



SASTEP

South African Sanitation Technology
Enterprise Programme

PROJECT TITLE:	Demonstration and Field-Testing of the Clear Technology
WRC CONTRACT NUMBER:	C2019/2020-00295
DELIVERABLE NUMBER:	7
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Revised contract period	31 March 2023
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Number of deliverables	8 to 11
Indicate if submissions are a Progress or Final Report	Final Report

Acknowledgements:

We thank the South African Sanitation Technology Enterprise Programme (**SASTEP**) for the selection of Enviro Options [PTY] Ltd to evaluate the Clear [Suzhou] Environmental Technology's product. The evaluation was only made possible through the funding and support received from SASTEP and The Water Research Commission (**WRC**).

We also acknowledge and thank the Bill & Melinda Gates Foundation (**BMGF**) for their active and supportive role.

Additionally, we thank our supporting demonstration supplier, evaluating sites and communities, namely: -

1. Clear (Suzhou) Environmental Technology Co. Ltd
2. Tsholetsega Primary School, Principal Rajuile
3. Mofolo North Informal Settlement, Meadowlands, Soweto, local Ward 47 Councillor Tebogo
4. Johannesburg Water, Innovation Technology Management Team
5. Tirelo Farm School, Principal L.M. Molete
6. The Department of Basic Education for identifying Tirelo Farm School

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Executive Summary

The Clear (Suzhou) Environmental Technology's recirculating flushing backend treatment plant is a new generation "Reinvent the Toilet" non-sewered sanitation system (**NSSS**) introduced locally as part of the South African Sanitation Technology Evaluation Programme (**SASTEP**), an initiative spearheaded by the Water Research Commission (**WRC**).

Bacteria is introduced into a closed-circuit tank that biodegrades the organic pollutants contained in black wastewater and reduces their concentration. The wastewater is treated within a membrane biological reactor which separates the pollutants. The treated water is then further disinfected via a UV process before being recirculated for the next flush. Without the need for sewer connections and a continuous potable water supply, the Clear Enviro Loo Sanitation Treatment Plant treats wastewater and kills pathogens by means of a natural, organic process.

This process ensures an odourless system with clear water that does not stain the ceramic toilet bowl. The spread of harmful pathogens is prevented reducing the risk of infectious disease caused by poor sanitation. All the while saving precious water resources in our water stressed environment. A solar option allows for the system to be 100% off-the-grid.

The self-contained treatment plant prevents the illegal disposal of waste into the environment and can be located near to classrooms ensuring the safety of learners. New or existing ablution facilities with multiple toilet seats can be utilized making the Clear Enviro Loo Sanitation Treatment Plant ideal for schools, clinics, housing projects or anywhere that does not have access to a continuous water supply or sewer infrastructure.

The aim of this aspirational product is to transform the lives of individuals, as well as empowering communities, by providing an off-the-grid, fully recycling and flushing, cost effective, sustainable, and dignified sanitation system.

Evaluation of the product took place at three sites, Tsholetsega Primary School, Mofolo North Informal Settlement and Tirelo Farm School. The aim of these differing demonstrations was to determine the performance under African operational conditions, user acceptability, sustainability and cost effectiveness. Additionally, to showcase and test the market interest of local sanitation Implementing Authorities, Municipalities, and the private sector.

The evaluation period commenced during August 2020 and is ongoing to date, some 29 months later. No serious challenges or operational issues were encountered, and only minor component breakdowns occurred. Operational servicing and maintenance requirements proved to be minimal and more of a monitoring nature. The only serious challenge encountered was electrical grid loadshedding for those units connected to the mains grid. This was overcome by installing and testing full solar generating systems, which overcame the challenge.

The third aim was to investigate a locally sourced and produced product under license from Clear (Suzhou) Environmental Technology Co. Ltd. This was successfully accomplished with a 100% South African manufactured and fabricated product now in production and available to the market.

User acceptability, operation, sustainability, and cost effectiveness was a resounding success across all three sites.



