



Emerging Challenges for Cleaner Production Networks – The decline of the Global Resource Efficient and Cleaner Production Network (RECP_{net})

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Abstract

Cleaner production has been channelled through National Cleaner Production Centres (NCPCs) across the world since the year 1994. In order to strengthen the scaling up and replication of Resource Efficient and Cleaner Production (RECP) in developing and transition countries, the Global Resource Efficient and Cleaner Production Network (RECP_{net}) was formed as a platform for networking, knowledge exchange and information transfer. However, the success of such networks can become short-lived if there is no funding strategy beyond project financing and if individual network members fail to take ownership of the network. This research assesses the role of the Global RECP_{net} in promoting cleaner production and analyses the challenges that the network faced in ensuring its continuity beyond project finance. The research further identifies barriers in the advancement of the Global RECP_{net} and its goals. A Case Study methodology was used and within the case study, interviews were undertaken with key industry experts in the field of Resource Efficient and Cleaner Production (RECP). Questionnaires were also sent to selected members of the network. Content analysis was undertaken on publicly available Global RECP_{net} documents and evaluation reports. We conclude that networks such as Global RECP_{net} are effective drivers of cleaner production, but require a plan for network survival beyond patron agencies. However, without patron agencies and international funders, the network proved not to be viable, as most of the members could not finance their own subscriptions. We propose for a hybrid mechanism of network financing and dealing with dependencies on development support.

Keywords Networks · Circular Economy · Resource Efficient and Cleaner Production (RECP) · Collaboration

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Introduction

Towards Resource Efficient and Cleaner Production (RECP) in Developing and Transition Countries

Humanity stands at the cusp of destruction, if there is no comprehensive transformation in the consumption and production patterns and reduction in the environmental impact of anthropogenic activities [6]. Sustainable practices are urgent in ameliorating the variety of environmental problems affecting the world [12]. Various parts of the world are grappling with a plethora of problems that affect the ability of the environment to regenerate [9]. Increased extraction of resources for human consumption and the increasing needs of society, continue to cause scars on the ecological haven of humanity. One of the last gateways of salvaging humanity is through preventing pollution and implementing pro-active approaches such as Resource Efficient and Cleaner Production (RECP). Implementing cleaner production in project based formats, may not yield sustainable outcomes with regard to the widespread adoption of cleaner production, if we do not move beyond projects [2].

Preventing pollution has been a burden in developing and transition countries for many years. Whilst traditional end-of-pipe systems were favourable, it is increasingly becoming clear that proactive approaches are more effective [2, 31]. Cleaner Production is defined as the continuous application of a preventive approach to processes, products and services, so as to improve overall efficiency and reduce the risk to human health and the environment [2].

The world population is currently above 7 billion people as at the year 2023 and it is projected to exceed 9 billion people by the year 2050. Rapid changes in the production and consumption patterns are necessary, if we are to ensure human survival amidst an unprecedented environmental crisis and population growth. Policies and regulations for promoting cleaner production have been promulgated in different parts of the world to try and deal with the threat posed by environmental pollution. Shifting the mind-set of organisations from an end-of-pipe treatment philosophy, is an imperative that is needed in the quest to attain a circular economy.

Networks are considered as channels of dissemination of cleaner production knowledge and technical capacity in developing and transition countries [12]. Through multiple-actor cooperation, cleaner production can be disseminated and transferred from one organisation to another. Networking for cleaner production is a recent phenomenon at global level, although some other forms of collaboration had existed in the form of guilds of merchants, weavers and other trades [8]. Whilst these forms of association existed, they did not have a deliberate focus on cleaner production networking. Given this background, the formation of cleaner production and circular economy networks has gained momentum in different parts of the world [20]. Although cleaner production can be promoted through government intervention, awareness and technology transfer, there is need for collaboration in order to facilitate joint problem solving and agenda setting for industry.

The urgency of cleaner production networks in developing and transition countries is higher, due to the fact that they are more vulnerable to the effects of environmental challenges such as climate change and the fluctuating weather conditions. Climate change has been on the rise and results in negative impacts on society [23]. High level dependency on natural resource extraction in developing and transition countries, makes cleaner production more imperative. Whilst the assessment and research of cleaner production networks has been restricted in developed countries, there is little independent research on cleaner

production networks in developing and transition countries. Networks help to improve innovative capabilities of organisations [12, 32, 33, 35]. The orientation, governance and continuity of networks beyond donor financing remain key issues determining the success or failure of networks. In the absence of networks, it is very difficult to transfer knowledge amongst organisations and facilitate scaling up and replication of cleaner production. Hart [13] proposes that organisations need tacit knowledge in order for them to adopt sustainable development. This knowledge can be gained through networking and inter-organisational collaboration [21].

Inter-organisational collaboration has been studied in multiple country contexts [12, 19]. It can either be through networks which are geographically associated with each other in the case of industrial clusters, or else in geographically dispersed environments such as networking at a global level [16–19]. The emergence of the Covid-19 pandemic, also facilitated more proliferation of global networks, including those that network in a virtual space without physical relations. Despite these essential realities, little research exists on cleaner production networks as well as their success and failure. Most research is restricted to mid-term and terminal evaluations at project level. Wider research on a global and national scale is essential to understand the differences between idiosyncratic and networked organisations, as well as determinants that favour success or demise of these networks.

Formation of Global RECPnet

The Global Resource Efficient and Cleaner Production Network (RECPnet) was formed to bring together organisations with a focus on cleaner production. Under the guidance of the United Nations Industrial Development Organisation (UNIDO) and United Nations Environment Programme, the Global UNIDO-UN Environment; the Resource Efficient and Cleaner Production (RECP) Programme for Developing and Transition Countries was formed [25]. Within this programme, a networking component that sought to establish the Global Resource Efficient and Cleaner Production Network also known as the Global RECPnet was formed [27, 28].

Implementation of Resource Efficient and Cleaner Production is a mechanism meant to deal with the end of pipe treatment technologies affecting many developing and transition countries. Cleaner production attains a Circular Economy (CE), through raw material substitution, on-site re-use and recycling, good housekeeping, process modification, and product modification. Due to the burgeoning crisis of climate change, preventive approaches have become useful in facilitating a CE transition.

The Global RECPnet was officially established in 2010 and it was institutionalised through the Nairobi Declaration and was anchored on a Charter that explained its modalities of existence [25]. The network was formed with three categories of members including *Regular Members*, *Associate Members* and *Observer Members* [26]. Initially the network was comprised of 41 members drawn from different stakeholders such as National Cleaner Production Centres (NCPCs), research centres and other RECP service providers.

Whilst it was envisaged that the RECPnet would grow, it eventually did not grow as expected due to a number of challenges [27, 28]. Networking at a global level also meant that organisations that were networking had to do so from a geographical divide of Regional Chapters. Despite the failure to exponentially grow, there has been no research undertaken on the network in order to understand what affected its continuity, apart from terminal evaluation that was undertaken at the conclusion of the Global Resource Efficient and Cleaner Production Project. The independent evaluation cited challenges related to the

sustainability of the RECPnet. However, there is need to have a deeper understanding of which the network failed to attain sustainability. It is against this background that there is need to assess the factors that affect network success and continuity. In general, it is also essential to clearly understand the role of networks in promoting a Circular Economy and identify barriers that affect network growth as well as identify strategies of scaling up network activities.

Eventual Demise of the Global RECPnet

Despite undertaking a wide range of activities, global workshops and training initiatives; the Global RECPnet eventually ceased physical activities in 2018. This was at the conclusion of the main RECP project that was implemented by UNIDO. Whilst the RECPnet was said to be succeeded by consequent Eco-Industrial Parks projects, the vibrancy and active participation of members of the RECPnet withered after the end of the project financing.

