
THE DIGITISATION OF SANITATION

Transformation to smart, scalable and aspirational sanitation for all

A thought piece from the Toilet Board Coalition
November 2016



About the Toilet Board Coalition (TBC)

The TBC is a business led coalition. We share a joint vision and are committed to providing the necessary leadership, mentorship and investment needed to accelerate the pace of change to achieve universal access to improved sanitation and aspirational toilet experiences.

We work at the systems level to co-create the necessary ecosystem to support sanitation businesses to scale. And, we work directly with promising businesses in low-income markets that have the potential to deliver sustainable and resilient sanitation at scale.

We have created a platform for global business leaders to join the global sanitation community in a public-private partnership with the aim to accelerate business solutions that deliver smart, sustainable and scalable sanitation through the market.

Mobile for Sanitation Feasibility Study Participants

We are grateful for the generous time spent with us on this study - from the inspiring and innovative small and medium sized businesses who opened their doors and plans to us - to our members and invited experts who created an infectious “can do” environment that has allowed us to dream big, and connect our starting points to real opportunities today - and to our skilled analysts who went into overtime on many occasions to make sure that all avenues presented were explored and all voices were heard. You have been a dream project team and we thank you!

We would like to extend special thanks to our project partners and core team: Michael Nique and Caroline Sheldon of the GSMA our mobile experts; Saskia Reus and Vincent Kouwenhoven of Africa Funded, Aqua4All, and eVentures respectively, our business analysts; Michael Lindenmayer our TBC Entrepreneur in Residence and Toilet Hacker; Claire Balbo and Alex Knezovich our chiefs of getting it done! With much appreciation.

Our list of study participants is below:



About this paper

In 2016 the Toilet Board Coalition ran a Feasibility Study to explore the potential role of mobile and digital applications to drive efficiencies and consumer demand in sanitation business models operating in low-income markets. The following questions were at the centre of our inquiry:

- How are sanitation businesses operating in low-income markets using mobile and digital applications in their businesses today?
- How are sanitation businesses and entrepreneurs thinking about next generation opportunities for mobile and digital applications for their businesses in the future?
- What is needed to build the ecosystem for the digitisation of sanitation for the low income markets?
- Is there commercial interest and demand from large industrial operations to become buyers and investors into the system?

Our study engaged twelve small and medium sized businesses engaged in the sanitation sector across low-income markets, with experts from multinational corporations, development organisations, and specialists from across the mobile for development, smart cities and internet of things sectors.

Our approach was to understand the business, technical and customer demand feasibility of each of the businesses where the entrepreneurs saw potential for mobile and digital applications. Business transactions are at the centre of our approach, focusing on opportunities for business efficiencies and opportunities to add value for the low-income sanitation consumer. It is our vision to leverage the toilet for broader health benefits and aspirational value beyond the hardware.

The transition to smart, sustainable and aspirational sanitation for all, and unlocking the promising business opportunities associated with it, will not be without risk. For example, data privacy and ethics standards will need to be managed to optimise business opportunities.

This paper presents the findings of our study in the form of a thought piece on the topic of the digitisation of sanitation for all. Our intent is to present a number of business opportunity spaces, where we believe that value has been left on the table and customer needs unmet, to be explored further in the decade ahead.

Disclaimer: *The contents of this paper provide a synthesis of our discussions and findings from the Feasibility Study. All information has been subject to the interpretation of the authors, the Toilet Board Coalition Secretariat, and does not necessarily represent the views of all Toilet Board Coalition members, or those companies and experts who participated in the study.*

Introduction

Mobile & Digital for Sanitation

We started to think about the emergence of mobile and digital applications for sanitation when we asked ourselves the question, who is succeeding in selling basic needs goods and services to low-income consumers in emerging and frontier markets at scale?

Creating consumer demand in low-income markets to pay for a toilet and its servicing remains a key barrier to achieving SDG goal 6, universal access to improved sanitation by 2030 - toilets for the 2.4 billion people currently without. People everywhere don't just want a toilet, we want a pleasurable sanitation experience. Universally, people not only want what fulfils our basic needs today, but what fulfils the lifestyle that we aspire to in the future. From a business view this makes a lot of sense when you follow the experience of the user - consumer.

Observing the transformational trends of mobile applications for development such as the powerful enabler of mobile money and its success in providing access to energy with pay-as-you-go solar systems, we sought to understand how this transformation could be applied to provide access to sanitation at scale. We asked leading mobile operators¹ for their view on what the catalytic factor was for the rapid growth in demand for pay-as-you-go solar systems. They told us that while mobile money cut the 'barrier to entry' in terms of the ability to pay \$1 a day for the system vs. \$200 up front, it was when they put a phone charger in the system that sales really took off. Those product designers understood that the energy was simply an enabler to what people really wanted - the connectivity, information and entertainment on their mobile phone.

What then could be the equivalent value add, leveraging the low-income consumer's aspiration for mobile and digital, that we could add to a toilet that would make them 'fly off the shelves'? It is this quest for understanding the future low-income consumer, their aspirations in terms of personal sanitation and health, and their relationship with transformative consumer technologies and applications that has motivated this study.

We are grateful to our partners, the GSMA, whose forward looking report, *The Role of Mobile in Improved Sanitation Access* published in August 2015 allowed us a very useful starting point for our inquiry. The GSMA's report identified 5 key areas where sanitation businesses might apply the learnings of other utilities in their successful applications of mobile for development. These 5 areas focused on driving efficiencies in the business with mobile and digitising key business processes to enable scale.²

At the same time, we have started to explore the realm of the internet of things (IoT) and its powerful data capture opportunities to understand the possibilities of mining key health data from the toilet. It is our vision that the opportunity to obtain health information from your toilet could drive demand for the toilet and its usage amongst the 2.4 billion people currently without.

At the Toilet Board Coalition it is our mandate to identify, support and accelerate business solutions for universal access to smart, scalable sanitation. We believe that collectively, we can enable universal access by 2030 to reach the target of SDG 6. In fact we believe that this goal provides savvy businesses with the opportunity of the decade - to capture unrealised business value and to address unmet needs of future consumers.

This report provides some exciting signals through case studies of current business applications - where mobile and digital applications for sanitation are already underway in local communities in low-income markets - and encourages large businesses to look into these new opportunities to take the system to scale.

In this decade we will install the most toilets and sanitation systems in a single period of time in human history. This achievement will also lock-in important infrastructure that will need to serve our growing populations into the future - it would be a shame if this massive change in sanitation access and usage was not smart, and resilient into the future, i.e. not able to link into the smart cities architecture being enabled across all other sectors right now.