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Objectives

#	Objective descriptor	Output (What is the product, goods/ services produced from project)	Outcome (What is the intermediate term effect from the intervention on your product/services or business)	Impact expected. (What is the longer effect expected in the system, your business/sector or communities from the project)
1	Understand the technical & commercial aspects of the Clear (Suzhou) Environmental Technology system	Backend NSSS fit for purpose system ready for the market	Mindset change of sanitation decision makers, implementing agents and future aligned project budgeting will result in sales opportunities	Consistent volume driven production lines will result in cost effective and affordable NSSS
2	Technical feasibility under African operations	User acceptability and ease of use with a sustainable NSSS	Communities have the opportunity of restored dignity via an aspirational sanitation experience	Installation of NSSS will result in long-term water savings within water scare countries
3	Local manufacturing	A 100% South African sourced and produced product under licence from the IP holder	Export opportunities	Adoption of NSSS will result in long-term job creation
4	Compatibility of the backend system to differing frontends	A remotely installed versatile backend system able to connect to multiple and any design of frontend	A sustainable new generation sanitation backend product able to accommodate multiple aspirational water saving flushing frontends	Ability to service informal communities, rural schools, health clinics and applications within the private sector
5	Working towards achieving ISO 30500 outputs	Waste analysis indicates that ISO 30500 accreditation will be achieved	Further output testing is required by ISO 30500 SANAS accredited laboratories for noise, air emissions and certain solid waste outputs	Achieving ISO 30500 will provide undisputed confidence in NSSS

Methodology and Approach to Demonstration

Site Selection

To adequately evaluate the Clear NSSS within the South African context it was important to cover test sites in urban and rural locations. Sites providing existing sanitation challenges were targeted so as to provide realistic conditions and an appropriate evaluation environment.

Consideration was given to: -

1. 100 % Historically disadvantaged communities and users
2. Type of existing sanitation system in use and/or non-existent
3. Suitable quantity of potential users to fully evaluate under peak usage periods
4. Access to the site to avoid demolishing existing structures
5. Application i.e. Informal Community Settlement, school and/or communal ablution facilities
6. Local Authority engagement identified and provided a list of potential sites
7. Awareness of not creating user expectations during site investigating visits

Once a site was deemed appropriate and deserving, extensive social facilitation was undertaken with the community, local councillors, and the appropriate local authority/department. The facilitation fully covered the evaluation objectives, envisaged outcomes, support to be provided, timelines, local job opportunities, expected roles and responsibilities by all interested parties.

Tsholetsega Primary School was the first chosen site followed by the concurrent installation sites of Mofolo North Informal Settlement and Tirelo Farm School. The reasons for adopting the sites, contact details and addresses are as follows: -

Tsholetsega Primary School – EMIS number 700252023

653 Leeu Street, Kagiso 1, 1754

Principal: Mrs Nozibele Constance Rajuile

Tell: 011 410-0642

Department of Basic Education, Mogale City, Gauteng

Cnr. Boshoff & Human Streets

Representative: Mr Thozamie Horace Signili

Tell: 011 660-4581

School user numbers: + 1,301

Commissioned: During August 2020

Tsholetsega PS has an enrolment number of 1,300 learners. Of the three existing ablution blocks two had collapsed due to sewer connection failure to the municipal connection resulting in raw sewerage regularly escaping inline inspection covers and flooding the school quadrangle, necessitating closure of the school until after a clean-up. The third and only in use ablution facility was in a state of disrepair, unhygienic and with leaking potable water at an estimated cost of R 30,000.00 per month.



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We were able to reinstate the first two frontend ablution blocks by redirecting the main sewer outlets and connecting to the Clear remotely placed backend. A main grid electrical connection was available and connected to. No challenges apart from mains electrical load shedding were encountered and there were no acts of theft or vandalism. There was full acceptance and ownership of the technology and project by the student governing body (**SGB**), educators and learners.