Anchoring networking activities of cleaner production networks on project donor funding resulted in dependency syndrome for the members of the RECPnet such that members failed to carry it forward beyond the financing from development partners. According to researchers in the area of networks, without a funding strategy, networks struggle to be sustainable [3, 14]. It is essential to assess the circumstances that resulted in the lagging behind of the RECPnet especially after the finalisation of UNIDO funded projects.

Despite having a unique value proposition and starting with a bullish 41 members, the RECPnet ended with 70 members at the time of demise and failed to grow itself to the stage of sustainability and self-sustenance, despite the early promising network growth. Notwithstanding the growing number of members, some of the members could not take responsibility of ownership through regular payment of subscriptions. As at the year 2016 almost 50% of RECPnet members were in default of network membership fees [27, 28]. The lack of full payment of subscriptions is a challenges documented in literature [27, 28].

Whilst networks, are formed in different parts of the world, it is not all of them that manage to survive many years beyond their formation [20]. Some barriers such as financing, lack of participation and ownership by members, ineffective recruitment strategies all have an effect on the eventual success of the networks. Some challenges of networks may emanate from diverging priorities amongst members [24, 34]. Managing networks housed within international organisations that finance them, may not always be an effective way of network administration as the delegated responsibilities may be deployed elsewhere as soon as programme financing diminishes. Although the Global RECPnet is still “*in principle*” in existence, it is considered as less active in 2023, in comparison to its peak years of 2010 to 2018. This reality, provides the foundation of undertaking this research to seek a clear understanding of why networks may be subdued outside project or programme support. Networks are under researched across the world and there is limited information on their function and changes that result from participation in networks [21].

Research Focus

This research specifically assesses the role of network participation on implementation of Resource Efficient and Cleaner Production (RECP) with a particular focus on the Global Resource Efficient and Cleaner Production Network (Global RECPnet). In particular, the research assesses the following questions:

- i. What is the role of networks in promoting cleaner production?
- ii. What factors led to the decline of the Global RECP_{net}?
- iii. What role did development partners play in the success or failure of the RECP_{net}?
- iv. Which barriers did the global RECP_{net} face in scaling up its cleaner production network activities?
- v. How did external contextual factors influence the eventual fate of the Global RECP_{net}?
- vi. How can similar networks be governed in order to ensure continued viability of networks?

Literature Review

Towards Sustainable Development, Innovation, Contextual Interaction and Isomorphism

In order to transform the current patterns of production and consumption, a permanent shift in the philosophy of humanity is required towards circular economy [11]. Sustainable Development is defined as the development which meets the needs of the present without compromising the ability for future generations to meet their own needs [2, 6]. One of the most effective mechanisms of attaining sustainable industrial development is through cleaner production [2, 31]. Cleaner production is the continuous application of a preventive approach to processes, products and services so as to increase overall efficiency and reduce risks to human health and the environment [31].

Theories that promote sustainable development were popularised from the adoption of the Brundtland Commission's Report – Our Common Future in 1987 [6]. The Sustainability Theory proposes that we must undertake our developmental activities with a due consideration of the generations to come. It postulates inter-generational equity and the fact that no generation is superior than the other. In the context of industrialisation, sustainable industrialisation activities have been promulgated in many organisations worldwide. The demand for sustainable practices has been necessitated by the pressures from regulators, shareholders and an emerging breed of green customers [1]. It is also becoming difficult to export products to international markets, without demonstrating sustainability concepts such as cleaner production. The demand for green products is also soaring each day. Therefore, implementing cleaner production is a key strategy towards attaining sustainable development [15].

Furthermore, the Diffusion of Innovation Theory by [22], proposes that organisations go through various stages of innovative capabilities from early adopters and those classified as laggards. In order to attain sustainable development, there is need for diffusion of innovation in industrial production processes. Various examples of diffusion of innovation have been demonstrated through cleaner production assessments and cleaner production projects. Some of the projects have been promoted by National Cleaner Production Centres (NCPCs) as a way of scaling up cleaner production in developing and transition countries [2].

The Contextual Interaction Theory proposed by Bressers [5], suggests that the success or failure of policy goals is influenced by contextual factors such as power, information and cognitions. This typology of contextual factors is often referred to as the Contextual Interaction Theory (CIT). In assessing cleaner production projects implementation, their

success and factors can be better explained using the Contextual Interaction Theory (CIT). Due to the fact that networks operate from different country contexts with varying combinations of contextual factors, the CIT can clearly explain the factors resulting in network success or failure.

Di Maggio and Powell [7] proposed the Institutional Isomorphism Theory in organisations as a phenomenon where organisations gradually became similar in their practices as a result of mimetic, normative and coercive pressures. Some of the pressures could be as a result of seeing other organisations flourish in implementing cleaner production innovations, whereas some of the pressures could be as a result of forced circumstances such as regulations. In the context of cleaner production, organisations can become isomorphic and behave in the same way with regard to preventive production approaches, especially due to participation in inter-organisational networks.

The Need for Resource Efficient Cleaner Production (RECP)

Cleaner production is a philosophy that shifts the way of production from merely relying on end-of-pipe to adopting preventive approaches of dealing with industrial environmental problems [2, 31]. It is widely acknowledged that industry is one of the sectors with key abilities to cause anthropogenic environmental challenges including climate change [23]. At the same time – paradoxically; industry is a source of economic development and creates jobs. Traditional approaches to development were concerned with transferring the problems by treating waste at the end of pipe. The primary motivation was on increasing production. However, this came at a cost to the environment.

The early 1900s were characterised by a care-free attitude towards environmental sustainability and pollution. Baas [2] postulates that notions of pollution prevention became popular in the 1980s in Europe and United States. The concept of cleaner production was coined by United Nations Environment Programme (UNEP) in 1989 [2]. Early strides in establishing a global footprint for cleaner production occurred in 1994 when the first 8 National Cleaner Production Centres were established worldwide. Their role was to promote the new concept of cleaner production. By the year 2023, over 50 National Cleaner Production Centres exist worldwide. Their morphology and structure varies from not-for profit, quasi-government institutions, research centres and consultancy model organisations. The evolution and diversification of NCPCs into different types of organisational forms is clearly acknowledged by researchers such as [31].

One of the main roles undertaken by National Cleaner Production Centres was to undertake Cleaner Production Assessments using the framework developed by UNIDO and its partners. This framework is illustrated in Fig. 1.

Implementing cleaner production enables an organisation to cut costs of production, reduce losses, prevent environmental pollution and meet the demands of regulatory authorities. In many countries there is an increased burden of compliance and meeting regulatory requirements of legal authorities. Empirical evidence from a 20 year evaluation of cleaner production programmes confirms resource efficient benefits of cleaner production in multiple country contexts [15]. Strict laws have been promulgated in the areas of air emissions, effluent, air quality and waste management. Organisations that adopt cleaner production are better able to deal with the legal demands and expectations of national policy and legislation. Other benefits of cleaner production implementation include the ability to export to international markets due to the sustainability of products and services, necessitated by the implementation of cleaner production. Companies that implement cleaner production

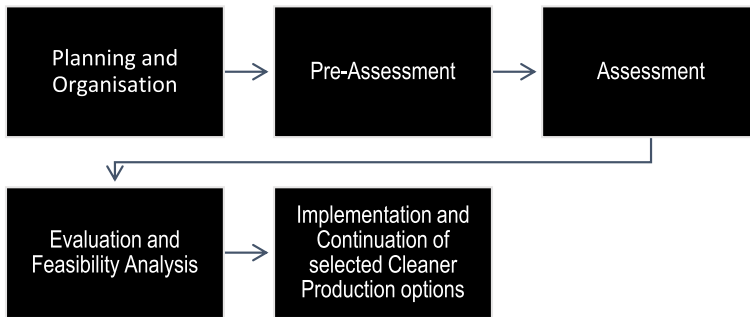


Fig. 1 Process of undertaking a cleaner production assessment. Source: Van Berkel [30]

are better able to market their products and services in foreign jurisdictions due to the ability to meet complex environmental laws existing in those countries. Whilst the concept of cleaner production is also referred to as pollution prevention in other country domains such as earlier in Europe and United States of America, it is clear that the benefits are desirable for many organisations despite their geographical location [2].