The digitisation of sanitation is not something for the future - it is something that we need to seize today. We can't wait!



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Foreword

2.4 Billion people still lack access to an improved source of sanitation, yet up to 95% of this population is covered by mobile networks and unique subscriber market penetration is above 63%, i.e. more than 4.7 Billion people have at least one mobile phone number. With more than 411 Million registered mobile money accounts, mobile is also increasingly changing the landscape of financial inclusion. As a result, some people can browse the internet on their smartphone, get connected to the rest of the world and receive mobile money remittances from relatives leaving in far away countries, while they still don't have any safe solutions to fulfil one of the most basic human needs, going to the toilet. This is a paradoxical situation for millions today living in emerging markets.

The good news is that mobile devices, technologies and services are not disconnected from the water and sanitation sectors and can operate as enablers to improve current services and support the next generation of sanitation models. Since 2013, the Group Special Mobile Association (GSMA) Mobile for Development (M4D) Utilities programme has supported innovation in the energy and water sectors, thanks to funding from the UK Government; and in 2015, started working with sanitation entrepreneurs looking to pilot mobile technologies in their models.

One of the learnings from our activities is that, across the energy, water and sanitation sectors, mobile money, machine to machine (M2M) connectivity and mobile services are already creating an impact. Enabling unbanked and underserved customers to prepay in small instalments to access a reliable service and collecting data on their payments and usage to create a unique “digital footprint”, are foundational to service populations living at the bottom of the economic pyramid. This has been exemplified by the traction of the solar Pay As You Go (PAYG) model in an increasing number of markets.

As outlined in our report “The role of mobile in improved sanitation access”, although mobile is at an early stage of integration in sanitation, the sector can already benefit from mobile to improve the efficiency of its value chain: for example, provide financing solutions for affordable toilets and/or emptying services; and collect reliable data on usage and operations to identify gaps and inform policy decisions.

What the sector needs now is a better understanding of how mobile is practically harnessed by pioneers through lesson sharing from current pilots and deployments; collect proof points about the impact it creates across the value chain; further support entrepreneurs looking to integrate mobile, through funding and/or access to technical expertise. In the coming months, our programme will publish two case studies related to the learnings of the sanitation pilots GSMA M4D Utilities has funded: Loowatt in Madagascar developing a mobile application to gather and transmit information on toilet servicing and waste management, and enabling customers to pay using mobile money; and Sanergy in Kenya developing and testing the use of sensors to optimise waste collection routes and reduce operating costs.

Finally, it is also through partnerships with technology and connectivity providers that the sector will grow. Mobile Network Operators can support the deployment of local smart solutions by facilitating access to their core services around communication, mobile money and M2M.

The GSMA M4D Utilities programme will continue to support the Toilet Board Coalition's forward-looking activities to further build bridges between the mobile and sanitation ecosystems and players, so that the digitisation of economies improve this basic human need, access to a toilet.



Areef Kassam,

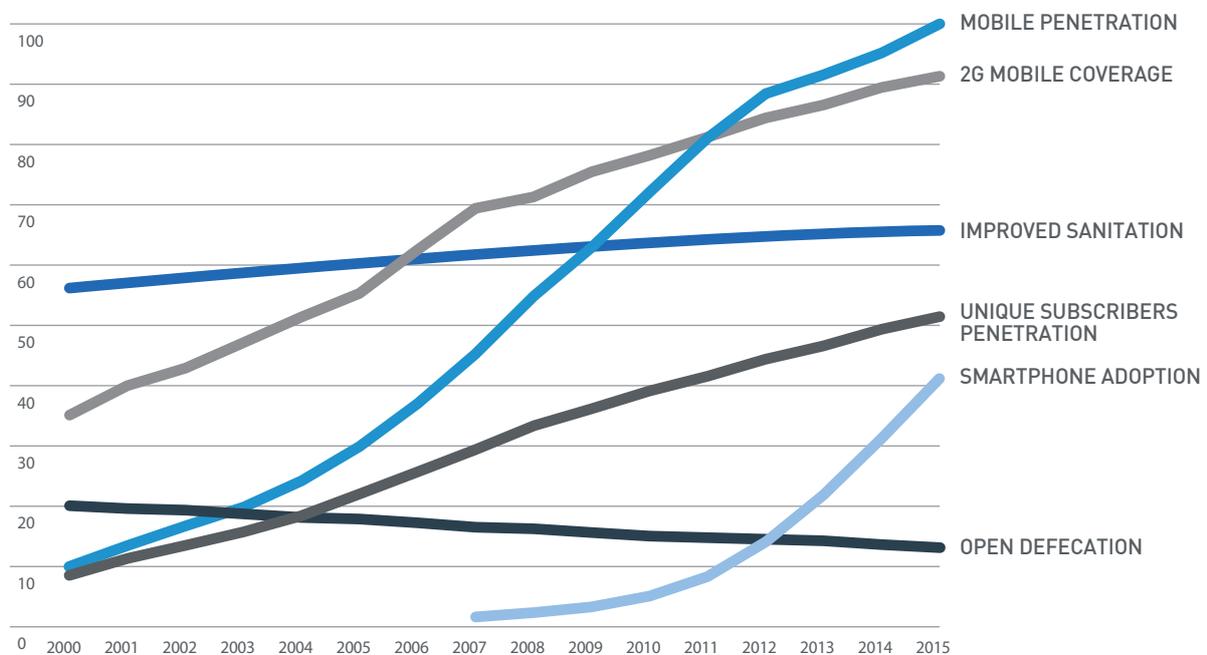
Head of M4D Utilities, GSMA

Our Key Findings

Our initial study into the digitisation of sanitation with entrepreneurs operating in low-income markets, experts, and multinational corporations, has produced five key findings.

- #1** Mobile & digital applications such as mobile money and the internet of things (IoT) are global development megatrends that are mostly unexploited in sanitation systems
- #2** Mobile & digital applications could transform the toilet from a necessary "waste" or toilet resources capturing hardware into a centre of health and information
- #3** There are essential mobile & digital business efficiency tools available for sanitation businesses operating in low-income markets today
- #4** There are innovative mobile & digital applications for industries beyond the sanitation sector in the future
- #5** There are key enablers required to accelerate opportunities for lowest-income consumers

Figure 1: Mobile is the Global Platform



Source: GSMA, 2015. The Role of Mobile in Improved Sanitation Access

Key Finding #1:

Mobile & digital applications such as mobile money and the internet of things (IoT) are global development megatrends that are mostly unexploited in sanitation systems



Mobile and the Internet of Things (IoT) technologies have climbed exponential growth curves over the past 15 years. Rising alongside mobile and IoT is cloud services and big data analytics. The convergence of mobile connectivity, IoT hardware advancements and wide spread adoption of cloud services make low-income smart sanitation possible.

