loss of authenticity, and higher cost of living (Arcgis, 2020). With the Covid-19 pandemic lockdown in the country, there was an opportunity to reimagine a model of sustainable tourism. A chance for the international community to leave behind a more positive and sustainable legacy.

The Bali Fab Fest was a unique event that brought global networks of digital fabrication, green technologies, and digital innovation together with Bali's local innovation ecosystem under the theme 'Designing Emergent Realities' to explore meaningful applications of digital fabrication.

The Fab Island Challenge was conceptualised as a unique collaboration format that rallied experts, enthusiasts, global leaders and other practitioners of design, making, digital fabrication, organising and eco-activism from around the world. By curating them into teams that ideated, designed, prototyped and tested solutions collaboratively on some of these most pressing issues around sustainability and life systems, we brought together local and global knowledge to address some of the island's biggest challenges.

Based on the ideas and prototypes created during the Challenge, the local initiatives were presented with a chance to be supported with seed funding to implement the innovation beyond the event.

This was an experimental and sustainable approach to address local problems with local resources coupled with global knowledge to make meaningful interventions in the host Island of Bali.

How was the Fab Island Challenge organised?

Through an open call, people from around the world were invited to work in teams to focus on and learn about a specific local initiative on the island of Bali, with the aim of proposing and prototyping design outputs to win seed funding for its implementation.

First, on-ground issues were identified by Fab City Foundation by partnering with local Balinese innovation initiatives. The Foundation team visited and worked with many local partners whose potential challenges addressed the most pressing issues around sustainability and life systems in these urgent areas of intervention:

Waste management	**Water conservation**	**Food security**	**Regenerative materials**
Sustainable mobility	**New Learning models**	**Preserving natural ecosystems**	**New systems of value and exchange**

After understanding the individual needs from the local partners, an open call was launched for applicants from around the world, aiming for people with various skill sets, working on projects, technologies or organisations relevant to the challenge themes.

The profiles aimed for were:

- **Local and global experts:** Local and global experts and enthusiasts such as students, academics, professionals and other practitioners of design, making, digital fabrication, green activism and community organisers who bring their skills to the challenge.
- **Technologies and methodologies:** Existing projects, technologies or methodologies that deal with or might fit into one or more of the challenge areas.
- **Networks and organisations:** Networks and organisations of practice that add value in the form of specific knowledge, skills or experience, including universities, advocacy movements and communities of practice.

As a result, over 200 individuals, many as a team or an organisation, from more than 30 countries, applied to be part of the Fab Island Challenge. Amongst many other professions, digital makers, design researchers, biologists, fashion designers, entrepreneurs and eco-activists coming from around the world from cities like Semarang (Indonesia) and Barcelona (Spain), all the way to Kumasi (Ghana) and Yucatán (Mexico). Many from the ASEAN region also applied from Malaysia and the Philippines.

Additionally, Fab City Foundation supported participants to attend the Challenge through a microgrants scheme. Selected participants were eligible to receive a microgrant, as an individual or in a team, to support their travel to Bali. This support came as a Skills Grant for individuals, a Project Grant for groups of 2–3 people, or an Organisation Grant for groups of 4–5 people, ranging from EUR 400 to 4000.

Next, the challenge teams were curated by an internal jury. Through an extensive selection process, participants were shortlisted and curated into teams that matched their interests, profiles, backgrounds, skills, projects or technologies with their preferred challenge themes, while ensuring diversity of creative minds within each team. The aim was to work together by bringing multiple perspectives and experiences to focus holistically on proposing solutions or design outcomes to the challenges.

Before coming to the event in Bali, two virtual introductory sessions were organised. The first was to onboard the participants to the Fab Island Challenge and explain the overall operation. The second was to introduce team members to each other, meet the local initiatives and introduce the challenges.

Introducing challenges and teams online

About the Challenges & the Challenge Partners

PLASTIC CHANGE

Empowering Sustainability with Plastic Exchange

Plastic Exchange is a sustainability movement that empowers communities to change their waste behaviour through dignity-based exchange systems that result in cleaner, healthier environments. They have multiple challenges, from efficient data collection and digitalisation, to effective data communication to convey impact, designing a cover for the compost holes, and scaling eco-enzyme fermentation products.

https://plasticexchange.org

KOPERNIK

Supporting Smallholder Farmers with Kopernik

Plastic Exchange is a sustainability movement that empowers communities to change their waste behaviour through dignity-based exchange systems that result in cleaner, healthier environments. They have multiple challenges, from efficient data collection and digitalisation, to effective data communication to convey impact, designing a cover for the compost holes, and scaling eco-enzyme fermentation products.

https://kopernik.info/

BAMBOO U

Making Connections with BambooU

Bamboo U promotes bamboo design, architecture and construction. Over the years, they found that though bamboo building is beautiful and full of potential, the joinery in round pole construction remains an issue due to the irregularity and diversity of bamboo poles. They have expertise in how to harvest, how to treat, and how to design and build. Their challenge was how to design better joints that are faster, cheaper, and stronger and have a positive impact on their craftspeople and community.

https://bamboou.com/

NU CYCLE

Waste to Value Communities with NuCycle

NuCycle has been working to develop community hubs across Gili Trawangan and Lombok islands to support the resiliency of local communities and ecosystems. Their challenge took place across two islands and focused on developing waste-to-value ecosystems for these small island communities by developing a platform and incentive system that allows the conversion of waste streams into valuable materials that serve the local community.

https://www.nu-cycle.com/

PRAKASH LAB

Looking Closer with Prakash Labs

Manu Prakash planned to tackle three specific problems that were all connected but had slightly different sets of challenges. These included Malaria diagnostics in Indonesia, Plankton monitoring (especially since the island had reports of Ciguatera fish poisoning) - for both reef monitoring and human health context and, lastly, life science education utilising foldscope as a tool.

https://web.stanford.edu/group/prakash-lab/cgi-bin/labsite/

Cesar Jung-Harada

Floating Hydrogen Pods with Cesar Jung-Harada

This energy-focused urgent challenge proposed to prototype multiple solar to hydrogen floating pods for off-shore energy production, designed in collaboration with local coastal communities, mainly with local materials to benefit the local environment and economy.

cesarharada.com

Water for Life with IDEP Foundation

Currently, measuring and monitoring a well's water level is challenging in many parts of the island due to the high costs of sensors and the fatiguing task of doing the work manually. IDEP Foundation challenged their team to develop a smart sensing solution to contribute to their Bali Water Protection Program by measuring and mapping the impact of the recharge wells.

https://www.idepfoundation.org/en/

1000 Prosthetics with Printridi +FabCare

Plastic Exchange is a sustainability movement that empowers communities to change their waste behaviour through dignity-based exchange systems that result in cleaner, healthier environments. They have multiple challenges, from efficient data collection and digitalisation, to effective data communication to convey impact, designing a cover for the compost holes, and scaling eco-enzyme fermentation products.

https://printridi.com/

Precious Plastic Community Challenge

The Precious Plastic challenge was developed collaboratively with over 15 members of the Precious Plastic community from across Indonesia. It was designed to respond to what the local organisations operating in Indonesia really needed, with the problem definition being the first collaborative action of the challenge.

https://preciousplastic.com/

What happened during the Fab Island Challenge at the Bali Fab Fest?