Mofolo Informal Settlement [under the auspices of The City of Johannesburg / Johannesburg Water **JW**]

Full solar powered treatment plant

Matime Street, Meadowlands, Soweto
Municipal Councillor: Mrs Tebogo Mhlari
JW Manager Innovation & Technology: Dr Zakhele Khuzwayo
Tell: 011 688-6608

User numbers: 75 Households at +/- 375

Commissioned: During November 2021

Mofolo has 85 erected informal houses with the limitation of no new and further additions due to the bordering infrastructure, a railway line to the east, a road and formal houses to the south, a wetland and major road to the west and a small drainage river to the north. For the approximate 340 residents, ten free standing rental chemical toilets were provided by the municipality for their daily usage. No main grid connection was available therefore a fully generating solar system was installed. It was important to measure the degree of user acceptability, accountability, and ownership when dignified and aspirational sanitation is provided to disadvantaged communities versus the typically despised chemical toilets. From a municipal level, the cost and sustainability between NSSS and chemical toilets was equally important. No challenges or acts of theft and vandalism were encountered and there was full acceptance and ownership of the technology by the community.

Tirelo Farm School – EMIS number 600102141

Knopfontein Farm, Verdoornpark, Coligny, 2725
Principal: Mrs L.M. Molete
Tell: 018 673- 0606
Department of Basic Education
Mr Lucas Seloga

School user numbers: + 247

Commissioned: During February 2022

During 2015 a new borehole fed waterborne ablution block was erected and connected to a conservancy and/or a septic tank. The system operated for a few months until the bordering farm fields became waterlogged with the overflowing wastewater due to the prevailing and adverse soil conditions. For seven years numerous alternative options were implemented or tested to no avail. During these seven years mobile chemical toilets were hired at a monthly cost of R 40,000.00. Installation of the Clear Backend Treatment Plant connected to the existing frontend ablution block



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rectified the situation with its commissioning during February 2022. No challenges, apart from mains electrical load shedding were encountered and there were no acts of theft or vandalism. There was full acceptance and ownership of the technology by the SGB, educators and learners.

Social facilitation and User Surveys

Social facilitation was covered above under “site selection”.

Qualitative surveys were undertaken at two of the sites, namely, Tsholetsega Primary School and Mofolo North informal settlement.

Surveying material was provided in English and translated into the most appropriate vernacular for the area. All surveys were conducted in private by an appointed external and unbiased company using picture grams to answer the questions. No names were taken during the surveys and the participants remain anonymous. Due to the age of some of the school learners, verbal and private one-on-one surveys were held. In all cases signed written permission and/or authorisation was obtained from those surveyed, the school SGB and Principal. In the case of minors, permission from parents or guardians was also obtained prior to commencing.

Both commenced with a baseline pre-installation / handover survey covering the user experience of the current/pre-Clear ablution facilities. Thereafter 6 monthly surveys were undertaken covering the Clear sanitation experience until user acceptability had been confirmed and it was ascertained that further surveys would not be of further benefit.

Performance Monitoring, Servicing and Maintenance

All three sites were subjected to initial weekly visits, then monthly visits, thereafter to monthly/and or as and when required due to the implementation of a remote cloud based key component monitoring system.

Samples of the treated flushing water and comparative untreated input wastewater from the 1st stage collection tank were taken weekly from Tsholetsega Primary School and tested at an accredited SANAS laboratory for a period of 28 months. Comparative historical records are maintained against the initial August 2020 baseline water loading sample.

The Mofolo North plant was subjected to monthly sample analysis on the same basis as above.

Waste analysis has now been reduced to once a month.

No sampling was undertaken at the Tirelo Farm School.

Analysis outcomes were found to be in line with ISO 30500.

Service events are performed as per the following: -

1. Minor service event every six months – membrane bioreactor clean with a downtime of six hours.
2. Major service event every 24 months – membrane bioreactor clean and plant desludging with a downtime of 12 to 36 hours.



Marketing

Since commissioning of the first system and during the entire evaluation period, continuous visits by interested local authorities, municipal mayors, municipal managers, sanitation decision makers, project designers, project funders and implementing agents have occurred.

Notably, most of the high-level delegation visits were influenced, arranged and organised by the WRC and the BMGF. Visits included the following organisations: -

- a. The South African Local Government Association
- b. Deputy Mayor of eThekweni
- c. Mayor of the city of Cape Town
- d. World Bank
- e. ONAD Utility, Côte d'Ivoire

Showcasing the sites as a venue for “World Toilet Day” celebrations, sites launches, hosting stands at Exhibitions and Conferences, has provided excellent and meaningful exposure.

Marketing efforts is an ongoing process.

