



BRINGING SAFE WATER OVER THE LAST-MILE: INSIGHTS FROM AUTONOMOUS CHLORINE PRODUCTION AS A SCALABLE HWTS

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Abstract:

According to United Nations, 1.8 billion people use a source of water that is fecally contaminated, while about 3.4 million die every year from diseases associated with pathogens in water. In order to achieve UN SDG 6 (access to safe drinking water), innovative approaches must be implemented. As providing piped-in water to every households seems out of reach, effective household water treatment solutions (HWTS), allowing families to treat their own drinking water, are very promising. Amongst the different HWTS technologies, chlorination is one of the most efficient and widespread.

Sustainability and scalability of interventions targeting populations living at the bottom of the economic pyramid (BOP) can be achieved by relying on economically viable business models. Distribution of positive impact products for instance should rely on sustainable supply chains to overcome the last-mile and reach scale.

Antenna Foundation (<http://www.antenna.ch>) develops appropriate technologies for BOP populations and helps its partners to build innovative business models to disseminate them. Antenna WATA[®], a device producing sodium hypochlorite (active chlorine) by saltwater electrolysis, allows local and autonomous HWTS sourcing. The paper at hand validates this approach and presents the results achieved and challenges met by Antenna's partners while producing, marketing and selling chlorine flasks as HWTS in developing world markets (Guinea-Conakry, Nepal, India and Pakistan). Hands-on experiences from small-scale to already scaled-up businesses provide key insights of the different steps of a growing HWTS social business. These lessons-learned should benefit social entrepreneurs from developing countries and development organizations that want to launch their own initiatives in this field.

Keywords: Household water treatment solution (HWTS) – BOP markets – Social business – Safe water – Chlorination – Waterborne disease.



1. Introduction

In the developing world, poor access to basic sanitation and water services are still causing dramatic consequences. According to the World Health Organization (WHO), inadequate drinking-water, sanitation and hand washing practices cause around 850,000 diarrheal deaths in low- and middle income countries (WHO, 2014), while the United Nations Environment Programme estimates that about 3.4 million people die every year from diseases associated with pathogens in water (UNEP, 2016). These heavy casualties are connected with the use of unprotected and untreated water sources. In 2012, 1.8 billion people indeed used fecally contaminated sources of water (UN ECOSOC, 2016). Some experts estimate that even 4.4 billion people lack reliable access to safe drinking water (Dalberg, 2017).

Nevertheless, significant progress in the access to improved water sources has been made during the last decades, the challenge of ensuring the quality of water up to the point-of-use remains problematic in many developing countries (UNICEF/WHO, 2017). Recent work from WHO indeed shows that diarrhea can be reduced significantly if water quality can be ensured up to the point-of-use (WHO 2014). While 2.6 billion people gained access to an improved water source since 1990 (UNICEF/WHO, 2015), many do not have access to basic forms of water treatment, which could ensure safe water consumption in their homes (Dalberg, 2017). Contamination between point-of-collection and point-of-use is indeed very frequent in many contexts (Wright, Gundry & Conroy, 2004) and thus represents a major limitation to approaches preconizing water source improvement as the only mean to deliver access to safe water.

In order to achieve UN SDG 6 (*Ensure availability and sustainable management of water and sanitation for all*), innovative approaches must be implemented. As providing piped-in water to every household seems out of reach, effective household water treatment solutions (HWTS), allowing families to treat their own drinking water, are very promising (Clasen, 2009). Significant reduction of diarrheal diseases (up to 45% depending on water source) can indeed be achieved by regular application of HWTS (WHO, 2014). In terms of risk management of microbial hazard, delivering HWTS to households is more efficient than examination of fecal indicator bacteria, which often highlights potential health risks when the exposure to the water already happened (WHO, 2016).

Water treatment by chlorination is a common way to treat water against bacterial contamination. Sodium hypochlorite (liquid bleach) was one of the first HWTS to be used broadly and it was estimated that, in 2007, around 7.3 million bottles of sodium hypochlorite were sold in around 18 countries (Clasen, 2009). In comparison with other HWTS technologies, the free residual chlorine that is left in the water after treatment has the advantage to protect water against new contaminations.

Developing products and services specifically designed for people living in poverty and using market-based approaches in order to disseminate them in developing countries has the potential to contribute to poverty reduction. In their seminal work, Prahalad and Hart (2002) defined the concept of the base of the pyramid (BOP), referring to the 4 billion people with less than US\$2 a day, and proposed that low-income markets could present interesting economic opportunities for the private sector while increasing the prosperity of the people. In a similar way, sustainability and scalability of development interventions targeting populations living at the BOP can be achieved by relying on economically viable business models. Distribution of positive impact products for instance should rely on sustainable supply chains to overcome the last-mile and reach scale (Koh, Hegde & Karamchandani, 2014). The spread of mobile money or of solar lighting products indeed shows the potential of making the lives of people living in poverty better through these innovative approaches. Barriers to scale are however numerous and many initiatives fail to achieve a significant impact for a variety of reasons (Koh et al., 2014).