The challenge took on a distributed design and innovative approach that is needs-based, project-driven, context-aware, and hands-on.

During the first days of the Fab Island Challenge, all teams travelled to different locations in and around the island to understand the community and culture, meet people, try out activities first hand and immerse in the context. The teams travelled to farmlands in North Bali, river clean-ups, the neighbouring Gili Trawangan and Lombok islands, local hospitals, schools, and several water bodies around the island.

Looking closer with Prakash Labs team collecting water samples in the open seas

Floating Hydrogen Pods team testing their prototypes at the beach

BambooU team workwith bamboo during their visit to the BambooU Campus

After two days, the teams gathered back in the venue of the Bali Fab Fest (the Jimbaran Hub) to work on their proposals. Teams had access to design spaces, tools, and a wide array of experts across domains who were present at the Bali Fab Fest. They also participated in various activities of the Bali Fab Fest: talks, working groups, workshops, and panels during the week.

On 20th October, the teams presented their projects and proposed solutions during the Makerverse open day. They talked to people from the community and the Bali Fab Fest attendees, who learnt about the projects and the solutions proposed to the local challenges, shared their feedback, and evaluated the projects through an online questionnaire. The challenge winners were presented during the Fab City Symposium the next day.

Teams presenting their projects during the Makerverse Open day

The Precious Plastics booth set up

Plastic Exchange team explaining their prototypes

Challenge Case Studies

To give more detail about the challenges, three case studies have been chosen, each with various characteristics in order to demonstrate the complexity and diversity of the approaches taken by each team - adding value in unique ways.

1. Precious Plastic Community Challenge

THE CHALLENGE
Precious Plastics
Respond to what the local organisations operating in Indonesia really need with the problem definition being the first collaborative action the of the challenge!

AREAS OF INTERVENTION
Waste Management
New systems of value and exchange, Regenerative Materials

PARTICIPANTS
Fifteen members
Precious Plastics community members from around Indonesia

SKILLS
Mechanical engineer, webdevelopment
user-centred design, artists, plastic recycling event organisation

LOCAL HOST
Precious Plastics | Global community
On-sight hosts: Mattia Bernini

SOLUTIONS
Precious Plastic Indonesia
Creating a structure for different plastic recyclers around Indonesia to form a community and inspire others to join the movement.

IMPACT
Providing the framework for others
to join in recycling plastic using the Precious Plastics machines and methods. Tackling Indonesias plastic waste problem by upcycling plastic into products.

INFO
https://preciousplastic.com/index.html

The challenge

Indonesia produces approximately 7.8 million tons of plastic annually. In the face of this massive problem, the government has set a target to reduce plastic waste by 70% by 2025 (The ASEAN Post, 2018). However, more than 60% of that plastic waste is currently mismanaged. The collection rates are minimal. People dispose of waste in open dumpsites or burn it out in the open. Rural areas make up two-thirds of the mismanagement of plastic waste (Worldbank, 2021).

Precious Plastics provides an alternative plastic recycling system through a set of open-source machines ranging from plastic shredders to sheet presses. They have been enabling grass-root plastic recycling efforts for small-scale plastic re-processing and production since 2013. Indonesia currently has 28 members of the global Precious Plastic community, including machine shops, collection points, artists, and manufacturing plants.

Before the challenge, the local Precious Plastic community members were aware of each other, but were their work was disconnected. So a representative from the Precious Plastics global team, Mattia Bernini came to Bali to bring the group together to figure out how they could tackle the plastic problem collaboratively and more efficiently. Unlike other challenges, the Precious Plastic challenge was to be developed collaboratively with fifteen local community members from across Bali and Indonesia. The challenge targeted the needs of the local organisations, with the problem definition being the first challenge within their action plan.

Highlight

This challenge was arranged differently from the others. Instead of assembling a team of international makers to support a local initiative, an international host travelled to Indonesia to get local minds, from the Precious Plastic community, together to develop a path to achieve their common goal more efficiently.

MEET THE TEAM

Global host

Precious Plastic is a global community developed from open-source machines created by Dave Hakkens in 2013. Over the years, his machine blueprints have been replicated worldwide. Currently, their internal team consists of seven employees and three part-time contributors. In 2020, the Precious Plastics Universe was launched to become the global alternative recycling system with over a thousand international active members. The Fab Island Challenge brought in Mattia Bernini, design director at Precious Plastic and an international expert in community development, to elevate the local PP community.

Participants

The team consisted of fifteen Precious Plastics community members from around Indonesia. Members included artists, product designers, educators, and engineers, all managing their own initiatives. Some participants even build machines using the Precious Plastic blueprint with locally available tools and materials.

UNDERSTANDING THE CONTEXT

The context was known to the participants as their work is already situated in Bali. So, the participants went on a field trip to visit some of the team members' initiatives. First, they went to The Space Available Museum, a new world gallery and circular design centre. The gallery showcases the work of Space Available Studios and a community of designers and scientists specialising in the radical recycling and upcycling of plastics.

Later, the team joined Sungai Watch, a local charity that takes care of Bali’s rivers by organising river cleanups. More than 80% of plastic pollution in Bali's ocean comes from rivers and streams fed by illegal waste dumps. The organisation builds river barriers that

stop plastics from ending up in the ocean. For the Precious Plastics team, the field trip focused more on team building and getting to know each other than on understanding the context. Through the field trip, they strengthened their mission of offsetting plastic waste in their country.

TALKING SOLUTIONS

Initially, the Precious Plastics team thought of developing a product they could collectively make to showcase their work and build better bonds. Then, more brainstorming led to the idea of creating a local sub-community for Indonesian recyclers. Therefore, during the event, Precious Plastics Indonesia was born.
The team shifted their focus from making a products to creating ways of making community development tools. They designed a website to share their collective mission and vision as a way for other people to get inspired to take action. They planned on creating a guide on how to set up a recycling space using the Precious Plastics ethos. They brainstormed on ways to work collectively without undercutting each other and instead came up with common prices for their work to ensure they earn what they deserve.