Mobile is the global platform. Mobile penetration growth outpaced all other major utilities, including energy, water and sanitation.

These forward looking mobile and digital applications are already being applied in the development context. In the famous case of mobile money in Africa, the continent is leapfrogging the need to build out physical bank branch networks by going directly to mobile platforms. For businesses operating in low-income markets, current mobile and digital technologies offer near term opportunities in cost savings and bundled services. Effective use of these technologies is advancing efficiencies in logistics, secure payment collection and maintenance of equipment. Recruitment and training stand to make efficiency gains. And it opens up new cost effective ways of bundling and cross promotion. Future innovations in both mobile and sensor technologies position sanitation to open up big data market potential.

These technologies are relevant for both urban and rural marketplaces. Rural communities and reaching the lowest income consumers present unique challenges that mobile, IoT and cloud computing help overcome and open up to new products and services.



PIONEERING EXAMPLE: Pay-as-you-Go (PAYG) Energy

Over the past five years, energy has been the early adopter and beneficiary of mobile and IoT technologies.

Companies like M-KOPA, Mobisol and Fenix International provide decentralised solar energy solutions. In order to overcome logistics, marketing, maintenance and payment challenges, they have incorporated mobile and IoT technologies into their offerings.

Mobile money and pay-as-you go (PAYG) are the main mobile services propelling forward the credit schemes behind solar home systems (SHS) for low income consumers. Mobile money offerings are on the rise. According to the GSMA's Mobile Money Report 2015, there are 93 countries with a combined total of 271 different mobile money services. These are processing over 33 million transactions a day. At present there are 411 million registered mobile money accounts. In 37 of these markets, agents account for 10 times as many access points as bank branches.

The adoption of mobile channels, and especially mobile money, has enabled more than 30 solar providers to install approximately 650,000 pay as you go systems. Pioneering firms are working with Mobile Network Operators ("MNO's") to find ways to use airtime usage as a means to assess the credit worthiness of potential clients.

Source: GSMA, 2015. Mobile Money State of the Industry Report 2015

The GSMA M4D Utilities' 2016 Annual Report on advancements in mobile for development in utilities sectors cited that while there have been advancements in water utility applications (following energy), sanitation remains nascent. Our study concurs that the potential for mobile applications in sanitation businesses is still virtually un-tapped. In addition, amongst the dozen sanitation SMEs participating in our study, sanitation entrepreneurs have often had to 'reinvent the wheel' re-creating costly technology programs and platforms that are already available due to a lack of coordination in the sector.

To overcome this challenge of the sanitation sector lagging behind, the GSMA's Mobile for Development Utilities Innovation Fund (supported by the UK Government) has helped to kick-start pilots with sanitation businesses interested in experimenting with mobile technology applications. These include the opportunity to make "smart" toilets that help the sanitation enterprises to understand toilet usage per user and optimise "waste" or toilet resource collection schedules and routes.

Case studies from pioneering sanitation businesses and GSMA grantees who participated in our study, are below.



PIONEERING EXAMPLES: From GSMA M4D Utilities Innovation Fund

Sanergy, in partnership with SweetSense, is developing and testing the use of sensors to determine the levels of Fresh Life Toilets, operator-owned waterless toilets designed for informal settlements. The seed grant will aim to test whether sensor technology works in the sanitation environment and is appropriate to optimise "waste" or toilet resource collection routes and reduce operating costs.

Sanergy, Kenya: "In partnership with GSMA, Sanergy is testing how we can use sensors in our Fresh Life Toilets to optimise our waste collection process thus increasing the availability of toilets for users." - Ani Vallabhaneni, Co-founder.

Loowatt is developing and testing an ICT platform and mobile application to improve the coordination of waste collection logistics and customer service associated to their waterless toilets for households in an urban area of Antananarivo, Madagascar. The seed grant aims to prove the value of ICT and mobile services on reducing the cost of waste logistics, improving the likelihood of safe waste disposal and collecting mobile payments from customers for their sanitation needs.

Loowatt, Madagascar: "Our mobile ICT platform aims to empower local urban sanitation operators by improving cost efficiency and verifying the provision of safe and sustainable waste treatment." - Virginia Gardiner, CEO.

GSMA, 2015: Mobile for Development Utilities Programme Catalogue of Grantees

Key Finding #2:

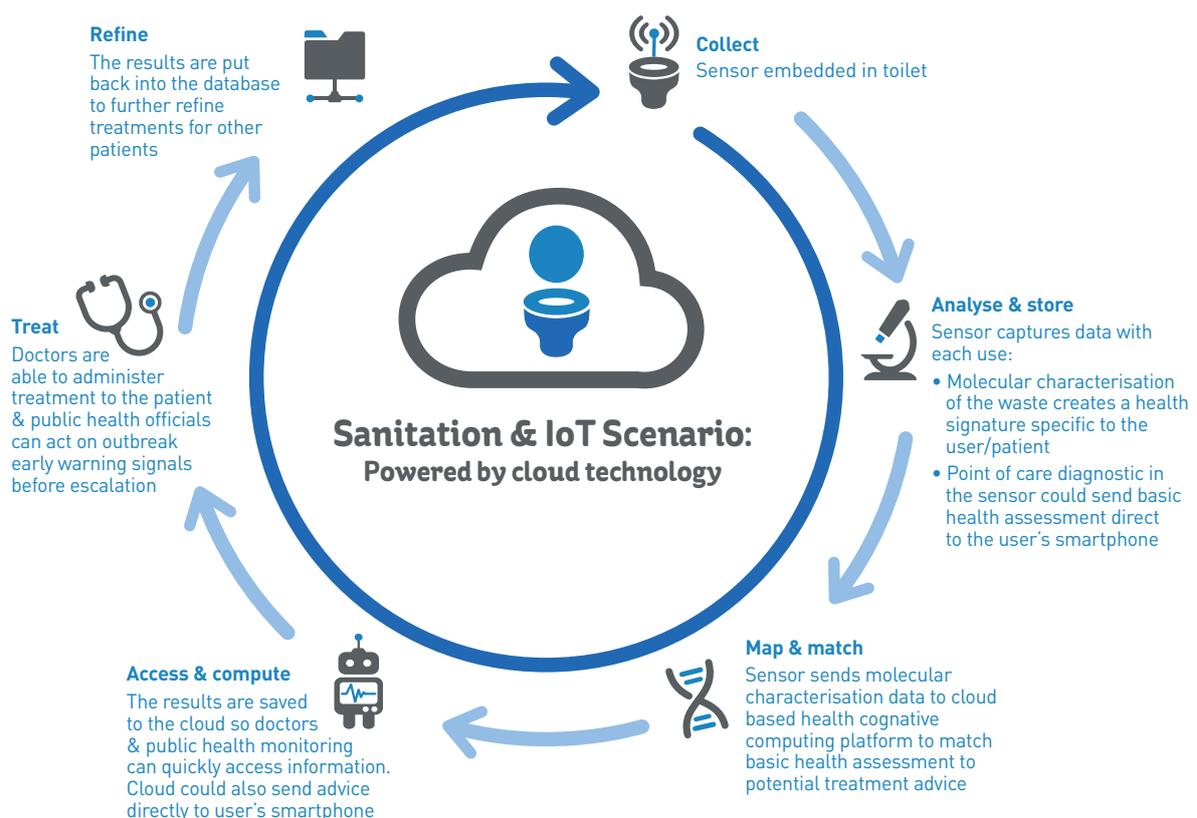
Mobile & digital applications could transform the toilet from a necessary “waste” or toilet resource capturing hardware into a centre of health and information