Results and Discussion

Innovation Description

Description:

“Off the grid backend non-sewered recirculation flushing sanitation system, which can connect to multiple frontends”.

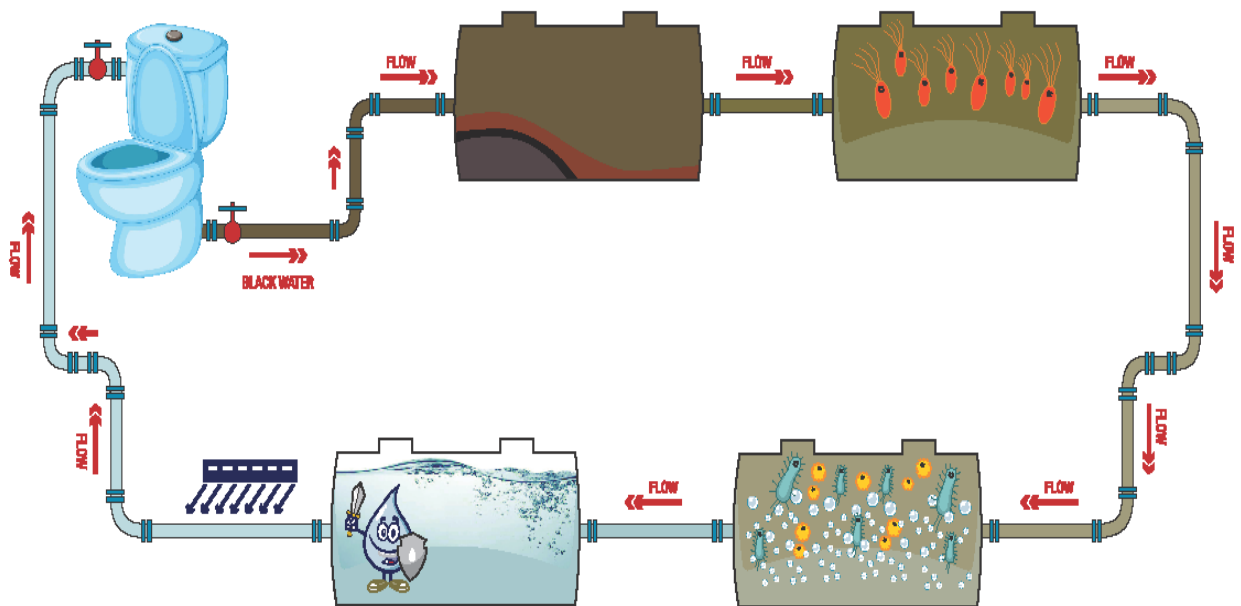
Wastewater is introduced into a fully automated closed-circuit set of tanks that biodegrades the organic pollutants contained in black wastewater and reduces their concentration.

The wastewater enters an incoming below the ground collection tank and via a macerator and lifting pump, it is transferred to above ground treatment tanks. Firstly, into the primary sediment and skimming tank. Thereafter the wastewater flows through anoxic and aeration tanks where controlled dosing takes place with diluted glucose and poly aluminum chloride. The next treatment tank is the membrane biological reactor, which separates the pollutants. Finally, the treated water is further disinfected via an ozonating process before being recirculated for the next flush. Without the need for sewer connections and a continuous potable water supply, the Clear Enviro Loo Sanitation Treatment Plant treats wastewater and kills pathogens by means of a natural, organic process.



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Innovation Name:

Clear Enviro Loo Treatment Plant

Competitor Products or Services:

Prana Consulting

WEC Projects provides the NEWGEN NSSS treatment plant.

Intellectual Property

All related intellectual property is held by Clear (Suzhou) Environmental Technology Co. Ltd.

Enviro Options [Pty] Ltd is governed by an exclusive manufacturing licence.

Commercial and Marketing activities

Enviro Options [Pty] Ltd has commenced with full local manufacturing and fabrication by installing a dedicated product production line, its own stores and as a cost centre within our business. Currently twenty units are being manufactured to stock in anticipation of near future sales opportunities.

The first private sector Corporate Social Investment sale was made during December 2022. Installation commenced on 09 January 2023, with handover to the school expected on 25 January 2023.

It is envisaged that exports into other African countries will commence during 2023.



