

NAVIGATING THE CIRCULAR FRONTIER: CURRENT PRACTICES AND FUTURE HORIZONS OF THE CIRCULAR ECONOMY IN THE MALDIVES

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Abstract The Maldives, vulnerable to climate change and combating numerous environmental issues, is geared to moving towards circular economy. This paper examines the key practices and strategies across various sectors and industries. A concurrent mixed method design was used in the study, involving the simultaneous collection of quantitative and qualitative data, separate analysis, and integration during the interpretation phase. A total of 203 participants took part in the online survey and 17 participants were interviewed. As per the quantitative findings, at organisational level, the current practices with the highest mean score were resource repairing and sharing across departments. The national level findings revealed that the highest mean score was for implementation of Single-Use-Plastics. The qualitative findings identified five themes for current practices and future directions, respectively. In addition, the proposed model will serve as a guide for implementing the circular economy in the Maldives, in a holistic manner.

Keywords circular economy . circular economy model . sustainable development . sustainable growth . Maldives
JEL Q53. Q58

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findings, at organisational level, the current practices with the highest mean score were resource repairing and sharing across departments. The national level findings revealed that the highest mean score was for implementation of Single-Use-Plastics. The qualitative findings identified five themes for current practices and future directions, respectively. In addition, the proposed model will serve as a guide for implementing the circular economy in the Maldives, in a holistic manner.

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1 Introduction

As societies grapple with the urgent need to address environmental degradation, resource depletion and climate change, the concept of circular economy has gained significant attraction in recent years. At its core, the circular economy represents a paradigm shift—a departure from the linear "take-make-dispose" model towards a regenerative and restorative approach to economic activity. By designing out waste and pollution, keeping products and materials in use, and regenerating natural systems, the circular economy offers a viable pathway towards sustainability and resilience. The Maldives, vulnerable to climate change and combating numerous environmental issues, is geared to moving towards a circular economy. This is evident from the National Solid Waste Management (SWM) policy, formulated by the Ministry of Environment, Climate Change and Technology of the Maldives. The goal of the policy is to facilitate and encourage the earnings of waste resources and use the proceeds for waste management on the islands (Ministry of Environment, Climate Change and Technology, 2015). However, challenges like, financial constraints, lack of policies, limited infrastructure, dependency on imports, economic constraints pose as significant hurdles on the path towards a circular economy in Maldives (Mohammed & Kaida, 2024). Nevertheless, it is vital to explore the existing practices in place to make the economy more sustainable. Furthermore, by being aware of these current practices, one will be able to identify strategies for improving the efficacy and efficiency of future practices. Therefore, this paper provides a thorough analysis of the present state and future trajectories of the circular economy in the Maldives. The paper examines key practices and initiatives across various industries. It also explores the diverse array of strategies employed to promote circularity. In addition to examining current practices, the paper explores the future horizons of the circular economy, envisioning the transformative potential of emerging trends and innovations. By studying the present landscape and the emerging trends shaping the circular economy, it aims to provide readers with an understanding of the extent of the circular economy being implemented in the Maldives and the frontier of circularity for sustainable development.

2 Literature Review

Circular economy is defined as an economic model wherein the planning, resourcing and production are designed and managed to maximize the benefits for both the economy and the ecosystem (Murray *et al.*, 2017). The concept of circular economy is modelled through the building of self-sustaining ecosystems through a circular flow of energy and resources (Brown, 2018; Brendzel-Skowera, 2021; Mohammed & Kaida, 2024).

2.1 Circular economy practices

In many countries, initiatives related to waste management practices are widely implemented to transition towards a circular economy (Khan & Haleem, 2021; Andriamahefazafy *et al.*,

2022). For instance, many countries have established valorisation as a circular economy practice of reusing resources. In countries such as Comoros and Madagascar in Africa and Luxembourg and Malta in Europe, valorisation of glass bottles into construction and transforming organic waste into compost and natural pesticides are observed (Bassi & Dias, 2019; Andriamahefazafy *et al.*, 2022). Segregation and recycling of waste is another practice that is becoming increasingly popular in developing nations such as Bangladesh and Malaysia where construction debris is recycled (Ngan *et al.*, 2019; Ahmed *et al.*, 2022). Similarly, minimising waste disposal by selling it to another company is also a practice that is seen in European countries. Statistics show that 55.4% of organisations in Europe have adopted or are about to adopt this practice (Bassi & Dias, 2019).

Environmental education programmes are widely used in countries as initiatives to reduce over consumption of resources and to educate the public. Good examples of such educational programmes are seen from the continent of Africa, where countries such as Seychelles and Mauritius offer large-scale programmes to the public (Andriamahefazafy *et al.*, 2022). Additionally, awareness programmes on circular economy principles for industry employees and the customers are also highlighted as essential by many researchers (Ünal *et al.*, 2019; Khan & Haleem, 2020; Andriamahefazafy *et al.*, 2022). Oktriono *et al.* (2025) study showed that in both country, digitalization has greatly increased waste management efficiency, resource recovery (RR), and carbon footprint reduction.