The toilet today is not often linked to health information. From a circular economy perspective there is new value to be found in mining, analysing, recycling and upcycling all “waste” or toilet resource (see our sister paper on Sanitation in the Circular Economy). If we look further into the human waste inputs that pass through a toilet we see the opportunity to capture essential health data which can improve our understanding of an individual’s basic health. A look into the future can envision a smart healthcare cycle being generated by the sanitation system.

The human inputs into a sanitation system are abundant in health data. This includes micro-biome, genetic and blood-based information through menstrual cycles. And aside from menstrual cycles being monthly, the rest of the input into the system is a daily delivery. This could yield one of the largest health data sets in the world. And it could produce customised or public health insights.

Figure 2: How it works: Sanitation & IoT Scenario



Source: Adapted by the TBC from Dell Children's Cancer Care Initiative. Downloaded from dell.com on 12 July 2016.

While our study did not find any current examples of sanitation businesses using sensor, IoT technologies to capture health data, the International Technology Union (ITU), a United Nations body, and Cisco's systems report, *Harnessing the Internet of Things for Global Development*, identifies some pioneering examples of the use of sensors in sanitation and potentially applicable sensor applications across sectors.



PIONEERING EXAMPLES: Sensor Technologies for Sanitation

Sensors originally designed to monitor water flows are also being used in sanitation. In Indonesia, flow sensors were combined with motion detectors to analyse behavior change related to hand-washing following latrine use. The sensors in effect enabled a more accurate reading of actual behaviour vs. the former practice of self-reported surveys in order to apply the most relevant solutions. Similar techniques can be used to monitor basic hygiene techniques in homes, clinics, and hospitals.

Sensors are being used to provide continuous data on usage and performance of programmes in water, sanitation, household energy and rural infrastructure including Latrine monitoring in Bangladesh and Kenya. These sensors use Wi-Fi or cellular networks to transfer data. The data is then integrated into a database, monitoring summary statistics on performance and usage to front-end users.

Outside the sanitation sector, in tea plantations in Sri Lanka and Rwanda, sensors are being used to monitor soil moisture, as well as carbon, nitrogen, potassium, calcium, magnesium, and pH levels. The sensors and connectivity modules are powered through solar panels, and the data are transmitted wirelessly. Similar sensor applications could be used in sanitation to understand the indicators of disease in human “waste” or toilet resources samples.

Source: ITU & Cisco, 2016, *Harnessing the Internet of Things for Global Development*, Geneva

During our study we spoke with IoT experts from CERN (The European Centre for Nuclear Research) who explained to us that they have been monitoring risks - health risks, environmental risks and security risks - via more and more powerful sensors in the last decades.³

These examples provide promise that while we are not yet monitoring our health based on what goes into our toilet, powerful sensor technologies already available today could be a key enabler to unlock this new opportunity.

Vibrant IoT Healthcare Market

There is a vibrant marketplace of players working on IoT applications in the healthcare space. They are applying IoT to clinical efficiency, clinical grade biometric sensors, consumer monitoring, brain sensors, fitness wearables, infant monitoring and sleep monitoring. Forecast to be a \$117 billion market for the IoT in Healthcare by 2020 according to Forbes.⁴ Mobile Health (“mHealth”) is also poised for dramatic growth. According to the PWC and GSMA *Touching lives through mobile health: Assessment of the global market opportunity* report indicates that the mHealth marketplace to be poised to grow into a \$23 billion USD market by 2017. They estimate that diagnostics will account for 15% of this marketplace at \$3.4 billion USD in revenues.

Take into consideration that these figures preclude big data being generated by future digital sanitation systems. Sanitation systems have the potential to provide the world’s largest, consistently updated and geo-location specific health data set.

Key Finding #3:

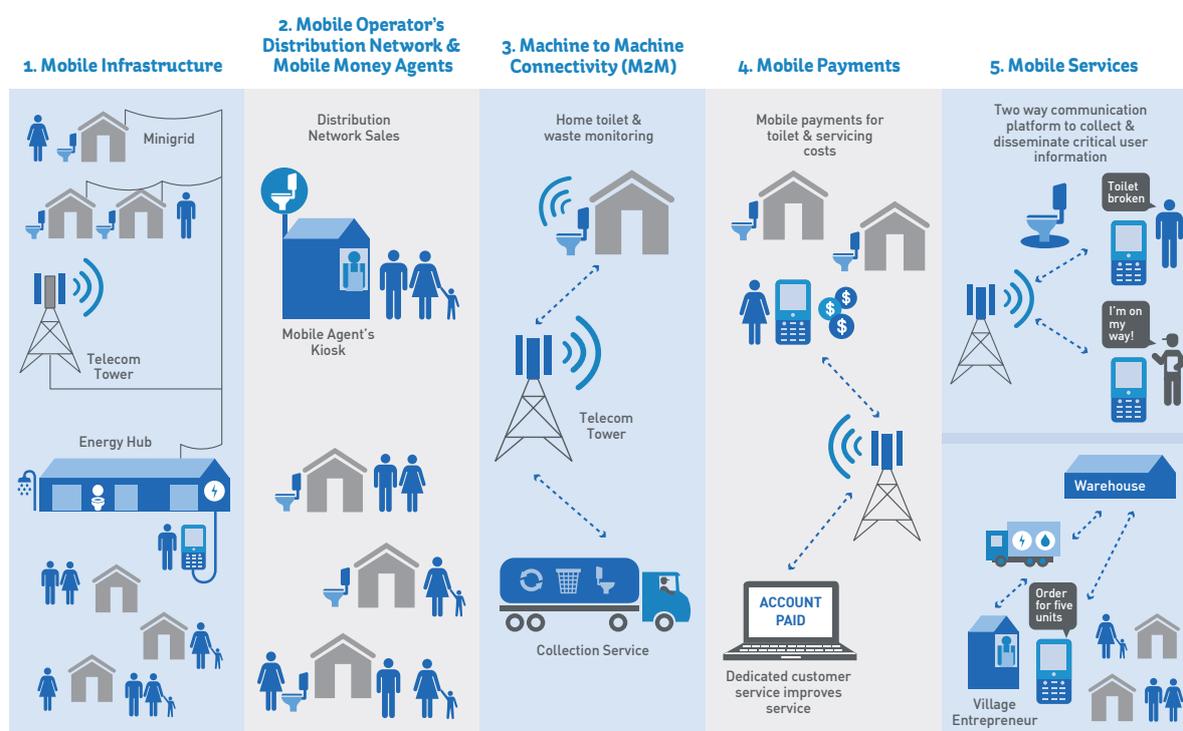
There are essential mobile & digital business efficiency tools available for sanitation businesses today