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Supply chain security and development internally and with external assistance.

The existing Enviro Options business model of appointing district based, trained, accredited servicing and maintenance technicians will be used for the Clear product range. This model will incorporate using existing and new re-sellers and distributors. This aligned to the company's ethos of job creation and providing a cost-efficient national service platform.

Marketing efforts are ongoing with completed hard and soft copy brochures, presentations, videos, and information packs.

Communication has occurred and will continue with media advertisements, press releases and the setting up of prospective client meetings.

Self Assessment

Technology Readiness Level

The TRL table allows an innovator to see at what stage his product is for the market and operational environment.

Technology Readiness Levels		
TRL 1	Basic research	An innovative principle was observed and reported on. The innovation is an idea. The observation cannot be reproduced or applied as yet.
TRL 2	Proof of principle	The innovation concept and/ or application has been formulated and it is possible to demonstrate parts of or the entire innovation.
TRL 3	Early lab scale demonstration	Partial proof of concept achieved. A laboratory-scale demonstration was possible. May not be reproducible yet.
TRL 4	Late lab scale	Lab scale validation of proof-of-concept through a trial, and/or input received from an external source. Innovation is reproducible.
TRL 5	Validation	Broader trial or validation of the proof of concept is achieved. Can include early stage commercial demonstration or application in relevant institutional environment
TRL 6	Early prototype	The early stage prototype can be fully or partially demonstrated in its relevant environment of use (possibly in a commercial or institutional setting). It is not a complete prototype. Learnings and iterations still ongoing.
TRL 7	Late prototype	The prototype can be demonstrated in its relevant environment of use (possibly in a commercial or institutional setting). The prototype is nearer to completion. Fewer learnings and iterations are needed.
TRL 8	Early stage commercial environment application	Innovation being tested or has been completed in its commercial or institutional environment. Learnings and iterations applicable to its commercial use are still generated.
TRL 9	Market ready application	Innovation is being used in its intended commercial setting. There is proven commercial use or proven institutional application. Fewer iterations are being done, if so then they are minor.

What was the innovation TRL of your product or service pre-WRC Accelerator Programme funding support?

TRL 9

What do you evaluate your technology to be post-project? Also briefly discuss key development needs still required.

TRL 9

Research & development with the aim of reducing the cost of components, improving operational efficiencies and ease of installation for contractors.

Note: add note that TRL does not need to change

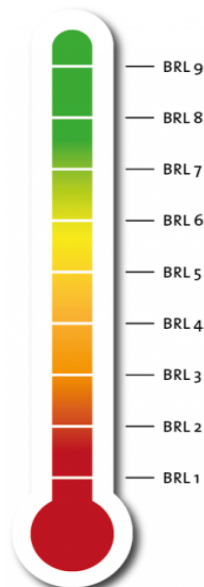
Technology Innovation Agency. n.d. Technology Readiness Levels. n.p



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Business Readiness Level



Source/reference

Business model is final and is scaling with growing recurring revenues that results in a profitable and sustainable business

Sales and metrics show business model holds and can scale

Product/market fit and customers payment willingness shown

Full business model including pricing verified on customers

First version of revenue model including pricing hypotheses

First projections to show economic viability and market potential

Draft of business model in canvas

First possible business concept described

Hypothesizing on possible business concept

What was your business readiness level before WRC Accelerator Programme funding support?

BRL 9

What is your current BRL? Also briefly discuss key development needs still required.

BRL 9

In time relocate this business cost centre to its own dedicated premises, which planning is already underway.

Note for innovator.

Technology Innovation Agency. n.d. Business Readiness Levels. n.p

Market Readiness Level



What was your market readiness level before WRC Accelerator Programme funding support?

MRL 9

What is your current MRL? Also briefly discuss key development needs still required.

MRL 9

Continue with knowledge sharing to enable sanitation project designers to realise the benefits of NSSS and adopting for projects by budgeting accordingly.