As a part of their newfound community, they developed a modular product from recycled plastic sheets. A building block that all community members can make

to raise their income. It can be put together to create products like toys, art, or anything one might imagine building. In addition, the product serves as a means to get familiar with plastic recycling. The team plans to make universal moulds that can be distributed to aspiring recyclers to start their own recycling spaces.

IMPACT AND SUSTAINABILITY

Precious Plastics has been a thriving global community that has been growing for almost ten years. However, many community nodes still need to be locally connected. For example, this was the case of the 28 members in Indonesia, which are spread across eight islands, most of them located in Java, Borneo, Sulawesi, and Bali. The challenge team has made an effort to strengthen the community within Indonesia to make it easier to join Precious Plastics Indonesia, growing the local community and, consequently, expanding its impact.

They hope to expand the Precious Plastics movement to more rural areas across Indonesia's 17,000 islands. They firmly believe that a more robust community leads to fairer pricing and enhances knowledge sharing. The team plans to organise a yearly get-together following up on the Fab Island Challenge. Precious Plastics was already a success story for the different Indonesian members before the event. The challenge, however, has strengthened their bonds and shown that they have a bigger impact when working together.

2. Supporting waste to value communities with Nu-Cycle

The challenge

Indonesia has the world's second-largest amount of plastic waste, behind China, reaching 7.8 million tons per year, making up 17% of the country's total annual waste (VOI, 2022). Unfortunately, only 7% of that plastic is currently being recycled. The rest ends up in landfill, in nature, in the ocean, or being burnt. However, plastics like PET bottles, which have a recycling value, reach nearly 70% of recycling waste (Sustainable Waste Indonesia, 2020).

Working primarily in Lombok and Gili Trawangan islands, nearby Bali, the Nu Cycle works locally on solving the plastic problem by creating ecosystems where all waste has value to improve the overall recycling rate across the islands. The organisation's vision is to create a 'waste-to-value ecosystem', giving value to all recyclable and non-recyclable waste to incentivise people to separate and collect not only glass and plastic bottles, but also single-use plastics and organic waste. Their platform is a solutions-based waste offset service that uses blockchain technology for individuals and companies to neutralise their waste impact. The service uses a paid monthly subscription, of which the revenue goes directly towards supporting their partners that undertake waste-to-value conversion processes in local communities. Their next step is crossing the ocean to Bali to upscale their waste offset partners and gain more support from Bali's vast tourism industry, through tourism credits.

Nu Cycle's challenge brief was defined with the international team during the two-day field trip to the islands where the organisation is active. The main goal was to upscale the current revenue streams and make them more transparent.

Highlight

Nu Cycle implements high-tech blockchain solutions in the local context rather than taking a grassroots approach. The target audience is not the local community but international visitors and businesses inclined to offset their waste production during their stay. This high-level approach supports the local community with revenue to improve successful existing solutions instead of creating new ones.

MEET THE TEAM

Local host

Nu Cycle is an SME with six employees working mainly in Lombok and Finland. Their team has over ten years of experience in operations in Indonesia's environmental and sustainability sector. Their platform, their core product, has been active since 2020. They have a network of waste conversion partners that turn non-recyclable plastic, glass, and organic waste into new products like fuel, animal feed, and building materials. These partners include GEO Trash Management, Lombok Eco Craft, FeedWerkz, and the Gili Eco Trust.

Participants

Seven international participants joined the Nu Cycle team during the challenge, including experts in NFT and blockchain, digital fabrication and indigenous justice. The group also consisted of two local bioengineers, who helped bridge the gap between the international team and the local stakeholders. Among the team members, there were experienced digital fabricators, FabAcademy graduates, as well as a Fab Lab manager.

UNDERSTANDING THE CONTEXT

The team went on a two-day field trip to Gili Trawangan and Lombok on the 13th and 14th of October. On Gili Trawangan they were confronted with the six-meter-high patch of landfill in the middle of the otherwise idyllic island. On top of the landfill, a new ecosystem had developed after more than 20 years of accumulating tourism waste.

After grasping the vastness of Indonesia's plastic waste problem, the trip's theme shifted from the problems to solutions. On Gili Trawangan, Nu Cycle works together with Gili Eco Trust. Led by Delphine Robbe, referred to as "eco-warrior" by Maria, the initiative is working towards a circular island, hosting activities from marine

The team was introduced to Geo Trash Management (GTM), FeedWerkz, and Lombok Eco Craft on Lombok. Three initiatives with different approaches to waste management. GTM built a pyrolysis plant that converts one ton of non-recyclable plastic into 700 litres of fuel in one day. The local community runs the plant, and the initiative plans to scale up to ten plants in the future.
Lombok Eco Craft is approaching non-recyclable plastics in a different way. The initiative primarily employs women and people with disabilities who would otherwise have difficulties acquiring and maintaining a job. They upcycle plastic waste into products like durable shopping bags. Lastly, the team visited FeedWerkz. The company turns biowaste into a protein-rich animal feed substitute, using a process involving black soldier fly larvae.
Together, all initiatives mentioned above take care of a large chunk of all waste that, otherwise, ends up in landfills or nature.