Governments, development partners and NCPs, have taken a lead in the promotion of cleaner production in developing and transition countries. However, it is the National Cleaner Production Centres which have contributed significantly to the implementation cleaner production worldwide [15]. Cooperation amongst stakeholders has enabled the establishment of networking platforms to focus and share information on cleaner production technologies.

One of the most promising initiatives that has been observed over the past three decades has been the establishment of cleaner production networks at national, regional and international level. Networks are seen as an innovative way to learn and share experiences between organisations [16, 19, 21].

Networks and Collaboration as a Tool for Sustainable Development

Networking and collaboration for the purpose of attaining sustainable development has gained momentum in the past three decades [21]. Organisations have started to belong to some sort of network. The main motivations of belonging to a network emanate from the need to access information, implement projects, build a critical mass for lobbying in the policy and legal space. Other organisations join networks merely to benchmark performance with other organisations.

One of the most organised networks that was formed to promote cleaner production is the Global Resource Efficient and Cleaner Production Network (RECPnet) [25]. The Network was formed with an initial membership of 41 members and currently stands at over 70 members. The network was formed under the tutelage of patron UN Agencies namely, United Nations Industrial Development Organisation (UNIDO) and United Nations Environment Programme, which is now known as UN Environment.

Despite formation of these and other networks, collaboration is still affected by many factors which are not researched upon [12]. There is a serious gap in literature as to how sustainability networks are formed as well as why they fail [21]. Scant information exists on case studies of networks. In particular, there is no thorough barrier analysis, business

model research, network governance evaluation and an assessment of the results of networks on cleaner production and promoting a circular economy. Understanding the morphology of networks through case studies enables the development of clear strategies, that allow networks to succeed and continue to make significant contribution to the implementation of cleaner production.

Examples of Network Collaboration

Network collaboration in the context of cleaner production can take different forms. Firstly, networks can be geographically associated and agglomerated in the form of industrial clusters or eco-industrial parks [4, 10, 19]. These organisations are located in close proximity with each other on geographical lines. Key examples of how they can collaborate is through training, awareness, benchmarking visits and industrial symbiosis. In industrial symbiosis regimes, organisations in one industrial cluster can access waste from another organisation and use it as a raw material for another organisation. Networks can also take the form of geographically dispersed organisations where organisations do not operate in close proximity with each other [27, 28]. The Global Resource Efficient and Cleaner Production Network (RECPnet), Greening of Industry Network (GIN) and the Advances in Cleaner Production Networks (ACPN) are typical examples of networks that operate at a global level, whilst being geographically dispersed.

Furthermore, at regional level, networks exist, such as in the case of the African Roundtable for Sustainable Consumption and Production (ARSCP) and the European Roundtable for Sustainable Consumption and Production (ERSCP). Networks also exist at national level but in a geographically dispersed manner such as in the case of Plastics SA and Business Council for Sustainable Development Zimbabwe (BCSDZ). Networks can also exist in the form of supply chain networks which involve various nodes derived from an organisation's supply chain.

Barriers and Emerging Challenges in Network Management and Continuity

Although networks are proliferating worldwide, there is no clear strategy of how the networks are to be financed [29]. The formation of networks is mainly driven by a group of professionals who are passionate about a certain professional field such as cleaner production. Establishing networks without a clear financing strategy and ownership by the “*would-be network members*” is a dangerous undertaking as the network is most likely to suffer a still-birth. Therefore, one of the main challenges that result in networks failing is the lack of funding strategies. Most networks anchor their financing in subscriptions from members after pitching their value proposition. Value proposition is the major factor flagged by networks [21]. This can be effective if members religiously pay their subscriptions. Research confirms that in subscription based organisations, the lack of payment of subscriptions is a perennial challenge even for established members [29].

Poor governance of the network and lack of a defined focus of the network, are recognised as other barriers encountered in promoting networking on cleaner production. The challenge of voluntary participation also entails that the network members can engage or disengage at any time in the tenure of their membership. It is also widely recognised that the emergence of other networks, results in organisations also dividing their time amongst multiple networks. Therefore, there is never exclusive concentration on one network by an organisation.

Although some networks have failed, very little has been done to investigate and research why they failed and to establish what can be done to revive them and inform future networks on how they should be managed [21]. The reliance on donor funding to initiate network collaboration, purports that an external party is initiating collaboration. If not carefully managed, this can brew a dependency syndrome amongst network members. Furthermore, the payment of subscription fees in kind [26] could potentially have effects on actual cash-flow of the network.

An Independent Terminal Evaluation of the Joint UNIDO-UNEP Programme on Resource Efficient and Cleaner Production (RECP) in developing and transition countries was undertaken including some aspects pertaining to the Global RECPnet. This evaluation confirmed the challenges facing the RECPnet network as lack of ownership and sustainability [27, 28]. Despite recognising these challenges, there is no consideration of additional barriers that could have hindered network success.

Materials and Methods

The research was designed as a Case Study focusing on depth, instead of breadth. The case study was selected using strategic sampling and especially thematic focus on cleaner production. In order to collect data, interviews were undertaken with key informants including a response from one of the agencies involved in the network. Additional responses were recorded on questionnaires to members of sustainable business network. The questionnaire included activities, roles, barriers and challenges associated with the networks as well as the impact that was achieved due to network activities. The questionnaire was disseminated using email communication. By the time of completing this research article, a total of 30 questionnaires were responded to by members of networks on cleaner production. Key informant interviews were also undertaken including representatives of individuals that belonged to networks. A semi-structured questionnaire was also sent to a representative of the network in order to get the perspective of the network.

Document review was undertaken on a number of documents related to the RECPnet. This information included independent evaluation reports, cleaner production assessment case study reports, Charters, project proposal documents and network founding documents. The documents were assessed in order to identify challenges associated with the network as well as the progress that was attained during the tenure of the network. Data was analysed qualitatively and trends were deduced from the thematic analysis. Various themes emerged from the research such as roles, challenges, barriers, success factors patron agency effect.

In order to ensure that there was high level of reliability, validity and accuracy of the data; the research employed a process of triangulation. The triangulation was undertaken on sources, by ensuring that there were at least 3 sources in investigating variables. In addition, there was deployment of the triangulation of methods; specifically—document review, interviews and questionnaires which were used and disseminated. The selection process of this case study was meant to ensure that the selection covered global networks, in order to form a basis of comparing with networks from Africa. The selection process is presented in Fig. 2.