Natural regeneration is another important practice of circular economy as it enables the restoration of natural resources. African nations are adopting strategies like marine spatial planning (Andriamahefazafy *et al.*, 2022) to protect their natural habitats and to prevent the complete depletion of natural resources from the economy. Similarly, re-planning of water to minimise usage is also a practice that is found in European countries, with adoption rates of this approach exceeding 30% in places like Portugal, Ireland, and Luxembourg (Bassi & Dias, 2019). Furthermore, Europe is also recognized as a region that embraces the use of renewable energy sources and reduces its energy consumption, through the implementation of energy-efficient production procedures in its manufacturing (Bassi & Dias, 2019).

Circular Supplier Chains (CSC) practices in reducing waste and increasing product value is yet another significant practice of circular economy (Ünal *et al.*, 2019; Ewijk & Stegemann, 2023). In CSC's companies collaborate with each other in cheaper sourcing through supplier and production (Mishra *et al.*, 2021). This can result in synergies between different organisations and industries as resources will be circulated within a closed circle, fulfilling the circular economy concept (Brown, 2018; Ünal *et al.*, 2019). These synergies will also lead to an industry symbiosis, where waste is exchanged as a resource between different industries. The oldest and the most famous symbiosis between industries is seen in the Eco-Industrial Park of Kalundborg in Denmark, where businesses exchange energy, water and materials. Similar symbiosis is also common in China (Ewijk & Stegemann, 2023).

Governmental engagement and involvement through policy formulation and framework are highlighted by many researchers as a significant contributor for circular economy transition (Khan & Haleem, 2020; Andriamahefazafy *et al.*, 2022; Antonioli *et al.*, 2022a, Antonioli *et al.*, 2022b). For example, incentivising businesses to transition to circular practices are found in countries such as Mauritius (Andriamahefazafy *et al.*, 2022). However, transformation of the business model to integrate circular economy practices is important for organisations to adopt these circular economic practices (Brendzel-Skowera, 2021; Antonioli *et al.*, 2022b). Hence, in some instances, organisations incorporate circular economy-based business models in their operations (Pollard *et al.*, 2016; Awan & Sroufe, 2022; Ewijk & Stegemann, 2023). For example, in product design, the incorporation

of recycled or biodegradable material is a practice in some industries to emphasise more on the life cycle impacts of a product (Khan & Haleem, 2020; Ewijk & Stegemann, 2023). Another relevant practice is that of reverse logistics, which enables repair, remanufacturing and other R's where the supply chain goes in the opposite direction (Ewijk & Stegemann, 2023).

Despite the growing body of literature in circular economy practices, significant research gaps remain, particularly concerning Small Island Development States (SIDS) like the Maldives. SIDS like the Maldives are absent from circular economy discussions, despite their unique vulnerabilities such as geographic limitations, import dependency and limited industries. For instance, key industries such as tourism and fisheries in Maldives generate significant waste and environmental impact. Yet, industry specific circular economy strategies in tourism or valorization in fisheries are not well-documented in literature. Additionally, there is a lack of studies on the role of awareness and stakeholder collaboration in circular economy adoption in the Maldives. Moreover, while circular economy business models and industrial symbiosis have been explored in larger economies, there is a lack of research on how these models can be adapted to smaller economies with minimal industrial activity. Given these gaps, this study is significant as it addresses the lack of literature in developing a circular economy framework or model specific to a SIDS like the Maldives.

2.2 Circular economy models

One model that is used in circular economy is the practice-based model, where four phases are used to represent an activity-based implementation performed by the organisation in collaboration with multiple partners to transition to circular economy (Cramer, 2020). This model describes the stages in detail and will be useful for organisations thinking of transitioning to a circular economy. However, this model is organisation based and doesn't reflect the external links to other partners or industries. Another similar model is the circular business model canvas by Lewandowski (2016), which is based on the business canvas developed by Osterwalder and Pigneur (2010, as cited in Lewandowski, 2016). This framework supports the process of designing a business model for an organisation transitioning to circular economy but does not show how the principles of circular economy can be directly translated into circular economy (Lewandowski, 2016). Similar, business model was developed by Pieroni et al. (2021), where a circular economy business model innovation was developed for the manufacturing industry. However, this model is also focused on the business model only and guides the organisation to transition to a circular economy.

Likewise, on an industrial level, a new model was developed by Ungerman & Dědková (2020) based on the 3R model and the life cycle assessment model, to determine the efficiency of the circular economy in business practices so that it can be applied in the domestic economy. This model helped to quantify the cost saved by the different operations at the organisational level in depth. However, once again, this model is also focused on the organizational and industry level only and didn't give the detail at a macro level.

The Hammarby model developed by the Municipality of Stockholm is a holistic model of a city in Sweden which details how the water, energy and wastes are reused throughout the city. This city operates its own eco-cycle and outlines how the resources can be recycled to create the circularity while reducing the impact of environmental effects on the city (Iveroth *et al.*, 2013). A similar model is the butterfly diagram of circular economy by MacArthur (2013), which illustrates the continuous flow of materials in the different sectors of an economy. It depicts how the circular economy principle can be generated among different industries within an economy. It is based on the principles of eliminating waste, circulating products and materials and regenerating nature. These two models look at the integration of the circular economy and sustainability of resources from a macro-level.

Although similar practices and models have been established in other countries, Maldives lacks practices or models that can be broadly classified as a circular economy, as the economy is more linear at present. As a small island development state with only two major industries and a dependency on imports, the Maldives offers a unique platform to explore this research interest area. The paper's findings will help to understand how a small island development state like the Maldives can transition from a linear to circular economy, given its unique geographical structure and limited economic opportunities.