TALKING SOLUTIONS

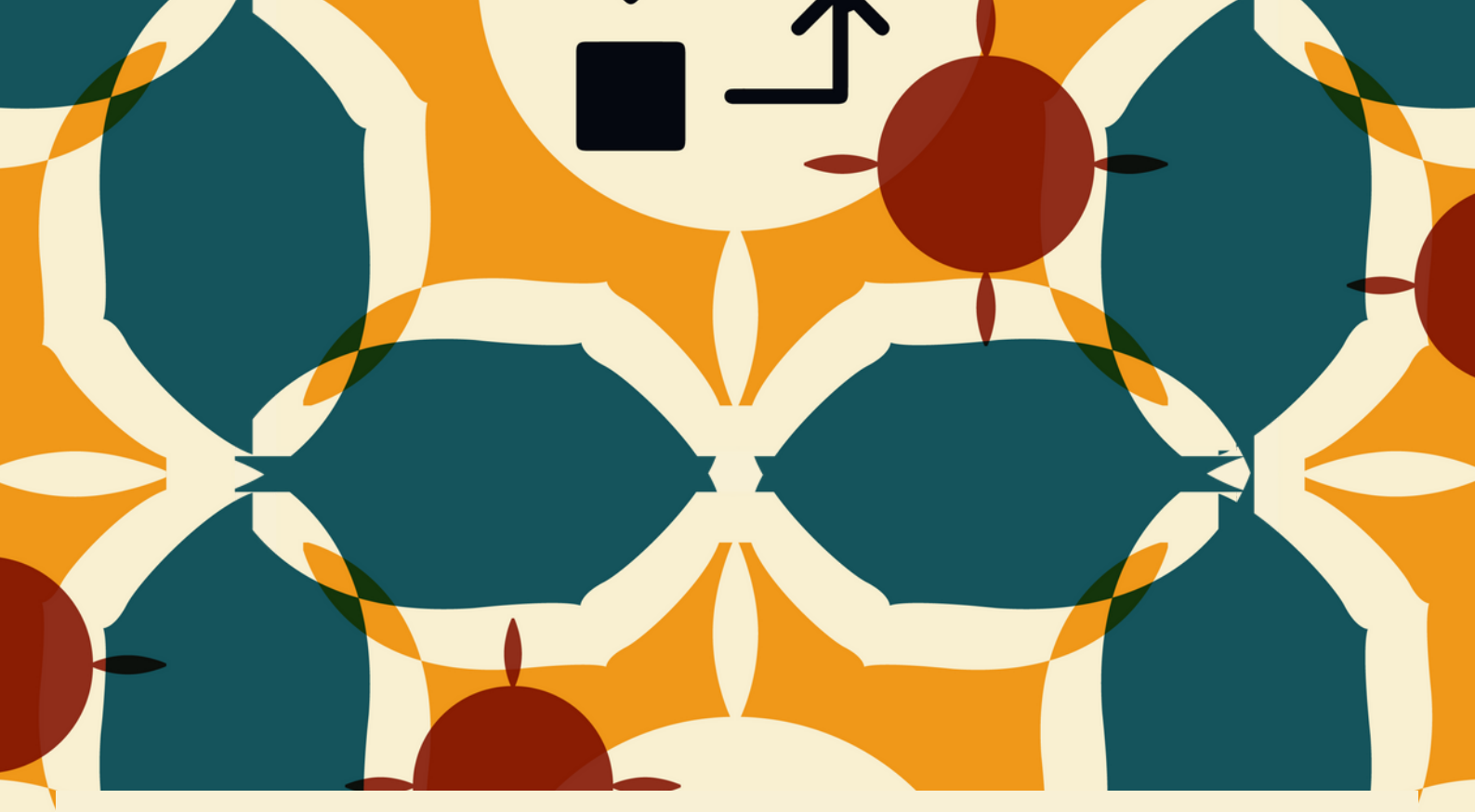
The team chose to work on streamlining the ‘waste-to-value ecosystem’ proposed by the Nu Cycle approach. The result of Nu Cycle’s Fab Island Challenge is a minimum viable product for satellite imaging for waste tracking. The team conceptualised the implementation of blockchain technology through NFTS and smart contracts for offset verification. They proposed using these technologies to transparently show individuals and investing companies where their investments go, and create a visible value stream through conversion partners. Finally, they made a scale model of their Waste Lab concept, combining different waste recycling methods into one waste facility. A scale model of the massive landfill, twice the size of the waste facility located on Gili Trawangan, showcased the scale of the issue during the Makerverse open day.

IMPACT AND SUSTAINABILITY

Nu Cycle team will expand the tourism credit in Bali to support their waste conversion partners and invest in developing their blockchain solution. Nu Cycle had a different approach during the Fab Island Challenge - to develop and share their story whilst creating a clearer impact roadmap. They estimate they will need at least USD 500,000 through investors to realise their vision with a large tourism base to pursue its 'waste-to-value ecosystem'.

In honour of the Bali Fab Fest organisational partners' collaboration with the Nu Cycle team, they calculated the waste impact of the event's combined 3100 attendees, estimated at 11,925 kg. The team will offset this by investing an equivalent amount in revenue in four of their waste conversion partners.

Through the Fab Island Challenge, Nu cycle kickstarted their upscaling process to include Bali. Their work is not just developing blockchain technology to promote waste-to-value but also about the broader social impact of dealing with trash through providing livelihood and changing one's relation with their own waste. Nu Cycle accelerated the process of amplifying their most notable impact - transforming tourism into transformational experiences by providing an opportunity to be a part of the change.



3. 1000 prosthetics with Printridi

THE CHALLENGE
1000 Prosthetics
Can we bring together a distributed community across Bali to design and print 1000 prosthetics in just 10 days?

AREAS OF INTERVENTION
New Learning Models
New systems of value and exchange

PARTICIPANTS
Ten members
Indonesian, Italian, Ghanaian, Swiss, Indian

SKILLS
Distributed organisation, design research
art activism, digital fabrication

LOCAL HOST
Printridi | Association | 5 employees
On-sight hosts: Erik "Evo" Rudolf, Djoko "Crewol"
FabCare: Adriana Cabrera, Enrico Bassi

SOLUTIONS
Establishing distributed manufacturing
to develop personalised, affordable prostetics
for amputees across Indonesia activating local makers

IMPACT
Empowering amputees across Indonesia
by creating a distributed production community of makers across the country, supported by the government and private sponsors

INFO
https://printridi.com/
Indonesia | https://fabcare.com/

The challenge

In 2011, Indonesia's health Minister Engang Sedyaningsih was quoted in the Jakarta Post saying: "Indonesia needs better orthotics and prosthetics services due to the vast increase in the number of disabled people." Unfortunately, only a few manufacturers in Indonesia provide quality, affordable prosthetics because of the lack of infrastructure, resources and skills, especially in poorer rural areas.

With the support of FabCare, Printridi proposed a challenge of 3D-printing a thousand prosthetics for amputees around Indonesia. The goal was not to use the challenge to print a thousand prosthetics. Rather, the idea was to create the system infrastructure and proof of concept for the feasibility of the challenge. The challenge also aimed to activate the national network of 3D printing professionals and enthusiasts to develop a distributed manufacturing system across the Indonesian archipelago.

Every amputee has a different form and need from their prosthetic. Thus they each require a unique type of prosthesis. Globally, many networks share open-source generic purpose prosthetics for people to apply in their own context. However, the Printridi team found a lack of resouces for 3D-printed prosthetics that caters to the hyper-customised needs. To develop an effective infrastructure, the team researched the local context not only to find the best way to include and educate people, but also to set up the tools for people to join the network.

Highlight

The Pritridi team collaborated intensively with FabCare, a global network of labs that focus on developing innovative healthcare solutions. The collaboration brought together two networks of experts in 3D printing and digital fabrication for healthcare, to collaboratively develop a new system and Indonesian network of makers, medical practitioners, and amputees.

MEET THE TEAM

The challenge hosts

Printridi is the Indonesian association for 3D printing. Their vision is to improve the effectiveness and quality of the Indonesian industry. Their goal is to educate people all across the nation about the power of 3D-printing technology. By creating awareness, they support the government's efforts towards its development of industry 4.0 practices. Currently, the association has a core team of five members with almost 200 active supporting members across different islands in Indonesia.