Figure 2 presents the key elements which were considered in selecting the case study for the research. This selection protocol was based on five systematic steps. Firstly, consideration for selection was given to collaborative organisations or organisations which were focused on facilitating networking amongst key stakeholders. The networking could either

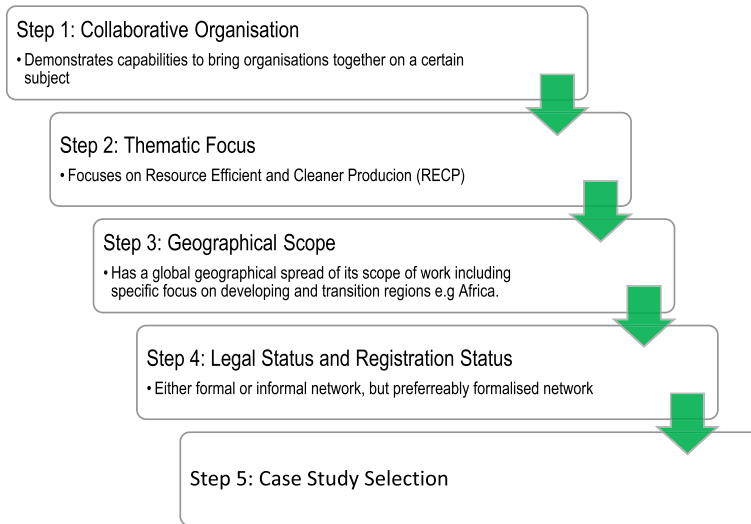


Fig. 2 Selection process of case study

be physical or virtual networking regimes. Secondly the criteria considered thematic focus of the network. Deliberate effort was undertaken to select networks which had a specific focus on cleaner production and circular economy related concepts. The other networks where collaboration occurred in unrelated areas to cleaner production and circular economy; an exclusion was undertaken.

Furthermore, the selection criteria considered geographical scope of the networks. In this case study; consideration was given to the networks that were operating at a global and regional level, as a basis for comparing with national level networks. The global or regional collaboration was considered from the perspective of physical and virtual networking. The specific focus of the global and regional networks was prioritised on the dimension of networks that focus on developing and transition countries.

The final dimension of selecting case studies was based on their legal status. Either formally registered networks with administrative structures or networks that are not formally registered but with administrative structures were chosen. This legal status dimension was considered to ensure that there was a focal point for the network. The research has received ethical clearance from the University of Twente, Behavioural, Management and Social Sciences ethical committee / Domain Humanities & Social Sciences.

Results and Discussion

Role of the Global Resource Efficient and Cleaner Production Network (RECPnet)

The questionnaires sent to key informants and the response from one of the patron agencies, showed significant progress made in the promulgation of cleaner production. Some of the major activities included capacity building, cleaner production workshops, demonstration projects, chemical lasing projects and environmental policy advise. The RECPnet managed to escalate the relevance and implementation of cleaner production in different

developing and transition and developing countries. The progress of the RECPnet and UNIDO-UNEP associated programmes on cleaner production can be tracked and assessed in terms of the gradual increase in the number or stakeholders involved from the inception of cleaner production projects in the early 1990s. Figure 2 shows that the initial National Cleaner Production Centres (NCPCs) worldwide were only 8. Through the work of UNIDO and UNEP, more NCPCs were established.

At the formation of the RECPnet in 2011, there were 41 organisations including NCPCs and other related organisations which focused on cleaner production. There was an increase in the number of organisations and therefore, formalising the network was seen as a solution to ensuring a guaranteed membership and subscription base. By the time the RECPnet held its last event in 2018 at the depletion of project funding, there were 70 members of the RECPnet. The data shows that there was an evident increase in the interest and implementation of cleaner production worldwide during the period of 1994 to 2018 as illustrated in Fig. 3. As from 2018 to the year 2023, there was no adequate data available on what remains as the membership of the RECPnet, apart from the information available as at the conducting of the last event of the RECPnet. Response from a former RECPnet secretariat staff indicated that they had been seconded to other projects.

Whilst the RECPnet enjoyed growth from 2011 to 2018, that growth was only due to the fact that UNIDO and UN Environment were supporting the network. Without the financing of patron agencies, it is not clear how many members remained beyond project funding and whether members still remain committed to the Charter of the RECPnet despite the waning financial support.

These roles varied amongst network members depending on the strategic thrust of the organisations belonging to the network or its parent organisation. The roles of the RECPnet included capacity building and information dissemination on the concept of cleaner production. Several events were held such as the Global Network Conference on Resource Efficient and Cleaner Production conferences, workshops and awareness raising events.

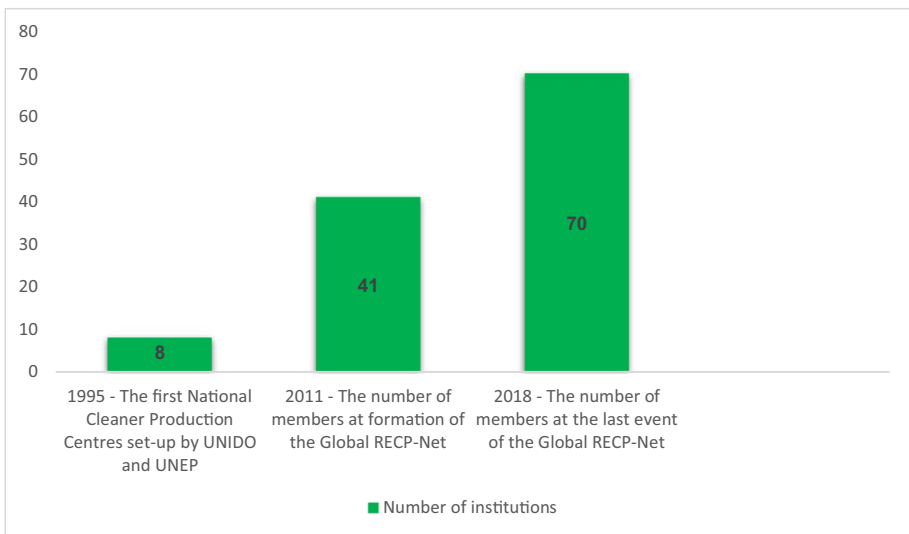


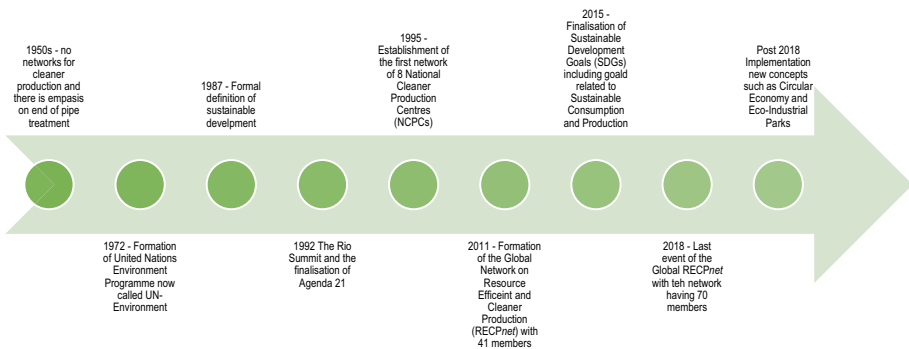
Fig. 3 Development of Cleaner production related collaboration from inception of cleaner production projects to the last event of the RECPnet

These events improved the understanding of cleaner production amongst the members of the network.

Some of the thematic activities that were undertaken by the RECPnet include -

Waste Recycling and Management, Resource Efficient and Cleaner Production (RECP), Safe Chemicals Management, water efficiency, energy efficiency, chemical leasing, training and capacity building, workshops, conferences, demonstration projects, industrial symbiosis, technical assistance as well as information dissemination. Some of the members of the RECPnet managed to adopt business models such as chemical leasing which is a functional business model that pays for the functions of chemicals, rather than chemical quantities. In addition to technical roles associated with cleaner production topics, the network of organisations within the RECPnet also contributed to policy advice.