Technology Innovation Agency. n.d. Market Readiness Levels. n.p

Manufacturing Readiness Level

Phase	MRL	State of Development
Phase 3: Production Implementation	9	Full production process qualified for full range of parts and full metrics achieved
	8	Full production process qualified for full range of parts
	7	Capability and rate confirmed
Phase 2: Pre production	6	Process optimised for production rate on production equipment
	5	Basic capability demonstrated
Phase 1: Technology assessment and proving	4	Production validated in lab environment
	3	Experimental proof of concept completed
	2	Application and validity of concept validated or demonstrated
	1	Concept proposed with scientific validation

What was your manufacturing readiness level before WRC Accelerator Programme funding support?

MRL 9

What is your current Manufacturing Readiness Level? Also briefly discuss key development needs still required.

MRL 9

Efficiently manage existing and available factory production space.

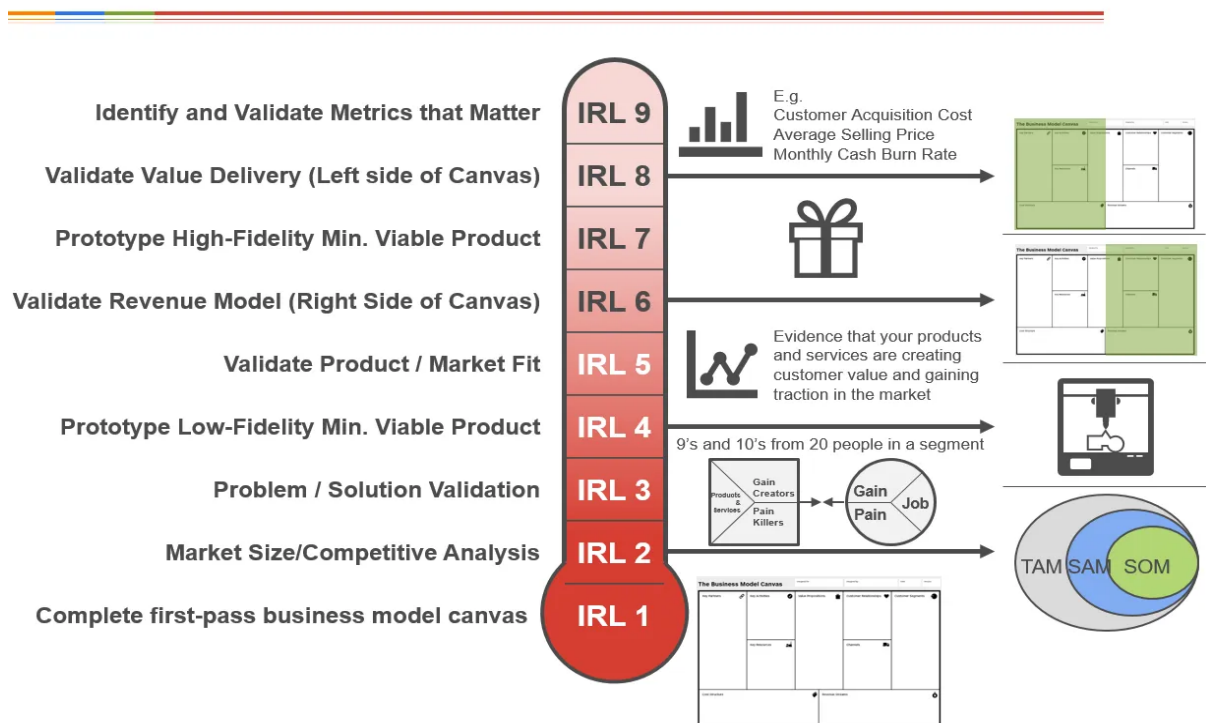
Rescoll. 2014. Available on: https://rescoll.fr/trl-technology-readiness-level-mrl-manufacturing-readiness-level_trashed/



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Investment Readiness Level



What was your investment readiness level before WRC Accelerator Programme funding support?

IRL 9

What is your current Investment Readiness Level? Also briefly discuss key development needs still required.

IRL 9

Ignition Framework. 2015. Available on: <https://www.ignitionframework.com/the-innovators-canvas-a-step-by-step-guide-to-business-model-innovation/>. [Accessed on 12 April 2021]

References:

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Appendices

All the following appendices are shared as separate attachments: -

1. Assessment report
2. Budget vs. actual spend
3. Marketing material
4. Surveys
5. Waste analysis