3 Materials and Methods

The study employed a concurrent mixed method design, which included gathering quantitative and qualitative data at the same time, analysing each piece separately, and integrating the results during the interpretation stage. It is a helpful technique for obtaining both quantitative and qualitative data and combining the findings to more fully understand a novel event (Creswell & Plano, 2023). This design aided in both qualitatively understanding the problem under investigation and statistically identifying pertinent elements to reach a conclusion. Data for the study's quantitative component were gathered via an online survey form. The primary goal of the quantitative data was to get the required information from a sizable number of participants. Comprehensive semi-structured in-person interviews were conducted for the qualitative component.

Representatives from businesses, non-governmental organizations, and government entities made up the study's target group. Purposive sampling, which comprised two groups, was thus employed to choose the most relevant participants. Specifically, the lower-level administrators and the senior management group. These groups had a total sample size of 203 (N=203), which was chosen by using the Cochran formula to get an ideal sample from the target population of 425. Purposive sampling was used to choose 17 individuals for the qualitative data. The selection of the participants was made based on their minimum of five year's work experience in the sector.

The survey questionnaire was divided into five sections, each of which included participant demographic data. The survey instrument was tested on five representatives from the target population and changes were made to the instrument because of the pilot process. An interview guide was created to get qualitative information. The questions were formulated with reference to the most recent research. Before the primary data collection, the guide was pre-tested, and any necessary improvements were made. Every interview was done at the participants' convenience and lasted approximately thirty to forty-five minutes each. SPSS (version 23) was utilized to analyse the quantitative data, while Atlas.ti 7 was employed to analyse the qualitative data. Thematic analysis, as suggested by Saunders et al. (2023), was used to analyse the data collected from the different participants. Descriptive statistics were used for quantitative data. The study's stated goal was accomplished by comparing the data that would influence the study's conclusions.

Cronbach's Alpha analysis was used to verify the internal consistency of the questionnaire. The result of the categories was between 0.7 and 0.9, proving that the items in specific categories are internally consistent with each other.

Table 1 Cronbach Alpha value for each category on the questionnaire

Categories	Cronbach's Alpha
Challenges- citizen behaviour	0.898
Challenges-regulatory	0.977
Challenges- financial	0.866
Challenges- human resource	0.957
Challenges-infrastructure	0.969

Moreover, the following Likert scale was used to interpret the findings of specific items for category.

Table 2 Scoring range of Likert scale – Circular economy practices

	Value	Range
Don't Know	1	1.00-1.80
Not adopted	2	1.81-2.60
Moderately adopted	3	2.61-3.40
Mostly adopted	4	3.41-4.20
Strongly adopted	5	4.21-5.00

Table 3 Profiles of respondents

Participant Code	Designation	Industry
A	Director General	Tourism
B	Director General	Manufacturing
C	Director General	Manufacturing
D	Manager	Construction and transport
E	Manager	Construction and transport
F	Manager	Construction and housing
G	Manager	Power and energy
H	Manager	Power and energy
I	Managing Director	Recycling
J	Manager	Construction and housing
K	Director	Public service
L	Assistant Director	Public service
M	Project Manager	Waste management
N	Director	Waste management
O	Assistant Manager	Waste management
P	Senior Program Office	Environment
Q	Project Consultant	Environment

Note. The profiles of the participants of the interview from different industries.

4 Results

First, the qualitative findings are presented, followed by the quantitative findings.

4.1 Current practices

4.1.1 Waste management

Waste management services were frequently mentioned by most participants as a current circular economy related practice. At present, the waste management performed by the waste management organisations includes activities such as waste collection from households, waste segregation at the segregation centres in Male' City and Thilafushi island, reselling of reusable items and recycling of household waste to generate fertilisers.

One waste management practice that the waste management organisation takes pride in is the recycling of kitchen waste, to produce fertilisers, referred to as "kaadhu" in Dhivehi.

"One of our centres in Addu City is a very good example of where household waste is turned into fertilisers, which we call as "Kaadhu". In this centre we segregate the kitchen waste and then produce "Kaadhu" which is used by farmers to fertilise their plants" (Participant N, personal communication, December 5, 2023).

Similar composting practices has also been tried on several other islands, but due to the laborious nature of the task, it has not been done sustainably. One participant gave an example of such an initiative.

"UNDP donated glass crushers to a few chosen islands. These were provided to councils, some of the councils to which it was donated have used it to make bricks by recycling glass bottles. However, it is a laborious process, so I am not sure how many of the councils are using it at present" (Participant P, personal communication, January 28, 2024).

Another example of a successful valorisation technique where all garbage is repurposed to generate other goods comes from the fishing sector, where all waste is reduced to near-zero levels.

"The fishing sector sets a very good example for recycling of waste. The food canning factory recycles every piece of waste generated from production of tuna. For example, fish bones are used to manufacture pet food, while fish excrement is used to generate fertiliser" (Participant Q, personal communication, January 28, 2024).

4.1.2 Energy conservation

A few of the participants who were interviewed emphasised on the significance of implementing energy-saving measures in their organisations' daily operations revealing the importance of conserving energy.

"In our organisation, we have installed an energy recovery unit in the water production system. This energy recovery equipment allows us to enhance water output by 30 to roughly 40% while lowering energy consumption and production costs" (Participant P, personal communication, January 28, 2024).