It was also observed that the role of networks for cleaner production evolved over a number of years depending on the changing landscape of sustainable development. From a situation of ignoring pollution, there was a conscious process of mainstreaming cleaner production in industrial processes. The evolution from the lack of consciousness on cleaner production networks to a level of maturity of high subscription of the RECPnet, attributed to the programmatic approach of the development agencies UNIDO and UNEP. However, post 2018, it seems that the RECP concept started competing for relevance with emerging concepts such as Circular Economy (CE) and Eco-Industrial Parks (EIPs). Whilst the cleaner production concept has effectively co-existed with similar concepts like eco-efficiency and industrial ecology for many years; it seems that the new wave of the Circular Economy has drawn attention worldwide in the last decade, thereby making it difficult to pursue cleaner production in isolation of circularity amongst stakeholder groups such as donors, financiers and industry. Therefore, many institutions including the patron agencies are being forced to repackage cleaner production in integrated forms and those that evolve it towards Resource Efficient and Cleaner Production (RECP) and recently Circular Economy (CE). Figure 2 illustrates the evolution of cleaner production networks.



Barriers and Challenges Affecting the RECPnet

Alignment and Focus on Other Related Concepts and Projects

The viability of the RECPnet, was partly affected by the strong realignment towards other concepts such as Circular Economy and Eco-Industrial Parks. Whilst it can be argued that

RECP can be implemented under those concepts, it is not the same when RECP was a standalone concept. Due to the varying international funding landscape, more resources to finance projects started to focus on Circular Economy worldwide and Eco-Industrial Parks. Whilst it is good to have a plethora of concepts and a diversity of different approaches to deal with sustainable development challenges, this research notes that there is an increasing phenomenon of the concepts ending up competing with themselves.

Whilst the Global RECPnet was named after a certain concept of cleaner production, the radical shifts in the sustainability terminology and what donors prefer to finance, has had an effect on the RECPnet and will continue to do so for some years to come. Structural changes were also noticed within UNIDO, one of the patron agencies which changed the *Cleaner and Sustainable Production Unit* into one which focuses on *Circular Economy and Environmental Protection*. These changes show alignment with the changing sustainability landscape. However, the name of the RECPnet remains static despite radical changes in sustainability concepts. At the same time, changing the name of a network each time new concepts emerge, is not sustainable and lasts so long as the concepts remain relevant. It is worth assessing the effect of the shift in the relevance of the Circular Economy to become more prominent and its potential to overshadow concepts such as Resource Efficient and Cleaner Production (RECP).

Consequently, the drastic shift by funders to finance more (CE) projects could have a long term bearing on the viability of networks anchored on cleaner production such as the RECPnet.

Financial Constraints

The continuity of the Global RECPnet suffered from the availability of financing. Due to the fact that the RECPnet was part of the project with a limited budget of resources and defined timeline, its continuation hinged upon that external financing. From 2018 until 2023, the research noticed that there was little or no activity related to the RECPnet apart from a remaining website of the network.

To make the situation exacerbated, the members of the network did not take ownership to finance the network. Secondary data from the evaluation of the Global Cleaner Production Projects showed that members did not take ownership of the network [27, 28]. The lack of ownership ultimately resulted in the lack of availability of financing. It is difficult to envision that the current members can finance even a workshop on their own without donor support. However, some best-practice and exemplary activities were observed within the National Cleaner Production Centre of South Africa (NCPC-SA), which was able to successfully arrange Colloquiums on its own.

Many members of the RECPnet emanate from developing and transition countries and the majority face financial challenges even to pay their own subscriptions. This situation means that there can be no meaningful fundraising to support the network. As a result, some of the members of the RECPnet could not pay the required subscriptions that were required by the RECPnet.

The greater control and administration of the network by the patron agencies means that if there were changes with them, the RECPnet would sneeze. Setting up the RECPnet without a clear business model of how it would operate beyond UNIDO and UN Environment was the main challenge that contributed in its decline. If any efforts are initiated to revitalise the network, one of the first aspects that should be explored is to define a clear business model for the network and how it would generate income

beyond the patron agencies. In addition, greater leverage should be given to the members themselves to administer the RECP*net*, rather than run the network through patron agencies. Limited leverage to administer the network has an effect on the ability of members to sustain themselves and it also builds an element of entitlement, which is difficult to overcome at the end of programmatic funding.

Lack of Full Coverage of Subscriptions and Members Evading Paying Categories

Whilst the RECP*net* developed from an initial 41 to over 70 members, not all of them were paying members. Some of the members were in categories that were called Observer members mainly earmarked for new National Cleaner Production Centres and other RECP service providers who had limited experience in RECP. However, some NCPCs with experience of over 20 years were also seen desiring to be Observer Members. In some cases, senior NCPCs took responsibility and assumed proper categories, but in several cases seasoned RECP service providers desired Observer Membership, which was free for a specified period. Such antics had the ability to reduce the revenue base of the RECP*net* as it would not realise its full potential. More Experienced NCPCs are expected to take leadership and accountability in networks, including taking the role of paying appropriate subscriptions in the proper categories.

Although Regular Membership was the highest proportion of the membership (59%), the number of Observer Members was substantial (33%) and the figure was increased by some NCPCs and service providers who evaded membership fees in order to take non-paying categories. Strategically, the RECP*net* should also have strived to reduce the number of non-paying members in order to enhance revenue collection for the viability of the network. The distribution of Membership categories shown in Fig. 4 should be used as a basis of setting strategy for recruiting new members.

For members which were in the paying category, not all of them paid subscriptions on time and that had an effect on sustainability. Whilst UNIDO and UNEP Global Programme on Resource Efficient and Cleaner Production could cushion and support activities despite incomplete subscriptions, the effects of non-payment of subscriptions would become more prevalent from 2018 to 2023.

Due to the fact that 2018 was designated as the year of the last event of the RECP*net*, it is not clear what would happen, if any member wanted to pay a subscription and to whom they should pay it to. It seems that at the conclusion of the project, there was limited follow-up on subscriptions. A few surveys were undertaken including one undertaken by GAIA to try and explore business models for the RECP*net*, but beyond these activities, the network became generally inactive or focused on other thematic areas. Therefore, extending the administration of the RECP*net* beyond the patron agencies was an imperative that should have been considered before the demise of the RECP*net*. The significant administration fees required to administer the network can be used for network development if the network is managed by the members themselves. Development organisations administering networks may be influenced by availability of programme financing for implementing certain projects. Innovative models of financing are essential and presented in this paper, in order to find ways of ensuring network survival beyond donor funding. The schedule of subscription fees of the RECP*net* are presented in Fig. 5.