FabCare is a global network, established in 2021 by OpenDot Fab Lab with FabLab Kamp-Lintfort, making inclusive and collaborative healthcare interventions.

Participants

Ten international participants joined the Pritridi and FabCare challenge. The team comprised artists, a community manager, a design researcher, a business consultant, and human rights activists. In addition, they also got support from Stikom University students. The students helped the team familiarise themselves with the local context. Simultaneously, the students were also educated on what it is to be an amputee, and how to develop 3D-printed prosthetics for them.

UNDERSTANDING THE CONTEXT

The team visited several relevant stakeholder locations during their field trips. The first place they visited was the Disability Center in Denpasar. Later, they met with the local governor of the department of Social Affairs to discuss with him the need to support more amputees to get prosthetics. Finally, they headed to Stikom University in Bali, where Printridi operates, to talk with the university's vice president. These first meetings aimed to involve stakeholders who could help to organise the network and keep the momentum going after the challenge was over.

Part of the team returned to the disability centre to have in-depth interviews with two amputees. One, a mother of three in need of an extra hand for cooking for her family and the other, a taxi driver needing an extra hand to drive his passengers safely. Apart from interviewing them to understand their struggle, they also took measurements of their stumps to develop personalised prosthetics for them.

TALKING SOLUTIONS

The team developed “Gerakan Seribu Tangan Palsu” (thousand prosthetics movement). This open-source hand-prosthetic production platform involves scholars, business owners, media, government, and the general public in the spirit of helping each other. The team did not only target people with disabilities to be a part of their network. They also involved the local people with 3D printing or other relevant skills who wanted to earn more income.

The team developed a communication strategy for the network moving forwards. They designed a logo, in the colours of the Balinese flag, depicting two people standing side by side, referring to the tagline they created: “Shoulder to shoulder to move forward” (Bahu membahu untuk maju). They also developed a social media plan, including Instagram and Facebook posting strategies, and the use of Youtube as a campaigning and educational tool. A website prototype was created for the local stakeholders to easily implement.

Besides that, the team developed a business plan for the system. Their mission statement was: “Create an ecosystem for physically disabled people to improve quality of life.” They plan to do this by providing prosthetics for day-to-day activities and opening new opportunities. They propose activating a network of makers across the island with

access to or owning a 3D printer. Amputees would have their measurements taken. The measurements are sent to a designer who models the prosthetic, which an orthopedist then checks. The files are sent to a local maker in the area of the amputee who provides the prosthetic. Each part of the system gets paid for its contribution. The team created a structure of government support and donors, targeting corporate social responsibility, to pay for people who cannot afford the prosthetics themselves.

IMPACT AND SUSTAINABILITY

The team employed members without experience in 3D printing to learn and eventually print the prototypes. They were able to realise several printed prosthetics in the ten-day challenge, proving that with the help of resources and evangelists, anyone can learn how to do it rapidly. Through a distributed network across Indonesia, the team tried to reach all amputees in need of prosthetics, even the poorest and most remote people. The title of their challenge - 1000 prosthetics, insinuates the possibilities they created by setting up the ecosystem and involving government, academics, and makers. The team expects to be able to print 1000 prosthetics first, but eventually hopes to be able to print thousands more. By employing local makers, who also can earn additional income, the production price of prosthetics is kept low. The team has made an effort to involve local government to support the project and, in turn, provide the means to develop prosthetics for more people.

During the event, the team printed two prosthetics using the system they developed to prove its validity. The prosthetics were donated to the two amputees that were interviewed by the team, showcasing the immediate impact the project can have. Additionally, the team educated a group of local students on disability and 3D printing, inspiring them to be a part of the network.

Enrico Bassi - *"We wanted to provide international knowledge and experience in the field. So we shared some documents that are part of the co-design materials that we created and explained how to use them. And they actually translated some of the materials that we gave them into Indonesian and added tips and tricks from the local culture."*

4. Supporting smallholder farmers with Kopernik

The challenge

Wealth inequality in Indonesia is growing faster than in any other ASEAN country, ranking sixth in the world. The poorest citizens, women in particular, receive low wages and have insecurities when it comes to a steady income. One of the reasons is that rural areas have much less access to quality infrastructure, such as decent roads and electricity (Oxfam, 2022).

For the past twelve years, Kopernik has been fighting to reduce poverty in Indonesia by experimenting with solutions that are easy to implement and scale amongst rural communities. Toshi Nakamura and Ewa Wojkowska founded the non-profit organisation to bring life-changing and affordable technologies to the poorer communities in the country.

The Kopernik team proposed two challenges to support smallholder farmers in rural Bali. The first one focused on the cacao farmers struggling with the excessive growth of weeds in their plantations. The farmers have to remove weeds two to three times a year, either manually or with heavy expensive machinery running on petrol. The other challenge involved coffee farmers who sold their beans unsorted. Sorting the beans is a tedious manual job that takes a lot of time. However, sorted beans are more valuable to intermediates, enabling the farmers to sell them at a premium prize.
The participants were challenged to come up with solutions to make both processes less labour-intensive. Both solutions needed to be easily attainable and widely scalable by the communities. For the cacao farmers, this meant improved physical health and overall life quality, and for the coffee farmers, it meant an increased income.

Highlight

The Kopernik team worked directly with the farming communities to ideate and develop solutions. They focussed primarily on low-tech solutions that could be quickly adopted and replicated by the community. Their approach was extremely hands-on and relied heavily on experimentation in the field. They were a great example of how the Fab Island Challenge was envisioned- implementing global knowledge in a local context, based on available skills and resources.

MEET THE TEAM

Local host

Kopernik is a non-profit organisation with almost 50 employees working on several projects all around Indonesia. They help underserved and disadvantaged communities around the world by creating more effective solutions to reduce poverty. They work based on the Sustainable Development Goals focusing on six expertise areas - energy and environment, water and sanitation, agriculture and fisheries, health, education, and women's economic empowerment.

Participants

Twelve participants joined the Kopernik team during the challenge, including an expert in creative advertisement, digital fabrication, bio-materials, and decolonising- and distributed design. The team divided itself to realise the two challenges, one focussing on bio-materials and the other on low-tech solutions. Amongst these participants were international artists, local designers, and FabAcademy graduates.

UNDERSTANDING THE CONTEXT

Kopernik organised two day-trips for the team to get a grasp of the context. The team spent their first day at the Kopernik office in Ubud to understand how the organisation worked and get a glimpse of some of the projects they are developing. Their office immediately communicates their message of low-tech solutions to support those in need. Most of their prototypes use locally sourced materials and easy-to-build solutions. On the second day, the team visited the Pajahan village in Papuan, where both coffee and cacao plantations are located.