Delivering sanitation solutions in low-income markets is a major challenge. There are both centralised and decentralised models. In most cases, decentralised systems are growing more quickly than centralised ones due to the upfront costs associated with installing centralised services.

Learning from the applications of other utility sectors, energy and water, there are several mobile applications and services today for sanitation businesses to overcome current business challenges, gain efficiencies and generate new business opportunities.

Figure 3: Mobile Applications for Sanitation



Source: GSMA, 2015. The Role of Mobile in Improved Sanitation Access Adapted by the TBC August 2016

Mobile money could unlock access to toilet hardware on a pay-as-you-go (PAYG) model. Toilets can cost \$200–300 or more which can be prohibitive for low-income consumers. Toilet service models (where the user pays for the regular collection of “waste” or toilet resources from a container toilet, cleaning and maintenance) charge a monthly service fee of \$10–15 per month can still be difficult, especially for seasonal workers, we were told during our study. PAYG rewrites this model and can help sanitation firms set up payment installments that are on par with a households expenditures on lighting and phone charging.

Mobile money is now available in 93 countries with 271 services.⁵ As mobile money becomes more ubiquitous it offers new cost saving and revenue generating benefits for toilet businesses. Mobile money can help to overcome challenges of payment collection and financial flows throughout the value chain ranging from end user payment, entrepreneur loan repayment to salary payments.

Machine to Machine (M2M) connectivity via mobile helps businesses to connect the value chain, infrastructure and capture real-time information throughout the operations that are typically challenging to monitor - such as route efficiency for sludge collection trucks based on customer needs.

Many of the SMEs participating in our study considered logistics and route optimisation for “waste” or toilet resources collection as a key factor in driving efficiencies in their business.

Mobile services can improve the flow of information between the workforce and customers via real-time, geo-locating and digitised customer relationship management (CRM). A continuous flow of centralised customer data can help sanitation businesses to ensure service quality, gain consumer insights, deepen customer relationships and manage growth.

In addition, near term revenue growth opportunities can be explored in: bundled services, advertising, product promotion programs, loyalty programs and recruitment of agents or franchisees.

It was the aim of our study to understand how these applications are driving cost savings or revenue generation in the sanitation businesses serving low-income markets today. Many of the companies involved in our study use mobile platforms to track their on-site cleaning teams. They use it for labour management as well as complaint reporting. Mobile apps and SMS can leverage geo-location to improve fleet management of “waste” or toilet resources collection. Mobile apps can help collect data on local sanitation practices and help feed into behavior change programs. Mobile apps and SMS can improve customer service in facility maintenance and waste collection. Mobile advertising offers up potential returns.



A PIONEERING EXAMPLE: Samagra, India

Samagra has developed a customer-centric public toilet block model that leverages technologies for a behavior change program that has dramatically increased the use rates of their toilets. Initially it was an analog loyalty program. Think of a coupon book. This has since been advanced into a digital and mobile readied platform that drives traffic to his sites. This has now become a core part of revenue generation for his business model. As part of their model, Samagra toilet blocks have kiosks that provide bundled products and services.