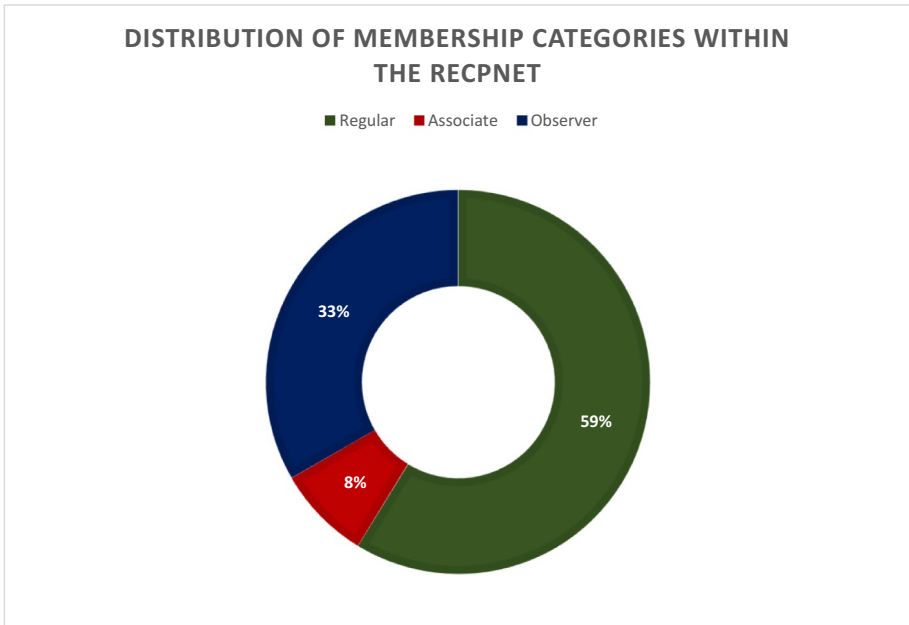


Fig. 4 Distribution of membership categories within the RECPnet

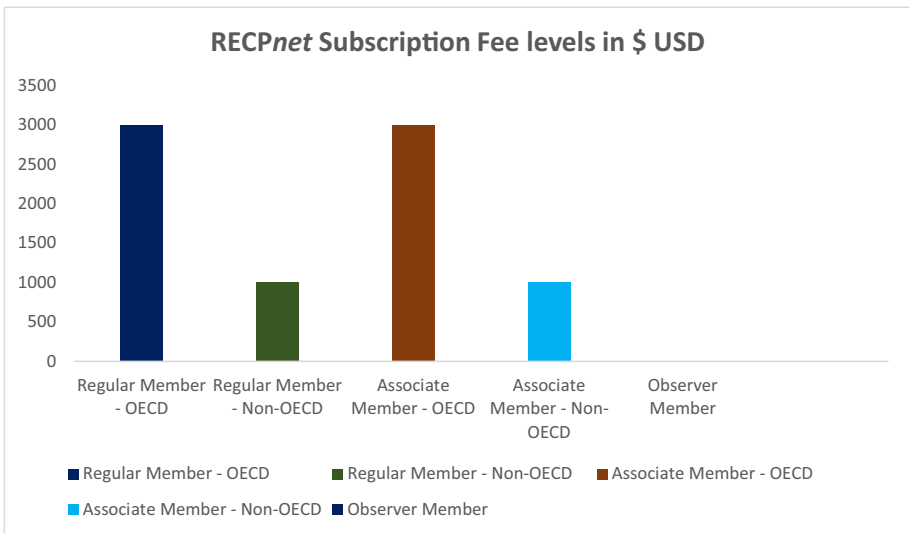


Fig. 5 RECPnet subscription fee levels in \$USD

Too Much Focus on National Cleaner Production Centres (NCPCs) Than Other Cleaner Production Providers

The *RECPnet* potentially could have faltered as a result of its high level focus on National Cleaner Production Centres (NCPCs). However, new players were entering the scene with comparable and even superior cleaner production approaches. It is understandable that due to the fact that UNIDO and UNEP pioneered the first cleaner production approaches between 1994 and 1995, they would naturally continue to collaborate with some of the institutions that they started cleaner production collaboration with. The impact of the NCPCs was highly evident and it became a legacy project of the patron agencies. However, from a business model and financial sustainability perspective, not all the NCPCs were becoming financially independent. Van Berkel [31] cites the evolution and diversification of NCPCs and it is not all of them that managed to attain financial viability. Some adopted consultancy models, whereas others went into capacity building. At the same time, some NCPCs remained “*quasi-government*” and under the influence of host country governments.

Whilst the *RECPnet* network indicated that it was opening up to new players who were service providers in cleaner production, there was no deliberate strategy to attract them and to market the *RECPnet*. Marketing the network to stakeholders beyond the NCPCs is an area that needs to be rectified, if the *RECPnet* is to be revived or to continue as a financially viable entity. There is urgent need to market it beyond the non-traditional stakeholders in cleaner production. These findings also resonate to other cleaner production networks beyond the *RECPnet*. Extending the membership categories to enable more members to qualify is also a key step towards building the “*critical mass*” and therefore developing a long term base of subscriptions. Broadening the revenue base of the *RECPnet* was not well thought out at its inception, partly which can be attributable to the availability of programme or project funding.

Different Levels of Maturity of National Cleaner Production Centres (NCPCs)

The different levels of maturity of NCPCs, also resulted in limited appreciation of the need for networking and collaboration. Due to the legacy of the cleaner production programmes being supported by development partners, it came a bit as a shock for some NCPCs to be required to pay subscriptions. Even in the case of failure to pay subscriptions, the follow-up was limited. Bringing the NCPCs to the same pedestal of development, conception and appreciating the relevance of network participation is difficult, if not impossible. Some of the NCPCs remained in government departments, research centres and some morphed into consultancy businesses and their management styles varied. Some in government settings performed well under those governance regimes. These external factors coupled with the contextual factors existing in their countries of origin influenced the ability of the NCPCs to afford subscriptions. In cases where they could be afforded, there was potential play of organisational politics and bureaucratic tendencies of organisations beyond the control of the *RECPnet*.

Network Coordination Undertaken Within Patron Agencies

The research noted that network coordination was mainly under the control of patron agencies and operated based on their rules of engagement. This was a good advantage to the

membership as it had access to project management and technical skills. However, this was not sustainable after the end of project support. Network administration should draw from the membership in order to ensure that beyond patron agencies, networks can be sustainable.

Legal and Policy Regimes

Stakeholders responding to the questionnaire send during the research cited policy and legal barriers as having a contributory factor to the demise of the RECPnet. This was with regards to the different regulatory regimes which existed in different countries. In some countries such as China there is Cleaner Production law and in Zimbabwe, according to the Effluent and Solid Waste Disposal Regulations, Statutory Instrument 6 of 2007, it was a compulsory for organisations to develop cleaner production plans including objectives of waste minimisation. Within the network, there were also some countries without any regulatory push for adopting cleaner production. The legal regimes tended to push organisations to seek cleaner production expertise including through networking. Although we could not establish a correlation between regulatory regimes on cleaner production and the willingness to accept membership, we believe that this is an area that warrants further research. The different legal and policy regimes affected differently the prioritisation of cleaner production and hence where cleaner production was not a legal issue, it was noted that in some occasions it was de-escalated. The de-escalation resulted in less demand for cleaner production services such as those originating from cleaner production networks.

Lack of an Effective Membership and Recruitment Strategy

Although, there was a secretariat responsible for recruiting members, there was inadequate verifiable actions to reach out to broader stakeholders. Where this was done, the recruitment was not massive as envisaged. Comparing with some in-country networks that consisted of over 100 members, the RECPnet still could not surpass 100 members and at the close of the project was at 70. Greater work could be done to improve the marketing and promotion of the network to new and prospective network members. This was as a result of primary focus on traditional cleaner production service providers such as NCPCs. In the process of reviving the RECPnet or similar network, a communication strategy that is effective in attracting new membership is essential within the Secretariat of the RECPnet.

Summary of Challenges Affecting the Global RECPnet

A summary of the challenges that affected the Global RECPnet were identified in the research and are presented in Table 1. Furthermore, we present new insights of how these challenges could be addressed. These challenges can easily be addressed by implementing the proposed strategies.