After the first visit, the team developed a set of initial ideas, some high-tech like imagining robots to optimise the process. But after talking to the farmers and watching how they work, the team changed their approach considerably. Part of the group tried using the heavy machinery the cacao farmers used to get rid of the weeds. They were also shown the large government-provided coffee bean sorting machine. A machine that most women were not strong enough to use, and men struggled to use for longer periods.
Therefore, the team realised why the

high-tech and large machinery were not feasible solutions. For them, the field trip provided the opportunity to ideate from within the community after briefly being a part of it.

TALKING SOLUTIONS

Talking solutions
The team devised several low-tech solutions to sort coffee beans. One used a steam basket with a piece of wood that had holes drilled in it. By using different hole sizes, the beans can be sieved through the basket in different grades according to their size. Another solution built was a small prototype using PVC piping fanning outwards at different angles. By rolling the beans along the pipes, the smaller beans fall through first in a designated basket, followed by medium-sized beans, and eventually the large ones.

The Brazilian team members, experienced in bio-materials, developed a weed matt for the cacao farmers. This mat was made from coconut husks and is biodegradable over time. The concept is based on generic weed mats made from plastic. These mats go around the tree's base to prevent sunlight and oxygen from reaching the soil. This way, the weed does not get enough nutrients to grow in the immediate vicinity around the plant. They used another local bio-material to replace the plastic growing bags used by the farmers. Therefore, making the whole process greener.

IMPACT AND SUSTAINABILITY

The Kopernik team was one of the winners of the Fab Island Challenge and received $5000 USD in seed funding. During the next six months, Fab City Foundation will support them in accelerating the project implementation. Their future steps are to test and validate the prototypes with the farming communities. Using their feedback, Kopernik plans to develop prototypes for more than twenty farming families to test. The bigger prototype will be placed in a central building for all villages to use. Although the direct impact of the solutions is not yet quantifiable, the team is determined to develop their solutions into products that can be implemented by coffee and cacao farmers across the island, and possibly all over Indonesia.

For the cacao farmers, the weed mats provide an environmentally friendly solution to the tedious job of getting rid of weeds, which takes around two to four hours a day, through up to nine weeks every year per hectare of land. This time adds up massively for farmers with plants over multiple hectares. The material used, gathered from other farmers, otherwise ends up as organic waste. For coffee farmers, the solution allows them to sell their beans sorted by size, resulting in a higher income. Sorting the beans can increase the sales price by up to 35% for the farmers. The solution is also inclusive of women, otherwise excluded from the sorting process due to heavy machinery. Both solutions were developed with affordable local materials, so local communities can easily replicate and repair them.

5. Floating solar to hydrogen energy pods with Cesar Jung-Harada

THE CHALLENGE
Floating Hydrogen Pods
Prototype floating solar to hydrogen pods, designed in collaboration with coastal communities with local materials to benefit the local environment and economy

LOCAL HOST
Cesar Jung-Harada | Academics
On-sight hosts: Cesar-Jung Harada, Alvaro Cassinelli, Pamela Pascual, Ni Made Dwidiani

AREAS OF INTERVENTION
Preserving Natural Ecosystems
Water Conservation, Regenerative Materials, Sustainable Mobility

SOLUTIONS
Balon Balon Ijo
Floating hydropod prototypes providing clean, scalable and decentralised energy to coastal communities.

PARTICIPANTS
Twelve members
Indonesian, Malaysian, Australian, Swiss, American, Singaporean, Uruguayan

IMPACT
Educating local coastal communities
about hydrogen as a new form of renewable energy to power stoves. Designing the floating pods as data gathering tools using LoRa technology.

SKILLS
Project management, blockchain
indiginous justice activism, fashion design, digital fabrication, civic environmental engineering

INFO
https://balon.energy/
Bali, Indonesia | Singapore

The challenge

Since the start of this millennium, CO2 emission in Indonesia has almost doubled (Our World in Data, 2021). Now, more than ever, there is a need for a transition to renewable energy. Indonesia is in the top five countries in the Asia-Pacific with significant potential and capacity for renewable energy. However, they still have a long way to go to satisfy its exponentially growing energy demand, projected to triple between 2015 and 2030 (Energytracker Asia, 2022).

Professor Cesar Jung-Harada, from the Singapore Institute of Technology, has been working on off-shore devices harvesting the power of the sun to turn ocean water into a clean energy source as a part of his PhD research. Together with a colleague Alvaro Cassinelli, from the Hong Kong School of Creative Media, and the community aiding blockchain specialist Pamela Pascual, Jung-Harada proposed a challenge to test decentralised, solar-powered, hydrogen harvesting infrastructure on the coasts of Bali. According to many, hydrogen is the perfect fuel being the most abundant element in the universe. It makes for a clean renewable energy source that can be used for a multitude of applications, like cooking, driving, and electricity generation.

Indonesia created many incentives for the transition to solar energy as a renewable source, aiming for 23% renewable energy by 2025. However, the influx of power from the increase of people buying solar panels was too large for the existing grid to support. As a result, the government had to roll back the initiative. This made the challenge team think about ways to circumvent the use of this power grid. Alternatively, their interest was concentrated to harvest and store energy off-shore and test their hypotheses.

Highlight

Before travelling to Bali, Jung-Harada developed a network of twelve local and international stakeholders to support the team during the challenge. This included sponsors that provided a fully functioning Electronics Lab, including microcomputers, sensors, hydrogen cells, and much more. The team also had their own production crew who created a ten-minute short film to educate people about the concept of hydrogen. Jung-Harada's team was extremely well-prepared and autonomous, and shared with and supported other teams in their electronics needs.

MEET THE TEAM

Local host

Jung-Harada and Cassinelli contextualised their through the Fab Island Challenge accelerate the renewable energy transition in Bali. They connected with Professor Dwidiani from Udayana University for local support and cultural knowledge. Pamela Pascual joined the team as a blockchain specialist to set up decentralised tokenisation of energy. They were supported by CNAM, Hong Kong School of Creative Media, Amber initiative, Seeed studio, JOGL, Helium Foundation, Safecast, Scoutbots, MakerBay, and Supplyframe.

Participants

Eleven international participants and observers joined the team. The members included participants with different backgrounds, such as fashion design, waste management, electrical engineering, and digital fabrication along with a FabLab founder and indigenous justice activist.