In order to deliver safe water over the last-mile in a sustainable way, similar approaches have been implemented in developing countries where markets are largely underserved. Safe water social ventures have indeed been launched and financially sustainable social business models have emerged (Dalberg, 2017). According to some estimation, if these initiatives were to scale and reach their full potential, they could reach approximately one billion people (Hystra, 2011). In addition, safe water enterprises often offer more cost efficient services than their alternatives (Dalberg, 2017).

Several of these initiatives combine market-based approaches with the production and distribution of HWTS. The affordable price and the ease of use of liquid bleach in particular makes it a high-potential candidate for implementing financially viable supply chains, from production to end-user. Antenna Foundation (www.antenna.ch; hereafter Antenna), a non-profit organization promoting appropriate technologies for BOP populations, developed WATA[®], a device able to locally produce chlorine by saltwater electrolysis. This original technology allows Antenna's partners to build innovative business models to autonomously produce HWTS and market them. Antenna's expertise in building sustainable business models to meet the essential need of BOP populations contributes to the setting up of the partners' own models.

The aim of this paper is to present the results achieved and the challenges overcome by Antenna's partners while producing and marketing chlorine flasks as HWTS in developing world markets (Guinea-Conakry, Nepal, India and Pakistan). Lessons-learned will be drawn from these experiences and remaining barriers to scale will be identified. Finally, new perspectives and potential developments of these innovative approaches will be discussed.

2. Methodology

2.1. The technology

WATA[®] technology uses a simple electrolysis process to produce active chlorine. It converts a saline solution (sodium chloride) into sodium hypochlorite (6 g/L). Kitchen salt, clear water and electricity (grid or solar) is all what is needed in order to produce a solution that can then be processed into chlorine flasks in a few simple steps (stabilization and bottling). The range of WATA[®] devices can produce between 1 to 80 grams of active chlorine per hour (Figure 1).



Figure 1. WATA product range

WATA[®] technology has been designed according to the concept of frugal innovation (Radjou & Prabhu, 2015) specifically for developing countries. It needs little maintenance and is easy to operate. Original reagents have also been developed by Antenna Foundation in order to propose a simple and efficient quality control. The WataTest[®] allows the testing of active chlorine concentration in the solution



produced, while WataBlue® helps end-users to measure in a simple way the free residual chlorine in their drinking water (Figure 2).



Figure 2. WATA reagents

2.2. The approach

The 5 case studies (from Guinea, India, Nepal and Pakistan) presented in this paper have different backgrounds and were built by Antenna's partners according to the local needs, and following the opportunities and constraints of national contexts. Generally speaking, these models are built on the entrepreneurial spirit of the partners and foster their autonomy. Technology transfer allows the development of the local capacity of chlorine production and bottling. Support is also given in the field of business administration and marketing. Specifics of each case will be described in their respective section. The legal status of the partners (limited companies or NGOs) depends on their own choices and legal national particularities.

3. Case studies

3.1. Nepal

Model description

In Nepal, two organizations adopted the WATA® technology to produce and market HWTS – the NGO ECCA and the limited company MinErgy Pvt. Ltd. (Boulloud & Heierli, 2017).

ECCA started liquid chlorine production 6 years ago. Some challenges regarding local technical capacities had to be overcome during the first years, but since 2015 ECCA has a well functioning lab allowing the high-quality production of WATASOL, the locally branded sodium hypochlorite solution. Their distribution and marketing model is based on different pillars. On one hand it is built around schools, where students together with teachers gather in safe water clubs to learn about safe water and to produce chlorine. Accordingly the schools drinking water is treated as well as the school premises cleaned. With the support of ECCA the clubs organize awareness-raising events on good safe water practices and the use of HWTS among students and the surrounding communities. The objective is to reach the students' communities facilitated by door-to-door campaigns organized in peri-urban and rural communities. During these events the students sell 60ml flasks produced by ECCA to the communities, allowing the students some pocket money. Beside these door-to-door events ECCA raises awareness on the community level through stalls at festivals and projects with self-help groups. Chlorine



flasks are also promoted through ECCA's sanitation programs, sold directly to other NGOs and through a pharmacy network in the Kathmandu valley (Boulloud & Heierli, 2017).