Patron Agency Effect

Assessing the documented information arising from the evaluation of the Global RECPnet, alongside responses to the questionnaires sent to members, there is a typology of issues related to the “patron agency effect”. These issues are either positive or negative and ultimately result in the success or failure of the network.

Table 1 Challenges affecting the RECP_{net}

Challenge observed to be affecting the RECP _{net}	Potential implication on network success	Strategies required to ensure viability of network
Limited financing restricted to the tenure of projects within patron institutions	Lack of sustainability without project financing from patron agencies	Develop new business model for the network
Classification of senior cleaner production service providers e.g. mature NCPCs; as Observer Members instead of taking Regular Membership Categories	Lost potential revenue that could have been earned by the RECP _{net} in higher membership categories	Restrict Observer Members to new cleaner production service providers
Lack of willingness to pay subscriptions by some members of the network	Reduced financial resources to finance network activities	Enforce deadlines and restrict network access to unpaid members
Too much focus on specific group of members such as National Cleaner Production Centre (NCPCs) and limited inclusion of other forms of organisations delivering cleaner production	Missed opportunity to grow membership and raise more membership fees	Extensively market the network to other organisational forms beyond NCPCs
Competition from emergence of other related concepts such as Circular Economy (CE) and Eco-Industrial Parks (EIPs)	Loss of funding as donors and stakeholders begin to shift away from cleaner production and support other emerging issues “ <i>the bandwagon effect</i> ”	Align cleaner production to new concepts to maintain its relevance
Free membership for members who would join in the middle of the year	Creation of “ <i>free riders</i> ” within the RECP _{net}	Charge membership on a “ <i>pro-rata basis</i> ”
Lack of effective mechanisms to follow-up on debts of members	Reduced financial resources for network activities	Increase ability to collect dates and enforce binding payment plans
Subdued activities beyond global networking events	Low visibility	Maintain vibrancy of the network on all platforms electronic, paper and digital media platforms even in periods without global networking events. Avoid going silent for long periods to prevent member losing contact with NCPCs and associated service providers
Two thirds membership fees in kind by OECD member countries through professional services	Potential effects on cashflow of the RECP _{net}	Ensure members pay subscriptions and any other services rendered must be transactional

Positive Aspects of Patron Agency Effect

The existence of patron agencies enabled the utilisation and availability of resources, thereby easing the financial burden in members. Due to their impeccable reputations as global brands, they had a high level of attracting power as well as leveraging power to draw more organisations. Whilst this is very much expected, it did not result in a spurt in membership drive but reasonable growth to above 70 members. This is quite commendable given that any activities of some sort on cleaner production were started in 1994 and then in 1995 only the first 8 NCPCs were developed. Therefore, although the convening power of international organisations existed, the financial commitment of subscriptions still restricted some organisations from joining the *Global RECPnet*.

Furthermore, the existence of patron agencies made it possible to interact with international donors on behalf of individual cleaner production service providers. If the individual members had sought funding on their own, it may have been difficult to accept all their proposals. However, with the formation of the *RECPnet*, it was possible to represent the collective and still gain legitimacy. The patron agencies also contributed immensely in monetary terms through supporting the *RECPnet* by the programme budget, technical skills transfer and manning the secretariat on behalf of the members.

Negative Aspects of Patron Agency Effect

Despite the progressive gains of having patron agencies involved in the form of UNIDO and UNEP, there were some other unintended effects such as the following:

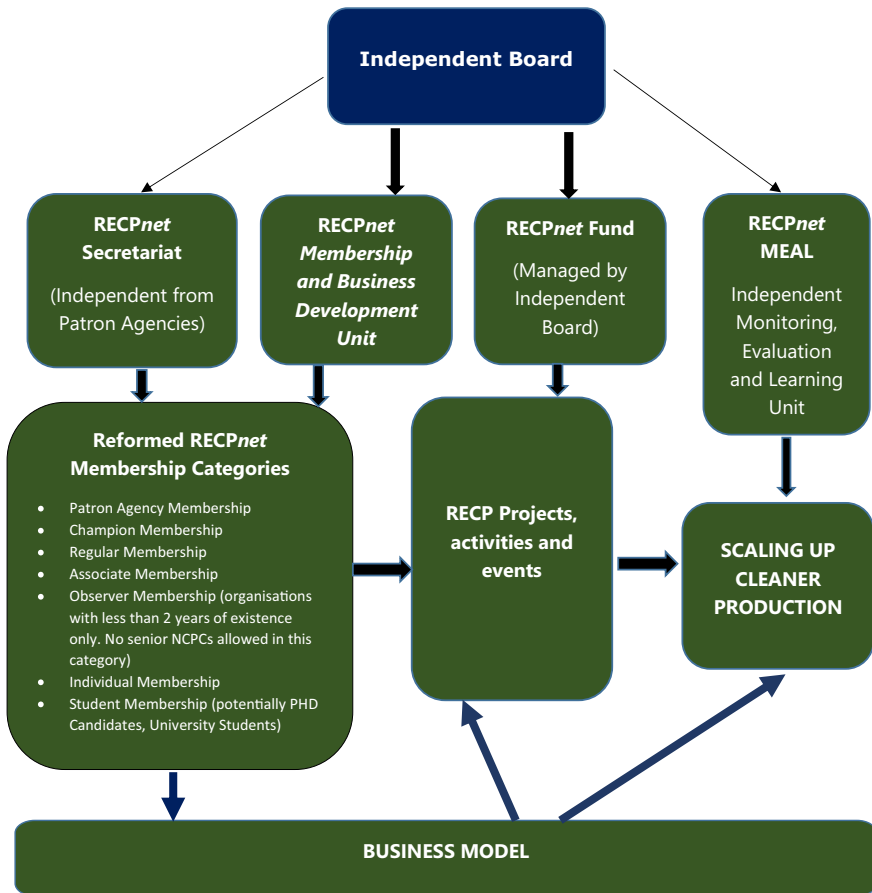
- building entitlement amongst the members of the network.
- creation of high expectations amongst members of the network.
- lack of capacity development in members developing their own network due to management concentrated within patron agencies.

Some of the expectations were difficult to remove at the end of the project when the *RECPnet* had its last event in 2018. Trying to now make members pay for network participation after getting support, became a challenge of sustaining the network. These negative aspects of patron agency effect can all be managed by putting in place a strategy.

Proposed New Network Typologies and Extension of Knowledge on Networks

Assessing the typological structure of how the *RECPnet* was formed, managed and demised – we are bound to imagine what organisational forms could be developed in order to facilitate a transition in business model and structural formation of the association. Key to the development of the new typologies is deliberate process of weaning off networks from the patron agencies. In addition, an effective strategy of raising funds is essential beyond project support. The *RECPnet* should also be managed independently from the influence of patron agencies if it is to survive. An Independent Board needs to be set up that oversees the operations of the network. In the proposed new typologies of the network, there is a possibility of ensuring wider extension of the *RECPnet* beyond the traditional NCPC and rope in potentially exciting new organisations forms. Existing

Executive Committees can be morphed into Independent Boards to enhance autonomy. Opening up new membership groups such as student membership is needed to develop a funnel of potential cleaner production professionals.



New network typologies should have a governance mechanism through an independent Board that is free of the influence from the Patron Agencies. Such a Board would be typically comprising of different stakeholders such as National Cleaner Production Centres (NCPCs), Research Centres, private sector, academia, independent experts, consultants and government stakeholders. Diversity of the Board from a composition perspective is essential to ensure that there is a broader perception of cleaner production beyond service providers. A new RECPnet should not ring fence membership to NCPCs alone but seek indulgence of a plethora of stakeholders. NCPCs can continue showing leadership and guidance due to their historical contribution to cleaner production worldwide, but at the same time, new innovative members should be considered.