UNDERSTANDING THE CONTEXT

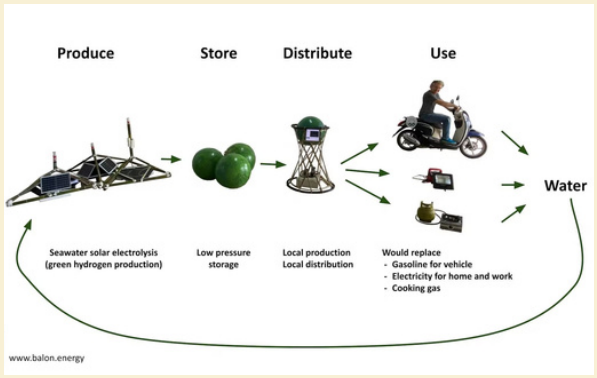
Before the challenge started, the hosting team scouted the south peninsula of Bali to familiarise themselves with the local infrastructure. Beforehand, they also discussed with Professor Dwidiani local possibilities of renewable energy. Finally, the team went on a field trip to Benoa Bay to better understand the ecosystem in and around the bay, including fishermen, aquatic animals, and watersports. Thus, getting familiar with the context was a determining factor in this challenge's success. Professor Dwidiani connected the team

to an indigenous fisherman population living in the Sahabat Mangrove. The villagers have built houses on the water where they are working to preserve the mangrove. Unfortunately, the giant highway built through the middle of the body of water has made a detrimental impact on local flora and fauna. Nevertheless, the locals try their best to keep the area free from plastics and chemicals, and make an effort to replant the mangrove.

The local crab farm and restaurant have been struggling with electricity bills. Because of the sediment, they can't catch crabs locally anymore, so they must import them from other places. To keep the crab from spoiling, they spend more than 400 USD a month on maintaining the freezers. For the local community around the mangrove, agency over the energy harvested locally would be a life-changing solution.

TALKING SOLUTIONS

The team developed Balon Balon Ijo, a system of modular pods that uses electrolysis to turn ocean water into hydrogen, a clean gas that can be used in many processes. The local community can use it, mixed with oxygen, to cook or power combustion engines. Hydrogen can be converted into electricity using a fuel cell to charge your phone or run electrical appliances.



The prototypes were built using locally sourced materials such as bamboo, empty plastic bottles, and styrofoam. The system is modular and consists of two different pods. A solar pod captures solar energy, and a balloon pod is equipped to store hydrogen.

The envisioned infrastructure is developed around people building their modules based on the team's blueprint. In addition, the modules are equipped with sensors to establish decentralised autonomous energy cooperation between the network of modules.

IMPACT AND SUSTAINABILITY

The team plans to work with sponsors to refine and test their prototypes. They want to collaborate with the local crab restaurant near the mangrove to develop a test site for their prototypes. Some plan to come back to Bali and install floating solar modules for the communities that could benefit from this technology because it reduces their energy cost. Simultaneously, the team can use the system's power supply to run their electrolyser and do regular system testing. They propose that 95% of the time the locals use the solar pod system, and the other 5% is used for testing. A partnership that is beneficial for both parties.

If Balon Balon Ijo works efficiently, they intend to open-source blueprints. This way, rural fishing communities around Indonesia and the world can replicate and adopt the system.

Evaluation and Winning Projects of the Fab Island Challenge

In line with the Fab ideology “think global, act local”, as well as the traditional Balinese philosophy of “Tri Hita Karana”, the projects were evaluated on these design considerations:

- **Local Balance** - Human Well-being, Community Development and Environmental Regeneration
- **Global Innovation** - Technological Feasibility, Global Scalability and Innovative Methodology

During the Markerverse open day, when all teams showcased their prototypes and proposals, the visitors were asked to fill in an online form that evaluated the projects in each of the design considerations. As a result, "Empowering Sustainability with Plastic Exchange" won a funding of USD 5000 from maximum public votes.

In addition, by gathering votes from the domain experts, "Supporting Smallholder Farmers with Kopernik" won USD 5000 to implement their projects after the event. Sponsored by the Helium Foundation, "Water for Life with IDEP Foundation" won USD 2000 for the best application of LoRa technology, a "Long Range Wide Area" low-power wireless network protocol in their project.

Finally, "Floating Hydrogen Pods with Cesar Jung-Harada" won an honoured mention for their floating solar to hydrogen energy solution.

Kopernik and Plastic Exchange teams while announcing the winners

Besides the monetary support from Fab City Foundation and Helium Foundation, the three winning teams enter a six-month acceleration program to implement their solutions. They will receive support from the Fab City Foundation where needed and are provided access to the Fab City Network and their partners.

Expert choice: Supporting Smallholder Farmers with Kopernik

The Kopernik team demonstrated an excellent understanding of the context and provided a clear implementation plan. The team ticked all the boxes on which they were evaluated. The result involved multiple solutions for the local initiative, producing social, economic and environmental impact altogether. The participants showed that solutions can be simple, yet extremely effective. Listening to the farmers yielded solutions that were accessible, easy to tend to and scale. Their understanding went beyond just solving the problem. By developing low-tech solutions based on waste and available material, they were able to solve multiple issues simultaneously. In addition, the team was very clear on the future steps for implementation and believed in the rapid success of their ideas. Kopernik is using the six-month acceleration program to test and validate the solutions through lean experimentation. They are realising the prototypes and testing the tools within the community, so it benefits them directly.

Public voted: Empowering Sustainability with Plastic Exchange

Over 250 accumulated votes resulted in a clear public favourite. Plastic Exchange showed a great understanding of the local context and issues. Their challenge took a proven and successful formula and applied it at a grander scale. By expanding Plastic Exchange into Bali Exchange, the team proposed to develop a value system that includes not only plastics but all waste, organic and inorganic. Plastic Exchange has been installing concrete compost holes in villages over the past years so families can transform their organic waste into fertiliser. The team worked on redesigning these concrete structures into containers made from the recycled plastic collected by the Plastic Exchange program. Janur Yasa, the mind behind the initiative, excitedly explained how this makes for a more circular process where waste is not only collected, but reused to keep more waste out of nature and landfills. Janur's team plans to use the seed funding to invest in machines capable of injection moulding non-recyclable plastic, without the need to clean, to make building material for the compost holes. The holistic approach to the challenge resulted in improvements from mapping Plastic Exchange's current infrastructure to developing a recycled plastic compost bin lid, light enough for an older person to pick up while letting air through to feed composting process.