The participants also highlighted the modest usage of solar panels in their organisations as an energy-saving measure.

"We use solar panels at a minimal level, it's more useful and it's working for us. We can consume energy through these solar panels. But the problem is that we do not have space to install solar panels" (Participant G, personal communication, December 17, 2023).

Another organisation that was interviewed was observed to produce water with thermal energy. This organisation has designed two of its power plants to produce water for its building which is consumed daily by their employees. This practice has proven to be an energy-efficient technique for them. This practice allows them to use the output of one process as the input of another, which is a significant practice in the circular economy model.

4.1.3 Sustainable tourism

The tourism industry in the Maldives has increasingly embraced sustainable practices, including eco-friendly resort designs, waste reduction measures, and marine conservation efforts. By promoting responsible tourism practices that minimize environmental impact and support local communities, the sector contributes to the preservation of natural resources and ecosystems, in line with circular economy principles.

“There are eco-friendly and green resorts in Maldives. They have energy conservation and sustainable practices built in their design and their operations. There are also resorts that are doing marine conservation of turtles and other marine life. We can see such eco-responsible tourism practices in our resorts tourism industry” (Participant A, personal communication, December 5, 2023).

Moreover, as per the tourism ministry, they have established policies and guidelines which promote sustainable practices in the resorts. In addition, they believe these could even be rolled out for local tourism implemented at the inhabited islands of Maldives which will promote waste management and sustainability at the island level.

4.1.4 Community-Led initiatives

Some participants mentioned community level initiatives at the island level that fall under the category of circular economy practices. These initiatives include neighbourhood recycling programs or recycling carried out by non-governmental organisations (NGO), upcycling workshops, and community gardens that encourage resource sharing, waste reduction, and sustainable living practices at the grassroots level. Such community-led initiatives play a crucial role in advancing circular economy practices in the Maldives by opening doors for locals to foster sustainable practices at the island level.

“There are a few NGOs’ who promote recycling in Maldives. One such organisation is the Parley which collects used plastic bottles to send for recycling abroad. There are also women-led small organisations at the island level that carry small recyclable work in the community such as making ornaments from scrap like coconuts and other such materials” (Participant I, personal communication, December 23, 2023).

These current practices demonstrate the Maldives' commitment to advancing circular economy principles and highlight opportunities for further integration and expansion of such initiatives across different sectors of the economy.

4.2 Future directions

4.2.1 Circular economic policies and regulations

All the participants of the interview agreed that circular economy policies and regulations need to be implemented at the national level for the Maldives. Even though the government of Maldives gives emphasis to environmental and sustainability goals, these are not reflected from the practices established at the government organisations.

“We need country specific, relatable circular economy policies and regulations for the Maldives. This is the most important thing we need to do at the national level before proceeding with investment or projects” (Participant F, personal communication, December 11, 2023).

Additionally, the significance of enacting a policy or legislation to provide incentives to companies using circular economy practices were emphasized by the participants. They strongly believed that such subsidiaries or incentives will encourage organisations to switch to a circular economy model.

“It is very important for the government to incentivise the organisations that practice such circular economy practices. This will motivate them and inspire more and more to implement such practices within their business operations. I strongly believe that the

government should implement such a policy or regulation, perhaps through tax or some other form of subsidiary” (Participant G, personal communication, December 17, 2023).

4.2.2 Collaboration and symbiosis within industries

Collaboration and symbiosis within industries and organisations was a significant practice mentioned by some of the participants. According to participants from the interview, it is possible to establish an industry level symbiosis whereby resource flow is arranged so that waste from one organisation is utilized as an input by another organisation.

“I believe to go for a circular economy, symbiosis is very important. We need to identify the waste collected and then interconnect it with the demand. We need to find a mechanism for establishing it “(Participant Q, personal communication, January 28, 2024).

Such symbiosis relationship can create many benefits for a small economy like Maldives where the resources can be utilised within the closed loop, one significant characteristic of a circular economy concept.

A symbiosis was also said to be able to foster industry collaborations and open opportunities for the establishment of a Circular Design and Innovation Hub in the Maldives.

“We can create a circular economy hub in Hulhumale’ industrial zone or the central zone in the Greater Male’ area. This hub can facilitate circular economy principles and offer innovative solutions to implement such practices at industry level and further down the lane, perhaps at the national level” (Participant Q, personal communication, January 28, 2024).

4.2.3 Circular Economy Education and Training Programs

All participants agreed on the necessity of creating awareness amongst the public about waste management, sustainability, and renewable energy practices. By empowering individuals with the knowledge and skills to embrace circularity, the Maldives can drive innovation, entrepreneurship, and sustainable development across all sectors of the economy.

“We need to integrate such principles and values into our curriculum too. If we can instil these values, students will become more environmentally aware citizens. We always say we need to condition people to realise how important it is to manage waste properly, but people would not realise the amount of work that is put into management of waste as they don’t directly experience it or hear about it” (Participant O, personal communication, January 15, 2024).

4.2.4 5R practices (Reuse, Redistribute, Refurbish, Remanufacture and Recycle)

Most participants suggested the effective usage of 5R practices within organisations and industries. For example, some participants emphasised on the growth of the concept of Thrift or Tuck stores, where reusable objects such as electronics and furniture may be resold at a lower cost. This application of Reuse can assist to Reduce the amount of waste created each day in the Maldives. Additionally, this might help businesses generate income and open new markets in the industry, aiding the growth of SMEs.