MinErgy Pvt. Ltd. is selling chlorine mainly to the private sector. It primarily targets the brick kiln industry, transportation and water tanker companies to promote safe water at the work place. Initially MinErgy sold HWTS (chlorine flask and filters) through a microcredit scheme to workers, deducting the costs directly from their salaries. For various practical reasons, the sales to workers did not take off and MinErgy had to switch to introducing centralized water treatment systems (water tanks disinfected with chlorine) in order to allow all employees access to safe drinking water. In parallel to installing such treatment systems MinErgy offers also maintenance services to keep the systems running and to ensure safe drinking water at all time. Providing safe drinking water is not only benefitting the employees as such, but increases also the business' productivity as health induced absenteeism is reduced radically (Füllemann & Graser, 2017).

Lessons-learned

Several meaningful insights have been drawn while co-implementing these models. To begin with, it has been a challenge for ECCA to fully integrate an entrepreneurial approach in its more traditional NGO model. For instance, the retail prices had to be adapted several times in order to effectively include all costs from production, to marketing and last-mile delivery. These findings emphasize the importance of fostering entrepreneurial spirit from the onset of the initiative, and thus reaching BoP customers through viable business approaches (Boulloud & Heierli, 2017).

ECCA's strategy to reach out to communities by raising awareness amongst students and using them as vectors to disseminate affordable HWTS is innovative and promising. This "training of trainers" approach has been picked-up and adopted by several other initiatives and is successfully implemented in other regions around the world (Boulloud & Heierli, 2017).

As workers were not buying HWTS on a regular basis, MinErgy had to adapt its business model and set up centralized water tanks and offer maintenance services. This flexibility and capacity to adapt to the customers' needs are key, while targeting this difficult market, to be successful. Unfortunately Nepal private sector still shows reluctance and little incentives to improve the working conditions of its employees. A long-term commitment of local initiatives as well as proactive communication on the economical benefits of improving the employees' health is needed to eventually allow a paradigm shift in this field (Füllemann & Graser, 2017).

3.2. Pakistan

Model description

Pakoswiss Technologies Ltd. was incorporated as a social enterprise in 2013 to take up the challenge of introducing sodium hypochlorite as HWTS in Pakistan (Khan, 2016). The objective of the company is to make chlorine readily available and affordable for BoP population in the cities of Islamabad and Rawalpindi. In Pakistan, options for disinfecting water are limited for several reasons. The serious energy crisis makes boiling water impractical and costly while chlorine tablets are too expensive for the population, and industrial chlorine granules or powder are neither available on the market nor adapted to treating water at the household level. There is thus a need and demand for affordable chlorine-based HWTS.



In 2014 the company started producing and selling AquaCleanDrops™, a stabilized sodium hypochlorite flasks produced with WATA® technology. The product is sold in 50ml flasks with dropper, available in shops and pharmacies, and in 2.5L containers, sold to restaurants and grocery stores. Pakoswiss centralized production facility is able to produce and stabilize 600 liters of sodium hypochlorite per day. Creating awareness about the importance of treating water and about the product still remains challenging. In order to succeed, the company has thus to organize regular social and commercial marketing activities (Khan, 2016). Campaigns to enhance awareness are executed at public water-collection points, in kiosks, clinics, hospitals and schools. Point-of-sale promotion, door-to-door sales and backlighted signboards were also introduced to increase the products visibility. To increase product availability, a partnership with around 600 retail shops has been established to sell AquaCleanDrops™. As margins on the product were small, the company had to diversify its product portfolio and develop additional products such as a SwissPak water filter, water dispensers, micro chlorine injectors and an emergency water treatment kit, amongst others (Khan, 2016; Boulloud & Heierli, 2017).

Lessons-learned

The launch and growth of Pakoswiss social venture offers a variety of lessons learned. First, the leadership and the motivation of the founder is key for the success of the initiative. Developing a social business in such a challenging environment as Pakistan indeed needs an important amount of entrepreneurial spirit as well as ingenuity. Being able to adapt to the needs of the customers as well as to the changing environment is also a must (Boulloud & Heierli, 2017). This case also reveals that in this context by solely selling a chlorination product an enterprise can barely reach viability. Diversifying its product portfolio through product bundling allowed Pakoswiss to piggyback newly developed products through the already established distribution network. This strategy also brought down business development costs incrementally, allowing reaching more and more customers (Khan, 2016).