A PIONEERING EXAMPLE: Saraplast, India

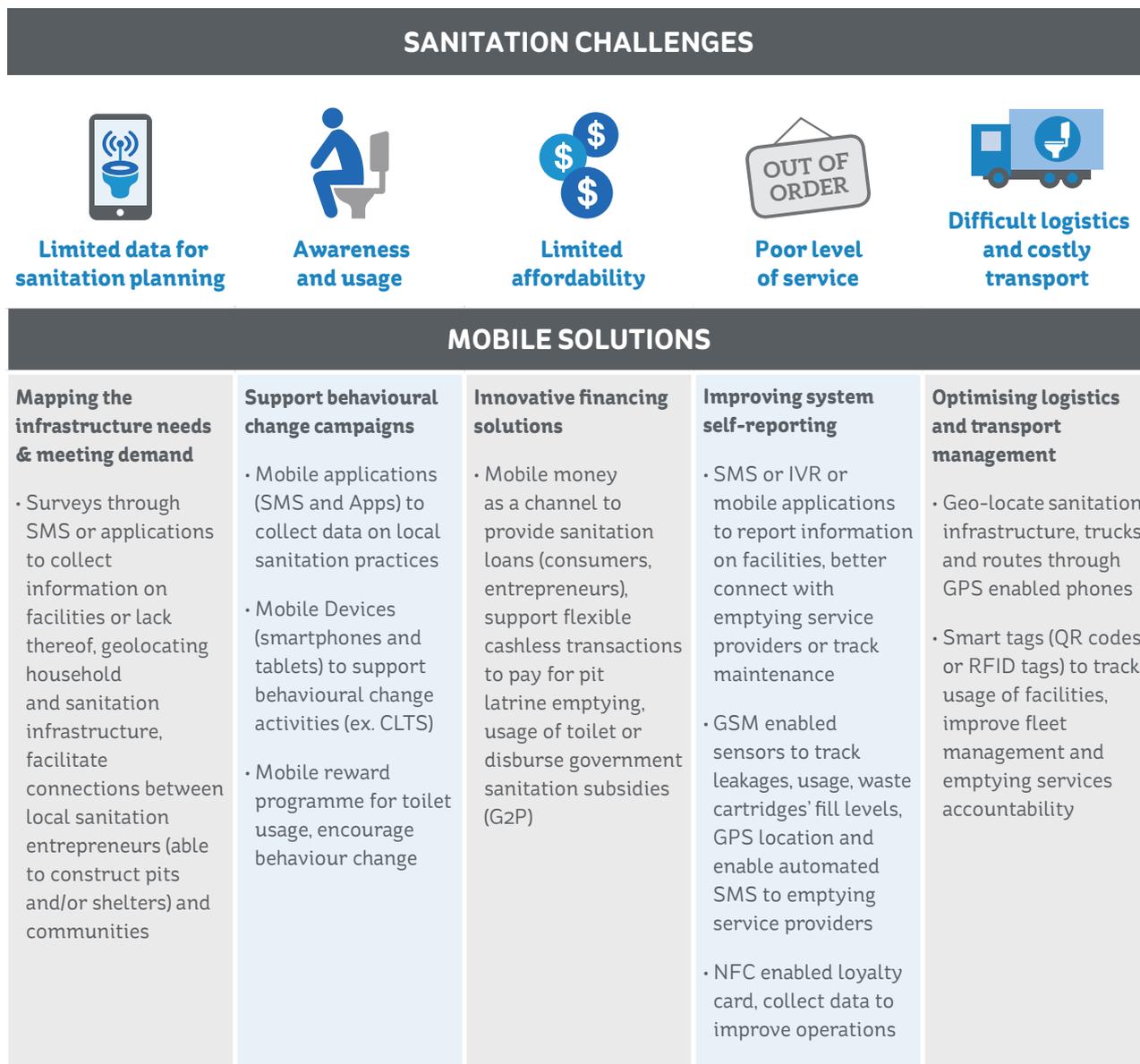
Saraplast has pioneered a “Mobi-Loo” business model of portable and mobile toilets throughout India. They specialise in construction sites and special events but also serve households, public sites and disaster relief zones. They leverage M2M and mobile service platforms to optimise the logistics of moving their toilets from event to event; and mobile services to communicate with their customers regarding the repair, maintenance and on-site cleaning of their assets. They have a mobile app to track their toilets via geo-locating and to aggregate services for waste management.



A PIONEERING EXAMPLE: Garv, India

GARV portable toilets are self-sustaining, powered by solar panels and equipped technologies for self-cleaning and maintenance such as battery packs to power LED Lights, exhaust fan, RFID and sensors. Garv has developed RFID technology to support efficient usage and maintenance, including sensor based (waterless) flushing and to optimise the servicing processes. GARV is piloting mobile solutions for pay-for-use, geo-locating, mobile market surveys as well as advertising on the toilets by the maintenance agency. The RFID dashboard is mobile friendly as well. Through this, the implementing agency will be able to monitor real time data (health, hygiene, asset related) on any mobile device through IoT.

Figure 4: Mobile Solutions to Sanitation Challenges



Source: GSMA, 2015. The Role of Mobile in Improved Sanitation Access Adapted by the TBC August 2016

Cloud computing and the value of big data for utility infrastructure

In addition to the possibility of controlling devices remotely, integrated M2M components in utility infrastructure allows service providers to collect a wealth of data on their system operations. Cloud computing now makes it possible to analyse large quantities of data to generate specific insights and intelligence, converting guesswork and speculation into predictive and analytical power. Using machine-learning algorithms on integrated data seems to be key to extracting accurate insights and triggering the right actions.

Big data adds value for utility models, allowing them to: generate insights on real-time operations and define a “normal behaviour” profile.

SOURCE: GSMA 2016, Mobile for Development Utilities:Unlocking access to utility services: The transformational value of mobile

Key Finding #4:

There are innovative mobile & digital applications for industries beyond the sanitation sector in the future

1. **Smart cities platforms and operating systems**
2. **Public health monitoring, information and connectivity**
3. **Individual health status diagnostics, cognitive computing, consumer health products and mHealth information**
4. **Blockchain possibilities**



Future Proofing Sanitation - enabling smart sanitation for all

The UN *World Urbanisation Prospects 2014* report indicates that by 2030 there will be 41 mega cities that are home to 10 million people or more. An increasing number of cities worldwide are integrating information and communication technologies (ICT) throughout their infrastructure and services to create what is called a smart city. IHS Markit predicts the number of full-scale smart cities will increase fourfold by 2025.

In India, the Narendra Modi government is promoting a vision of creating 100 smart cities that will require an investment of over \$150 billion over the next few years. It has already identified its first 20 cities for the initiative.⁶

If sanitation is to be future proofed, then sanitation businesses and government services need to design smart city ready sanitation systems and work with stakeholders to make sure sanitation is considered a core part of a well functioning smart city. This means understanding IoT as well as mobile. GE, IBM and Google were kind enough to speak with us about their views on the opportunity space ahead for IoT and Sanitation. (Quotes from each company are throughout this paper).

Growth Factors Fuelling Mobile + IoT in Development Applications

Several growth factors are driving the massive uptake of these respective technologies. These include the drop in cloud computing costs, declining cost of sensors, and the rise global access to smart-phone devices.

According to Tariff Consulting's *Pricing the Cloud 2016 to 2020* report, the cost of average entry level cloud computing has dropped by 66% since 2013 to just \$0.12 per hour. Sensor sales are climbing as the price per unit is plunging. According to IC Insights *2016 O-S-D report*, "Competition between suppliers and requirements for low-cost sensors in new high-volume applications drove down average selling prices ("ASP") from about \$0.66 in 2010 to \$0.40 in 2015.

Smart phones are also on the rise in low-income markets. According to Gartner research director Anshul Gupta "The availability of affordable smartphones in low-income markets saw consumers upgrade their 'feature phones' to smartphones more quickly because of the small price gap.⁷ Sales in low-income markets rose to 259.7 million units in the third quarter of 2015 — an 18.4 percent growth over the third quarter of 2014 — while sales in mature markets saw growth of just 8.2 percent over the same period."

These forces are combining to push forward the digital future for businesses in low-income markets serving low-income consumers.

IBM Watson: "IBM Watson, our cognitive computing platform, mimics the human mind and helps us to turn unintelligent data into usable, applicable knowledge and information. The healthcare industry has been quick to apply this technology to their need to process and quickly apply large volumes of new health and medical information. Watson can take in and process and provide application recommendations in minutes. Imagine the power for on-site basic health diagnostics in areas without easy access to health information and care."

- Dr. Alice Landis-McGrath.