“I believe composting can be a profitable business in Maldives. We need to provide the interested parties with the necessary training, equipment and materials. Also, we need to create a market for it as well. People are currently using imported fertilisers, so I believe composting can be a successful circular economic model that can be practiced in the agricultural and farming industry” (Participant P, personal communication, January 28, 2024).

According to construction industry participants' interviews, similar Reuse and Recycle practices may be used in the building and construction industry. The construction debris may be repurposed for future use. For example, the waste generated by the demolition of an old building can be reused to make bricks. They did, however, highlight the current shortage of infrastructure and machineries needed to convert building debris into useful material.

“The construction sector is booming in Maldives, but the debris that is generated is not reused or recycled. But this is something that we can do if we have the necessary resources such as machinery for turning this debris to recycled construction materials. This is something we can practice in Maldives in order to reuse and recycle the waste generated from the construction industry” (Participant D, personal communication, December 7, 2023).

4.2.5 Energy conservation

Many participants advised the deployment of large-scale solar panel installations in Maldives, as this represents a viable energy source for the country. A participant suggested using solar panels that have been customised rather than the generic one used on a large scale to overcome the land scarcity issue in Maldives. One such example was brought up from the European context, where the solar panel’s efficiency was by its satellite-bowl-like design.

“While I travelled to Europe, I saw a very good example of a solar panel that was designed as a satellite bowl and kept on the roof of a building. In Maldives, we always talk about the lack of space for installing solar panels. I believe such a customised solar panel will be very ideal for Maldives” (Participant I, personal communication, December 23, 2023).

Moreover, other participants suggested the option of placing floating solar panels on the sea. The Maldives can make excellent use of solar energy in this way as well. In addition, some participants suggested that renewable energy may be produced by harnessing the ocean current. However, the participants agree that adequate research is necessary before such practices are embraced.

“I believe that ocean current or wave current can be used. We need to research ways of how this can be used. There’s not much research done on this because the developed countries do not have the ocean, so they do not pay much attention to this. But for a country like Maldives, we are surrounded by the ocean, the sea. Hence, it would be advantageous for us if we find ways to use ocean current or waves to convert them to renewable energy” (Participant I, personal communication, December 23, 2023).

These future practices offer promising opportunities for advancing the development of a circular economy model in the Maldives, contributing to environmental protection, economic prosperity, and social well-being in the country.

4.3 Quantitative findings

Table 4 The demographic analysis of the participants of the survey

Items		Frequency	Percentage
Gender	Male	135	66.5%
	Female	68	33.5%
Type of organisation	Government	172	84.7%
	Private	31	15.3%
Years of experience	0-5 years	44	21.6%
	6-10 years	85	41.9%
	11-15 years	55	27.2%
	Over 16 years	19	9.3%
Highest level of qualification	Certificate	1	0.5%
	O’Level	4	1.9%
	A’Level	14	6.89%

	Diploma	41	20.2%
	Degree	77	37.9%
	Masters	65	32.2%
	PhD	1	0.5%
Level of position in the organisation	Administrative/Operational level	67	33%
	Middle management level	100	49.3%
	Senior management level	36	17.7%

Analysis of the demographic data shows that out of the 203 respondents who completed the questionnaire, 135 (66.5%) were males and 68 (33.5%) were females. Out of the 203 respondents, 172 (84.7%) worked in the government sector while 31 (15.3%) of them worked in the private sector. Additionally, of the 203 respondents, 100 (49.3%) held middle management positions, 67 (33%) held administrative/operational positions and 36 (17.7%) held senior management positions.

Table 5 Responses on circular economy practices in organizations -Organizational level

Items	DK	NA	MDRA	MA	CA	Mean	Standard Deviation	Interpretation
My organisation has implemented efficiency through lighting system	28	46	107	16	6	2.64	.920	Moderately adopted
My organisation practices Reusing of resources	1	13	165	22	2	3.05	.479	Moderately adopted
My organisation practices Repairing of resources	2	8	161	23	9	3.14	.592	Moderately adopted
My organisation practices Sharing of resources across units/departments/branches	3	6	160	27	7	3.14	.584	Moderately adopted

Note. N=203, DK=Don't Know, NA=Not Adopted, MDRA=Moderately Adopted, MA=Mostly Adopted, CA=Completely Adopted.

As per the interpretation, all the mean scores fall within 2.61-3.40 meaning that all the practices are moderately adopted as per the respondents. In addition, the highest mean (3.14)

was for practices such as repair of resources and sharing of resources across departments, while the lowest mean (2.16) was for the practice of implementing separated waste collection systems in organisations’, indicating that this practice is not common in organisations.

Table 6 Responses on circular economy practices in organizations –Human resources

Items	DK	NA	MDRA	MA	CA	Mean	Standard Deviation	Interpretation
My organisation has implemented training programmes on CE	34	110	46	8	5	2.21	.856	Not adopted
My organisation has allocated a person in charge of managing sustainability of CE	37	117	32	12	5	2.17	.880	Not adopted
My organisation has established guidelines for staff to adopt a common circular use and management of resources	11	25	142	18	7	2.93	.751	Moderately adopted
My organisation has installed signs and instruction posts for staff to ensure the correct circular use and management of resources	8	42	133	16	4	2.83	.705	Moderately adopted

Note. N=203, DK=Don’t Know, NA=Not Adopted, MDRA=Moderately Adopted, MA=Mostly Adopted, CA=Completely Adopted.