The future orientation of networks must establish a funding mechanism to finance its activities beyond donor support. The proposed RECPnet Fund should be endowed with financial resources to enable financing of network activities, projects and events.

Various mechanisms can be used to finance the facility such as through membership subscriptions, consultancy commissions from members of the RECPnet who acquire projects via the network. In any case the RECPnet should retain a percentage of any finance acquired. A proposal is also to acquire donor support that is predictable and covers long term activities of the RECPnet. Looking beyond traditional donors is also a key step towards financial independence of the network. New forms of finance, such as climate finance could be used to finance the RECPnet, by aligning donor cleaner production to climate change and emissions reductions.

Within new typologies of cleaner production networks, should be a Membership and Business Development Unit (MBDU) that aggressively markets the RECPnet beyond the existing 70 members. The marketing and business development activities can include promotional activities, digital marketing and physical engagements at conferences and events to attract new members. The Membership and Business Development component will be responsible for growing the network to levels where it can generate sustainable revenue.

An independent Secretariat that is autonomous from patron agencies is a key step towards ensuring the independence and sustainability of the network. Whenever network activities are undertaken within patron institutions, the network tends to adopt leadership styles and tenets of the patron agencies. A sustainable RECPnet is one which is autonomous in its operations and can manage its affairs, budget, personnel and membership.

Strengthening the RECPnet requires expansion of revenue streams and one of the first steps in order to reform the RECPnet is to expand the membership categories. Some prospective new categories of membership include Champion Membership (*a model adopted from the Business Council for Sustainable Development Zimbabwe where selected organisations pay higher subscriptions in exchange for higher visibility*). Student Membership would be recommended as a niche to capture members so that they continue as soon as they finish tertiary education. Patron Agencies are recommended to take up paid up membership to enhance sustainability of the network. In the new typology of network orientation Observer membership should only be allowed for new organisations with less than 2 years' experience. Restricting old generation NCPC from taking up Observer Membership is essential in imperative to the growth of the RECPnet. These typologies of course come with a lot of weaknesses but are suited for higher ability to generate more income and enhance sustainability.

Conclusions

i. What is the role of networks in promoting cleaner production?

Networks play a very critical role of promoting cleaner production in developing and transition countries. Using the example of the Global RECPnet, it can be observed that networks provide capacity building, technical knowledge and information dissemination on cleaner production. Furthermore, networks arrange events on cleaner production in the form of conferences, workshops and seminars – all of which help to improve the abilities of organisations to adopt cleaner production approaches. From the period of its formation to the last event in 2018, the RECPnet helped to escalate cleaner production, building upon the earlier work by UNIDO and UNEP who developed the cleaner production projects in the early years of 1994 and 1995.

ii. What factors led to the decline of the Global RECPnet?

A plethora of factors resulted in the decline of the Global RECPnet. Chief amongst them is the lack of funding beyond donor financing that was in the project of the Global RECP Programme. Coupled with limited ownership of the network, there was a challenge to ensure that the network continues without development partners. Lack of payment of subscriptions by members also contributed to the lack of mobilisation of sustainable financing for the association. Furthermore, some seasoned NCPCs still preferred Observer Membership categories with no subscriptions, thereby lowering the financial base of the network. The rapid changes in the global sustainability landscape, catapulted Circular Economy and Eco-Industrial Parks to the priority of many donors and stakeholders, thereby relegating cleaner production in terms of priority. The shift in concepts and donor preferences could also be a reason why the vibrancy of the network has been subdued.

iii. What role did development partners play in the success or failure of the RECPnet?

Development partners led to the success of the RECPnet through their convening power to bring stakeholders together. In addition, patron agencies brought a significant amount of resources in kind and support of administrative responsibilities that enabled hosting of secretariats of the RECPnet. Their ability to promote novel tools such as cleaner production became a selling point and promote the RECPnet. However, patron agencies failed to build an element of ownership with the network at the inception and tried to build this element after there was already network dependency. Reliance on subscriptions and failure to develop new business models financing the RECPnet is a flaw that was supposed to be addressed in the project design. Managing the RECPnet within patron agencies, deprived the network of managing itself and outgrowing the dependency that was noticed in the early years of the cleaner production programme since 1995. Treating the RECP as a legacy project of the NCPCs without venturing into new organisational forms to complement the NCPCs, set up the RECPnet to fail. New forms of technical support and projects should be designed in a way that patron agencies start weaning NCPCs from dependency at the conceptualisation of projects.

iv. Which barriers did the global RECPnet face in scaling up its cleaner production network activities?

The RECPnet faced a plethora of barriers in its quest to exist beyond donor funding. Firstly, the programmatic nature of the RECPnet made it difficult for it to exist as an institution. Beyond the Global Resource Efficient and Cleaner Production programme in developing and transition countries, it was not clear how the network would survive. The belief that members would take it up and forward its mandate beyond the project, was constrained. The lack of subscriptions and elusive behaviour of selected network members to take non-paying membership categories greatly hindered the RECPnet from building a financial base. Instead of keeping members regularly engaged, the RECPnet focused more on Global Networking events and relatively was quiet in the periods between these mega events. A knowledge management system is significantly acknowledged, but the need for effective communication strategies remains an area of improvement on the RECPnet.

xxii. How did external contextual factors influence the eventual fate of the Global RECPnet?

There were several contextual factors that affected the viability of the RECPnet. Firstly, it relates to the changing sustainability context which popularised related concepts such as Circular Economy (CE) and Eco-Industrial Parks (EIPs). Whilst cleaner production remained solid proven concept, the emergence of CE shifted donor priorities, organisational

priorities and even led to restructuring in many organisations including patron organisations. The paradox of aligning with new concepts and the challenges of practically following concepts remain issues to ponder within patron agencies such as UNIDO and UN Environment. Contextually speaking, in addition to aforementioned challenges, there were external issues like organisational culture, national legal regimes, which are beyond the control of RECPnet, but have an effect on whether or not an organisation joins the RECPnet. External micro-economic conditions had an effect on the ability to pay subscriptions to the network especially in selected developing countries.

- vi. How can similar networks be governed in order to ensure continued viability of networks?

Networks must be administered by the members themselves and not necessarily patron agencies. The role of patron agencies should be to facilitate networking. Through this approach, ownership is built at an earlier stage rather than during the project. Future networks should not be designed with a programmatic approach, but from an institutional approach to enable continuity. We propose new typologies of network orientation which establish a funding mechanisms, communication strategies, independent secretariat, independent Boards and a wide range of membership categories beyond the narrow 3 categories. More membership categories can enable reaching out to a wide range of stakeholders beyond the traditional ones. In order to maximise the revenue potential of the network, free membership for the members who join in the middle of the year should be abolished and replaced with charging on a *pro-rata basis*. The payment of subscriptions “*in kind*” for certain members in the OECD region, who render services, is also a challenge to the cashflow of the RECPnet. Commercial activities should be transactional and subscriptions should be paid when they are due. Business Development Unit as well as a Monitoring, Evaluation and Learning (MEAL) Units are necessary. The Business Development Unit should aggressively market the network to prospective and potential members in order to grow the network beyond 70 members. Similar networks can be governed with innovative business models that ensure that the network itself builds a sustainable source of adequate and predictable financial resources.

Author Contribution Tawanda Collins Muzamwese: Lead authorship, conceptualisation, methodology, investigation, writing, editing and reviewing.

Declarations

Competing Interest The authors declare that there are no competing interests with regard the research, that could influence the outcomes of this paper.

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