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Helium Grant winner: Water for Life with IDEP Foundation

The IDEP team won the Helium Foundation grant because of their application of LoRa technology, not only adding value to their solution but also for the expansion of the LoRa network on the island. During the challenge, the IDEP team developed a low-tech module to measure the water table level and the impact of recharge and gravity wells, with the intention of creating a water table map of Bali's rural northern area. This mapping provides the local communities with a better understanding of their area's groundwater distribution, so they can anticipate or even prevent saltwater intrusion into the freshwater table. Once the solution is tested and validated, it can not only be scaled across Indonesia but the team speculates its value in European countries prone to draughts, due to the modules' universal nature. The IDEP Foundation team worked with some participants after the challenge to develop version two of the module to get it ready for testing. They hope to spread the system across the island within the six-month acceleration program, to be able to showcase the water table for agricultural benefit.

Special mention: Floating solar hydrogen pods with Cesar Jung-Harada

IMPACT OF THE FAB ISLAND CHALLENGE

The Fab Island Challenge created a reciprocal impact for both, the host country and the global community. The challenge enabled a global collaboration between more than twenty countries. It provided direct value to the local communities in the form of solutions to pressing issues. For the global community, it provided a new perspective on culture, innovation, impact, and collaboration.

LOCAL IMPACT

Bali has long been Indonesia's hub for global visitors. During the pandemic, tourism completely vanished, giving time to reflect. The tourism industry has historically driven 80% of the Balinese economy (Time magazine, 2002), but simultaneously causes fresh drink water shortage, massive waste production, and diminishing of culture (Worldcrunch, 2012). The Fab Island Challenge has shown the power of a new form of tourism, driven by supporting local innovation and conservation of culture and environment.

Indonesia limits the import of certain goods into the country, underlining its belief in local production. Nevertheless, the Fab Island Challenge brought together global knowledge from over twenty countries with great local minds in a purpose-driven setting. This started conversations about the main problems the Balinese communities are facing today. The acknowledgement of these problems offered a massive energy boost to local initiatives.

Bringing global experts, in a multitude of different fields, broadens the horizon of possibilities for local initiatives. It shows the range of potential solutions to solve their problems. New perspectives result in different approaches to problem-solving. Bali's local initiatives gained access to the methodologies and technologies used by the Fab Island Challenge participants to develop the prototypes. This resulted in the rapid development of solutions that empowered the local hosts in dealing with the pressing issues they faced.

For the local initiatives that hosted national and international participants, the Fab Island Challenge has promoted the identification of the stakeholders whose contributions will be transformative in addressing Bali's urgent issues. Three initiatives received a combined USD 12,000 to develop the proposed solutions further. In addition, the Fab City Foundation will further support them through a six-month acceleration program.

Finally, Bali Fab Fest provided a stage for these initiatives to address a global audience. The event activated networks and creative communities in Bali - that are strengthened now more than ever - to develop solutions with the support of the Fab City Global Initiative, through connections with Fab Labs and Fab Cities.

+200

villages collecting waste support the development of organic waste conversion through **Empowering Sustainability with Plastic Exchange's** challenge solution.

+40

Students learned about foldscopes and are still propagating the knowledge in their own capacities through the **Looking Closer with Prakash Labs** challenge.

+20

farming families' work made more efficient, less intensive, and enabled to receive higher income through the efforts of the **Supporting smallholder farmers with Kopernik** challenge.

15

plastic recycling businesses are now part of a tight-knit community supporting each other and encouraging more entrepreneurs to join recycling plastic efforts through the **Precious Plastic community challenge**.

4

local waste conversion businesses receive increased monetary support through the **Waste to Value Communities with Nusa Sentara** challenge.

2

amputees empowered with 3D-printed prosthetics and a network activated to continue working toward the goal of making **1000 prosthetics with Printridi and FabCare.**

1

local crab fishing community will have more agency over their energy consumption and generation as a proof of concept enabled by the efforts of Balon Balon Ijo, the **Floating hydrogen pods with Cesar Jung-Harada** to scale the solution in other parts of the region.

Measuing the impact of the 150+ recharge wells and mapping the water table will enable better water management of Bali's freshwater table with the ingenious solution by the team of **Water for Life with IDEP Foundation.**

New approaches and possibilities opened up in designing joineries with the local craftspeople to aid bamboo constructions through the **Making connections with BambooU** challenge.

GLOBAL IMPACT

For the participants that travelled from around the world to Bali and contributed to the hands-on multi-stakeholder challenges, it was an opportunity to engage with a global network and experts in diverse fields, from construction to eco-activism, with a shared purpose. It was the beginning of new collaborations that led to the creation of meaningful and long-term knowledge, products or projects replicable in other regions and cities. This format of global collaboration also highlighted that problem-solving does not always require targeted solutions. Often starting the conversation can be enough to catalyse impactful change. In these reciprocal conversations, participants understood Bali's rich culture and its fundamental philosophy of living. The local community inspired participants to rethink how they work and how they go about their daily lives to become more sustainably aware. For some, the challenge provided insight into the magnitude of global issues, often perpetuated by the global north. They realised that it is imperative to take action now, and the way to do this is together. Local initiatives proved that sometimes simple steps can be very effective to solve issues in particular contexts, where high-tech solutions might not be practical.

The Fab Island Challenge has been an inspiring event that aligned many diverse minds towards a common positive outlook for the future. One where regenerative and reselient economies make for a planet where people and their environments can live in harmony and where social inclusion provides equity. The Fab Island Challenge has been a ten-day accelerator of change to showcase the impact of effective global collaboration focused on local contexts, combined with a shared purpose.

Alvaro Cassinelli - *"You meet so many different people, and so much different work. Life here is something else. You need purpose, and the challenge gives purpose. You discover other lives through the challenge. I don't know many places where you can have this exchange. The Fab Island Challenge is fantastic!"*

END NOTES / FAB CITY CHALLENGES IN THE FUTURE

Fab City Foundation has captured the Fab Island Challenge experiences in a documentary that will complement the two challenges that we have previously been involved in: Plastic for Good Challenge and Made Again Challenge.

Fab City Foundation is ensuring the documentation of the methodology to ensure the future replication of the Fab City Challenge format in different contexts worldwide. To inquire more about the challenge format or express interest in hosting a Fab City Challenge in your locality, please reach out to **challenge@fab.city**

The Fab Island Challenge at Bali Fab Fest was organised by the Fab City Foundation with, and gathered support from many international and local collaborators including -

Meaningful Design Group · The Center for Bits and Atoms · fabfoundation · Distributed Design · Co-funded by the Creative Europe Programme of the European Union · MAKING MEANING · CAST · Helium Foundation

Community Partners

seeed studio · hackster.io AN AVNET COMMUNITY · KOPERNIK · HACKADAY · MAKE · PRECIOUS PLASTIC · BRIN BADAN RISET DAN INOVASI NASIONAL · FAB LAB BCN · brother at your side · PLASTIC CHANGE

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