In this category, two items show a mean score of moderately adopted, and the other two shows a mean score of not adopted. The practices that fall within not adopted are implementation of circular economy related training programs and having a representative for circular economy management, indicating that human resource development in this area is currently not given significant attention.

Table 7 Responses on circular economy practices in Regulations-National level

Items	DK	NA	MDRA	MA	CA	Mean	Standard Deviation	Interpretation
My nation has implemented a law or regulation to promote CE	17	16	128	41	1	2.97	.798	Moderately adopted
My nation has an accountable authority or organisation on CE	18	15	125	42	3	2.99	.835	Moderately adopted
My nation has established infrastructure support for CE	21	22	123	36	1	2.87	.840	Moderately adopted
My nation has allocated funds for CE	39	13	110	40	1	2.76	.998	Moderately adopted
My nation has implemented education campaign on CE	19	12	130	42	0	2.96	0.81	Moderately adopted

Note. N=203, DK=Don't Know, NA=Not Adopted, MDRA=Moderately Adopted, MA=Mostly Adopted, CA=Completely Adopted.

As per the interpretation, all the mean scores fall within 2.61-3.40 meaning that all the practices are moderately adopted as per the respondents.

Table 8 Responses on circular economy practices in Sustainability-National level

Items	DK	NA	MDRA	MA	CA	Mean	Standard Deviation	Interpretation
My nation has implemented the promotion of the use of sustainable	7	6	143	46	1	3.14	.630	Moderately adopted

energy and materials								
My nation has implemented the promotion of alternatives to Single-Use-Plastic	3	4	105	88	3	3.41	.634	Mostly adopted
My nation has installed solar panels	4	3	110	81	5	3.39	.662	Moderately adopted
My nation has implemented the promotion of private sector engagement for CE innovation	23	29	114	37	0	2.81	.864	Moderately adopted

Note. N=203, DK=Don't Know, NA=Not Adopted, MDRA=Moderately Adopted, MA=Mostly Adopted, CA=Completely Adopted.

In this category, four items show a mean score of moderately adopted, and the other two shows a mean score of not adopted. In addition, it is interesting to note that the highest mean score (3.41) was received for the practice of using Single-Use-Plastic (SUP) reflecting the respondents' level of awareness regarding the implementation of SUP policy in Maldives on the import of certain plastic items.

Table 9 Responses on Waste management practices -National level

Items	DK	NA	MDRA	MA	CA	Mean	Standard Deviation	Interpretation
My nation has implemented an effective waste collection system	3	9	143	46	2	3.17	.584	Moderately adopted
My nation has implemented collection and storing of recyclable materials	2	10	142	48	1	3.18	.561	Moderately adopted

My nation has implemented a waste segregation and recycling mechanism	2	12	136	51	2	3.19	.595	Moderately adopted
My nation has implemented an organic waste management system	5	21	131	44	2	3.08	.673	Moderately adopted
My nation has implemented a system of landfill disposal and operations	4	5	137	54	3	3.23	.614	Moderately adopted

Note. N=203, DK=Don't Know, NA=Not Adopted, MDRA=Moderately Adopted, MA=Mostly Adopted, CA=Completely Adopted.

As per the interpretation, all the mean scores fall within 2.61-3.40 meaning that all the practices are moderately adopted as per the respondents. The highest mean score (3.23) was received by the item for having a system of landfill disposal operations, indicating that many respondents believe that the current landfill disposal operation is good.

5 Discussion

5.1 The current practices

The current practices that were identified in the study were both organisational level practices and national level practices. The findings of the questionnaire showed that resource sharing among departments and resource repair were the two most common organisational level practices, with mean scores of 3.14 for both, respectively. Other practices were observed to have a lower score, suggesting the lack of circular economy related practices within organisations. Also, practices such as implementation of training programmes related to circular economy had a low mean score of 2.21, suggesting that it is not adopted within the organisation. This finding emphasises on the significant need of such education and training programmes in Maldives.

The most prominent practices that were highlighted by the participants at the national level were the promotion of the Single-Use-Plastics (SUP) with a mean score of 3.41 and the installation of solar panels with a mean score of 3.39. Installation of solar panels at a modest level was also identified by the interviewed participants. It is believed that these two practices might have received better scores than others due to their recent media coverage. The government banned the use of SUP on 1st June 2022, as per the Environment Protection and Preservation Act 4/93 (Ministry of Climate Change, Environment and Energy, 2022) and through the World Bank project "Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE), Maldives has started implementing solar panels between Huhumale' and

Male' link road through the SinaMale' bridge since early 2022 (Maldives Financial Review, 2022).

Another national level practice that was highlighted by the participants was the waste management practices in Maldives. Interestingly all the waste management practices received a mean score higher than 3.0 and were interpreted as moderately adopted. Even from the interview, participants noted that waste management practices such as segregation of waste is gradually improving in Maldives with practices such as reselling of waste, recycling food wastes as fertilisers and valorisation of fish waste practised at a modest level. Similar practices were found in relevant literature where the waste was recycled in developing countries such as Bangladesh and Malaysia, however in large scale (Ngan *et al.*, 2019; Ahmed *et al.*, 2022) while compared to Maldives, which is still at its infancy stage.