Innovation for health

Within the IoT world, healthcare is leading the charge. As IoT continues to grow exponentially - Intel indicates there were 2 billion connected devices in 2006.⁸ And it estimates that there will be as many as 200 billion connected devices by 2020 - devices are generating data that is flowing from person to person, machine to person and machine to machine. Cloud computing and big data analytics is beginning to generate insights on these large data flows.

This generation of data, time savings and cost savings is big business. McKinsey Global Institute estimates that IoT will generate \$11.1 trillion USD a year in economic value by 2025. Over \$1.7 trillion USD will be generated in public health and smart cities. Another \$1.6 trillion USD will be generated for consumers via their health and fitness benefits. And \$850 billion USD will be generated by gains in logistics and transportation.⁹

The global IoT in healthcare market accounted for \$24.6 billion in 2014. It is expected to grow with an CAGR of 37.6% during 2015 to 2020 according to P&S Research.¹⁰ This is directly relevant to sanitation, as stakeholders evaluate ways in which to unlock the value in health data being generated by their users.

Figure 5: Digital Applications for Sanitation

Level	Individual	Community	Society
IoT	Smart phones Wearables	Connected Cars Health devices Smart homes	Smart Cities Smart Grids
Examples	GPS, Fitbits Visa PayWave Mastercard Paypass Employee passes	Intelligent Transport Systems Event Data Recorders (EDRs) Blood pressure monitors; remote burglar/heating systems	Smart metering, Smart water meters Traffic monitoring
Data	Mobile money Fitness data, GPS location-based data	Speed, distance, airbag, crash locations/alerts; Heart rate, blood pressure, Diet, remote heating data	Electricity/water consumption & billing; Traffic flow data
Intended Audience	Individual person Immediate friends/ family; banks; employers	GP, health authorities; health & car insurance; police, social networks	Authorities/regulators Utility companies; Other citizens

Source: ITU & Cisco 2016, Harnessing the Internet of Things for Global Development, Geneva Adapted by the TBC August 2016.



A PIONEERING EXAMPLE: Smart Meters for Urban Utilities In Kenya

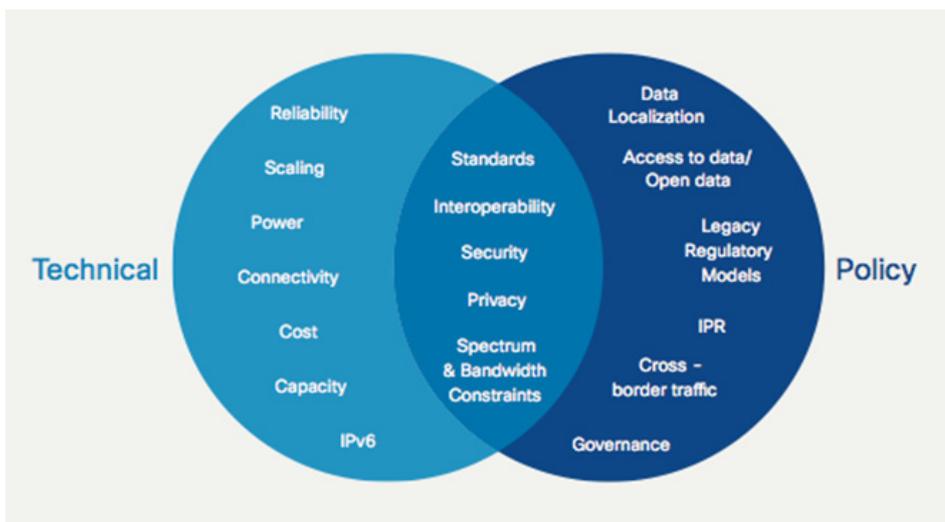
Sensor based tools are being tested to implement real-time monitoring systems to overcome key low income market challenges associated with non-technical losses, such as poor operations, low payment efficiency, and theft. Service providers Upande, and BRCK together with the Kericho Water and Sanitation Company (KEWASCO) in Kenya are using smart meters with alert modules and low-cost solar- powered data loggers to reduce non-revenue water losses. The data loggers measure water flow and transmit data to the cloud providing the accurate data on water usage and loss.¹¹

mHealth

mHealth has been succeeding in forging stronger connections between the mobile and healthcare industries with optimism that the new collaboration enable scale and deliver significant impact.. Mobile health applications have been extending the reach of healthcare to benefit millions at low cost. The GSMA states that, more than 1200 mobile health initiatives have been deployed to date.

General Electric (GE) Software: “Our intelligent cities platform is creating the operating system for industrial IoT. It’s not just sensors its information. Sanitation has an important place in intelligent cities. It could unlock valuable user information and consumer insights into how to increase toilet use and deliver healthier lifestyles”
 - Julian Loren, Director Solutions, IoT Big Context and Huge Puzzles.

Figure 6: Summary of Emerging Challenges



Source: Pepper, R & Garrity, J. (2014) The Internet of Everything: How the Network Unleashes the Benefits of Big Data. Global IT Report 2014. WEF.

Blockchain platforms could empower the sanitation sector

In simplest terms, blockchain is a distributed ledger technology. It is a technology that provides an encrypted and decentralised public ledger of data. It is highly scalable and provides transparency to transactions.

As an emerging technology, blockchain could play an important role in scaling up next generation sanitation opportunities. As a platform, it could fuel innovative asset management, circular economy and mHealth opportunities.

In a report released on July 13, 2016, JP Morgan and consultancy firm Oliver Wyman said “blockchain-related interest and investment have reached critical mass, and the technology has shown itself to be capable of driving major change.”¹²

Asset Management:

Within the asset management category, it could open up new possibilities in bundling, franchising and cross promotion in and around public and portable toilet business models. It would help improve tracking of assets and facilitate new commercial opportunities between trading partners. It could also help sync up the IoT data and help unlock new sources of commercially valuable data.

We can look at how other industries are thinking about blockchain and asset management. Wanxiang is the largest China based automotive components company measured by revenues. As a company they are investing \$30 billion in building a smart city.¹³ They think deeply about next generation technologies and how they will unlock value for companies, cities and citizens.

In September 2016, Wanxiang’s Vice-Chairman said, “we want to use blockchain to manage IoT and use it to help devices interact with each other.”¹⁴ They see blockchain as an integral part of developing a smart city at scale and expanding commercial possibilities.

Circular Economy:

Trust, certification and tracking are vital components in unlocking the circular economy possibilities of toilet resources. All three elements are essential to ensure the safety, quality and consistency of toilet resources. Blockchain can help reduce risks by bringing a new level of transparency in the supply chain through its public ledger model. It will also help potential buyers have a better view on location, quantities and quality of toilet resources as they trade in this marketplace.

mHealth:

Blockchain helps communities and individuals improve their control and flow of health data. It will enable them to understand how it is being used, where it is being used and how the value is being accrued. For potential users of the data, it helps improve quality control, scaling and potential provision of products and services back to the providers of the health data.