Participants also mentioned a few sustainable initiatives currently observed in the tourism industry, such as eco-friendly resorts and marine conservation. This is particularly significant for the Maldives, a nation whose tourism industry contributes the most to its GDP, with the industry accounting for 22.4% of the total GDP in 2022 (Maldives Bureau of Statistics, 2023). Similar marine conservation practices in the tourism and marine industry were identified in African nations where conservation of marine resources such as spatial planning and implementation of self-renewal practice were found to be implemented (Andriamahefazafy *et al.*, 2022). These techniques can also be applied in a nation like the Maldives.

A significant finding from this study was community-led practices at the island level. Small-scale recycling programs and community gardening projects were among the measures that were emphasised at the island level for sustainability. Since the Maldives is a small island state, it lacks both human and material resources. Thus, these small-scale initiatives in agriculture and production can create resilience and sustainability at the island level, which at a larger scale can benefit the economy in the long run.

5.2 Future directions

Industry collaboration and symbiosis is a significant future practice recommended by the participants. One participant proposed the creation of a Circular Design and Innovation Hub in Hulhumale', the Greater Male' region's centre. This kind of symbiosis can assist in the development of a closed-loop system that allows resources to be shared across the economy and converts one organisation's output into another's input. Such excellent practices were observed in the European Union, where 55.4% of organisations use their waste as an input to form closed resource loops with other organisations (Bassi & Dias, 2019).

However, the establishment of effective laws and regulations can make this kind of collaboration feasible, particularly in a nation lacking in such laws like the Maldives. For this reason, most participants recommended national objectives and policies to be aligned with circular economy models and practices. Additionally, it's critical to provide incentives for such a shift to motivate organisations. This is consistent with the reviewed research (Khan & Haleem, 2020; Andriamahefazafy *et al.*, 2022; Antonioli *et al.*, 2022a, Antonioli *et al.*, 2022b) that highlights the significance of government involvement and policy formulation for the circular economy.

Implementing nationwide programs for education and understanding of the circular economy is another significant practice recommended by the interviewed participants. According to the questionnaire, "my nation has implemented educational programs on circular economy" achieved a mean score of 2.89, which is interpreted as lowly adopted. This highlights the significance of putting these programs into action. This corresponds with findings from

previous literature (Ünal *et al.*, 2019; Khan & Haleem, 2020; Andriamahefazafy *et al.*, 2022) that highlights the importance of creating awareness amongst the public on circular economy.

Participants have also highlighted 5R and energy conservation practices that can be implemented in Maldives. The amount of household waste thrown away every day was brought up by participants from the waste management industry. For instance, there were wastes that can be reused through the valorisation process which include glass bottles and kitchen waste. Comparable practices have been noted in literature in Asian countries like Indonesia, Thailand, and India which have similar industries as Maldives (Sarker *et al.*, 2022). Likewise, in nations like Comoros and Madagascar in Africa and Luxembourg and Malta in Europe, valorisation of glass bottles and composting has been suggested as beneficial (Bassi & Dias, 2019; Andriamahefazafy *et al.*, 2022), indicating the possibility of bringing such practices to the Maldives as well.

The Maldives has a high import rate, rising from 35.4% in 2021 to 40.3% in 2022 (Maldives Bureau of Statistics, 2023), indicating the nation's heavy reliance on imports from other nations. Therefore, the adoption of the 5R is considered a crucial practice in the Maldives to address the problems related to waste management and reliance on imports. With just two main industries, Maldives needs to develop the manufacturing and production infrastructure in 5R to increase its sustainability and resilience. For instance, reverse logistics is a practice that can be implemented, given that the findings from the questionnaire indicates that there is potential for repair of materials in Maldives. Reverse logistics allows for repair, remanufacturing, and other R's when the supply chain moves in the opposite direction (Ewijik & Stegemann, 2023). Moreover, the government can promote local agriculture and fisheries in the Maldives to contribute to circular economy practices by reducing reliance on imported food products and supporting sustainable food production systems.

5.3 Model of circular economy

Data was widely collected from the different sectors of the Maldives including the waste management, power and energy, construction and development, water and sewerage management, environment and sustainability, public service and tourism. Based on the findings from the current and future practices, the following model is suggested for Maldives to transition into a circular economy. The model emphasises on the formation of a symbiotic relationship between the different industries where the output of one industry can be used as an input of the other industry, creating a closed loop of economy. The model is based loosely on the Hammarby model suggested by Iweworth *et al.*, (2013) through the incorporation of the current and future directions suggested by the participants of this research study.