Key Finding #5:

Critical enablers to accelerate opportunities in low-income markets

To realise the full potential of mobile and digital applications for sanitation there are a number of critical enabling factors that will be required. Some of these issues are global in scope and others have specific relevance to the opportunity spaces that we have been discussing in this paper.

In terms of the global scope, businesses in all sectors seeking to capture the benefits of mobile and digital applications are at the mercy of the availability of internet connectivity, affordability of devices and services, relevant content in the form of apps and the digital and general literacy of potential users. There is ongoing work by dedicated bodies seeking to overcome these barriers to unlock optimal growth and development. For example, the World Economic Forum's Internet for All initiative¹⁵ and the Broadband Commission for Sustainable Development¹⁶ are working at a global level.

The GSMA is optimistic about the growth rates in all of these areas, however also cites the following list of current challenges:

Projected growth for mobile enablers:

Mobile network connections in developing countries are expected to grow from 5.9 billion in 2015 to 7.4 billion in 2020.

Unique mobile subscribers in developing countries are expected to grow from 3.7 billion in 2015 to 4.6 billion in 2020.

Mobile money is available across 93 countries, enabled by 271 service providers, with 411 million people now registered to a mobile money account

- 4 billion people remain offline, unable to participate and unaware of the opportunities. The unconnected population is predominantly located in developing world markets, typically on low incomes and lacking basic and digital literacy skills.
- Over 2 billion people yet to get online live within a 3G network footprint.
- Digital skills, increased affordability and locally relevant content will be key to unlocking demand.
- Most of the uncovered population live in hard-to-serve rural locations requiring collaborative industry solutions.

The ITU's *World in 2015 Facts & Figures* report cites that "mobile broadband is the most dynamic market segment; globally, mobile- broadband penetration reaches 47% in 2015, a value that increased 12 times since 2007". However it also shows the levels of internet connectivity in developing markets well below developed and still marginal in least developed countries - at 35% and 9.5% in developing and least developed markets respectively compared with 82.2% in developed markets..

While there are promising signals coming from the broader healthcare IoT growth rates, evidence of sensors specifically fit for the purpose of analysing human "waste" or toilet resources captured in each use of a toilet have so far eluded us. Our advisors to this study from the health informatics sector suggest a hackathon to invite sensor makers to meet this brief.

When talking about health data the issue of data security and ethics will need to be closely monitored. The TBC's NGO and IGO members have expressed an interest in supporting this effort.

The Business Case

One of our objectives with this study was to understand the business case for large and small commercial actors to invest more significantly to scale the system. We found the business case to be compelling for both multinational corporations as well as small and medium sized enterprises operating in local contexts in low-income markets.

In order for digital sanitation models to emerge quickly and at scale, it will take large and small players finding ways to create value together.

Digital sanitation requires that the large players that produce the infrastructure, products and services that come together to deliver both mobile platforms and IoT work with the local entrepreneurs who are installing sanitation systems and winning clients.

This covers four main areas of corporate symbiosis: innovation, distribution, standards and circular economy.

Innovation

Sanitation offers daily interaction with its users. Generating opportunities to passively and actively contribute data at the local level will provide a valuable data source for innovation by large players. It helps them understand the end users behaviors, aspirations and needs.

Larger players then can leverage their innovation infrastructure to generate new products and service offerings that help the local entrepreneurs meet their end users demands.

Distribution Partnership

Sanitation systems offer bundling and distribution partnership opportunities. Small local operators and large players can look for ways in which to bundle products. Potential areas include consumer goods, digital offerings, hardware accessories for the toilets, fragrance options for home enhancement, energy, airtime discounts, Wi-Fi access and water.

Large and small players can also evaluate the full range of sales, marketing and distribution options for building up a network of sanitation systems. This could include direct sales, resale channels and franchise models.

Google: "We have been exploring various applications of technologies for development. In the water space we have explored earth system, future water systems, gamification and health informatics. We believe that technology has the ability to disrupt development. For sanitation we can imagine the use of storytelling and immersive technologies for more effective story-telling for behaviour change. Low cost and low power monitoring of flows, and communicating data over the mobile networks. We have the opportunity to engineer more sustainable systems of the future. Generalised platforms enable volume."

- Joshua To, Virtual Reality

Setting Standards

Regulation is an important factor to consider when looking at sanitation. It is often difficult for small players to guide governments towards a sustainable and pro-business regulatory environment. Large players have both the expertise and influence to help guide policy makers.

Equally important will be setting communication language standards, inter-operability of devices and innovating devices that address low energy access environments.

Circular Economy

Multinationals can also look for Circular Economy opportunities that buy the outputs from the sanitation value chain. Large and small players should come together to ensure that mobile and IoT platforms develop and offer inter-operability. This will boost the capability of small players to integrate with large players supply chains. This in turn will open up new revenue sources for the small operators and reduce the risk of raw material inputs for multi-nationals.

Cisco Systems: “There is still more we can do to improve the deployment of these technologies in developing countries. Network deployment, power requirements, reliability and durability are all uneven and policy considerations concerning access to data, legacy regulatory models, standards, interoperability, security, and privacy need to be addressed.” - Chuck Robbins, CEO.¹⁷

Conclusion

The Role of the Toilet Board

Magnifying opportunity spaces through collaboration

-  Business platform - identifying business opportunities
-  Brokering breakthrough collaborations between large and small businesses
-  De-risking new investments with collective action
-  Facilitator of mentorship, partnerships, and investment for Sanitation

As the mobile and digital ecosystem develops, it will take large and small businesses and stakeholders coming together into a vibrant commercial eco-system for it to succeed at scale. It will take entrepreneurs and innovators with strong local connections, working with leading global corporations, to have new sanitation systems scale quickly and effectively.

The Toilet Board Coalition seeks to provide a business platform focused on identifying, supporting and accelerating business solutions for universal access to sanitation. In the case of mobile and digital applications for sanitation business models we seek to support the development of robust business models that leverage the new and transformative technologies of mobile and digital to deliver smart, sustainable and aspirational sanitation for all. We have found in our study that these connections are not always obvious in terms of natural partners; and are not always easy, in terms of perceived and actual risk on either behalf.

The Toilet Board Coalition can therefore play the role to both make connections to natural partners easier, and to work through current challenges associated with perceived and actual risk.

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