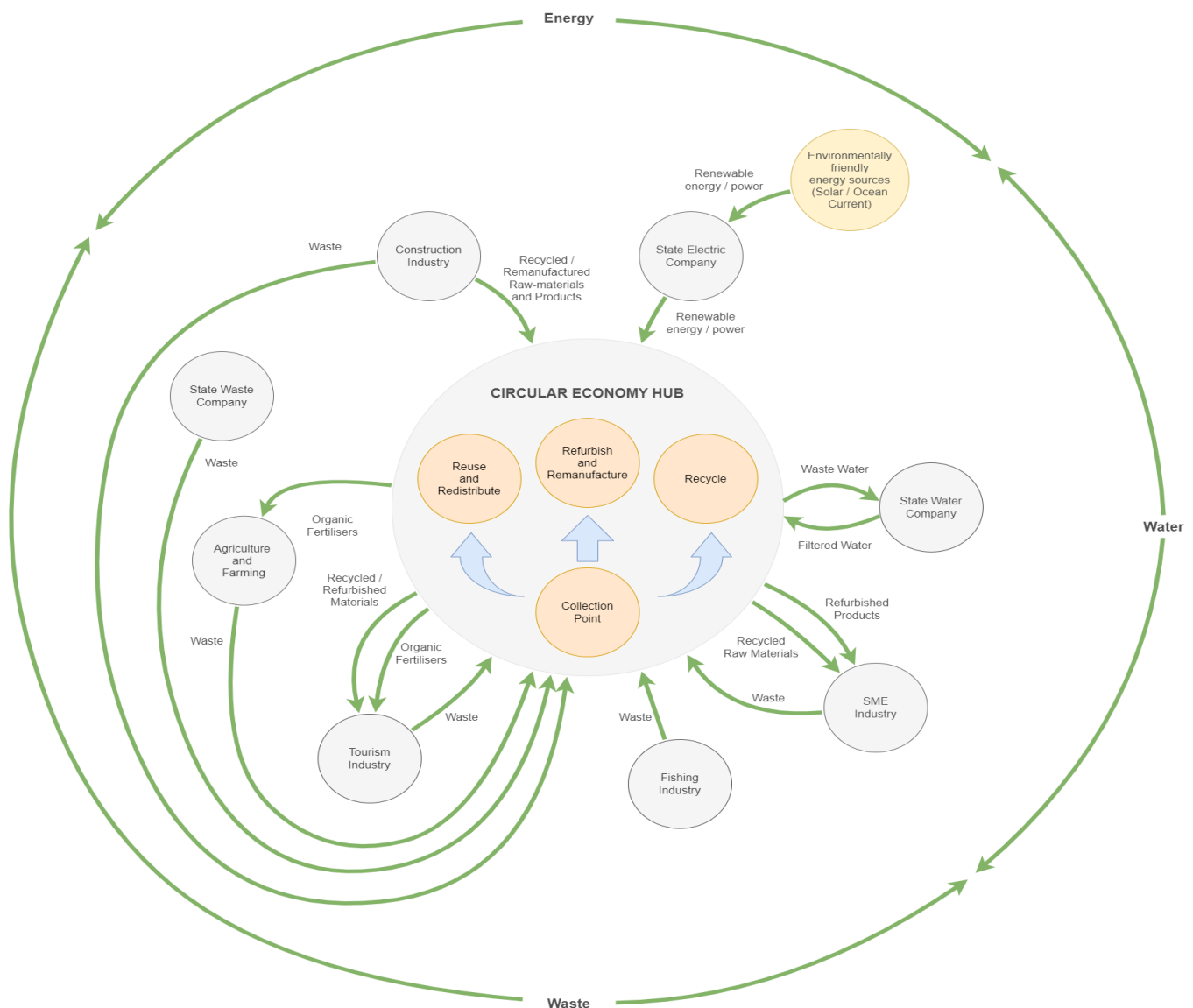


Fig. 1 Model of circular economy for Maldives

The primary objective of the model is to establish a resilient and sustainable economy by decreasing waste and producing renewable resources via the drive of various stakeholders at a national level.

The hub for the circular economy, which is the central point of the model, is made up of the 5R process and can be created in the central Hulhumale' area, a part of the Greater Male' region. This hub can be a government-created renewable industry, or it could be a collaborative effort amongst numerous SME's carrying out the 5R processes, operating under strong waste management policies and regulations.

The rest of the model explains how the different industries in Maldives such as tourism, fisheries, agriculture, construction, waste management, energy and power, water management and SMEs can be incorporated in the model. The model places a strong emphasis on maximising the few resources available in the Maldives, reducing leaks within the loop, and circulating the resource inside a closed loop in an efficient mechanism.

6 Conclusion

Overall, the study's findings contribute to the extant literature on circular economy practices that can be implemented in a nation transitioning from a linear to circular economy. In particular, to the practices that a small island development state such as Maldives with just two main industries can implement to transition to a circular economy.

The findings of the study show the importance of introducing related policies and regulations at the national and organisational level for an effective transition. Maldives being a country at risk of climate change, the nation should incorporate environmental and sustainability criteria into policies that emphasise on recycled content and product durability. Similarly, community-led initiatives should be empowered to conserve natural resources, enhance food security, and promote economic resilience at the local level. However, to promote sustainability and circular economy practices it is necessary to educate the relevant stakeholders and the public.

Furthermore, collaboration and symbiosis identified from this study will lead to the development of industries and enhance the economy. The model suggested by the research explains how a circular economy hub can create the closed-loop economy at a national level, especially in the Greater Male' region of the nation where one third of the population resides. With the aid of this model, the government will be able to create policies and implement regulations that will facilitate the country's resource circulation within a closed loop, minimising leaks and optimising the scarce resources at its disposal. Over time, this strategy can assist the nation in developing a renewable industry, enhancing the economy's resilience and sustainability.

Future research could explore industry-specific circular economy practices in key industries like fishing, tourism and agriculture in the Maldives, while assessing the socio-economic impact of these initiatives on small island communities. In addition, comparative studies with other SIDS could provide a deeper insight into successful circular economy transitions.

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