3.3. India

Model description

Technology and Action for Rural Advancement (TARA) is a social enterprise, part of the Development Alternatives Group, set up in 1985 in New Delhi, India. TARA consists of multiple sub-businesses that aim at fostering employment, entrepreneurship, sustainable technologies, as well as meeting basic needs in India. TARAlife Sustainability Solutions Pvt. Ltd, one of TARA social businesses, was set up in 2014 to address the issue of the lack of access to safe drinking water. Using WATA® technology the social venture produces and sells Aqua+™, a 50ml liquid chlorine flask. One bottle of Aqua+™ can purify up to 500 liters of water, representing a cost of INR 0.8 (US\$ 0.01) per 10 liters of water purified (Boulloud & Heierli, 2017).

In order to increase its reach TARAlife developed an innovative micro-franchising model. As described by Lehr (2011), micro-franchising “leverages the basic concepts of traditional franchising, but it is especially focused on creating opportunities for the world’s poorest people to own and manage their own businesses”. TARAlife provides the flasks of liquid chlorine along with all the appropriate marketing and training material to a regional franchisor. This franchisor distributes Aqua+™, coordinates activities between the micro-franchisees, oversees sales records and assists with the training and social marketing events and reports to TARAlife. Most of the micro-franchisees are selected amongst small shop owners or micro-entrepreneurs that already have experience in sales. Social marketing is a key component of their marketing strategy. A lot of efforts have indeed to be invested in convincing the customers of the health benefits and medical expenditure savings achieved through the continuous use and purchase of



Aqua+™. As this job is challenging and the margins are quite low, a selection is done amongst the micro-franchisees during the first weeks. Only the most dedicated and skilled sales men and those convinced about the product and its positive impact persevere. This selection is also a learning process for TARAlife in order to be able to directly identify the right partners with the adequate understanding the local market. As margins are low, TARAlife decided to identify more products to sell together with Aqua+ as part of a basic needs multi-product portfolio. This has the potential to increase both the incomes for the micro-franchisees and the impact for the communities (Boulloud & Heierli, 2017; Erismann, 2017).

Lessons-learned

Taralife's experiences show that building a steady distribution system to monitor and support sales agents is key for marketing HWTS. In this perspective, Taralife is improving its model through a remote mobile data application to reinforce efficiency in sales. Working in safe water is a struggle for BoP businesses, as awareness creation among people is needed. Having budgets for such social marketing activities is necessary and needs to be combined with motivated and skilled sales people. Dedicated social marketing activities are designed and implemented by working together with other departments of TARA. Lastly, an important factor of success is to have attractive margins for franchisees, keeping in mind that the last-mile delivery, particularly in India where roads and transports are complicated, is very costly. High margins can be achieved either through high volume of sales or diversifying the product portfolio (Boulloud & Heierli, 2017).

3.4. Guinea Conakry

Model description

Tinkisso is an NGO based in Guinea. It uses entrepreneurship and market based approaches in order to produce and market liquid chlorine in different regions of the country. WATA® technology is used to produce the chlorine which is branded as Chlore'C and conditioned in 250ml flasks. In 2010, a first pilot project was successfully launched in the northern regions of Guinea. The subsequent significant decrease in number of diarrhea and cholera cases within the intervention zone cemented a multilevel partnership and built the basis to leverage this initial success. Today Tinkisso applies a diversified distribution strategy with direct sales to urban communities, through a reseller network (kiosks, pharmacies, sales points) and institutional channels (Ministry of Health and UNICEF) (Duvernay & Camara, 2016). To raise awareness Tinkisso uses a step-by-step approach combining social and commercial marketing strategies to address both distribution channels (Bühlmann & Duvernay, 2014). The support of Population Services International (PSI) has also been key to broadcast TV and radio advertisements and to leverage social marketing on a national level (Duvernay & Camara, 2016). After historically high sales figures in 2015, with more than 5 million bottles sold, the social venture had to deal with a market disruption in 2016. Several humanitarian agencies indeed freely distributed their aging chlorine stock to population, ending up destroying the commercial market. This led to a significant reduction of sales in 2016, with around 700,000 bottles sold, reaching about 100,000 people in five provinces (Camara, 2017). In order to deal with this challenge, Tinkisso decided to diversify its product portfolio and to transition to a limited company structure in 2017 (Camara, com. pers.).

Lessons-learned

Over the years a multitude of lessons learned have been collected. First, it is obvious that sales in remote areas are economically more costly and challenging due to high transportation costs but also having to raise awareness among the population and to create a demand for an unknown product (Maurer, 2016). Tinkisso thus had to rely on the support of humanitarian agencies in order to perform



social marketing activities in these regions, while it could use its own resources for doing commercial marketing in more urban areas. In order to increase the impact of social marketing activities, Tinkisso also collaborated with community institutions such as mosques, churches, schools and community centers. This led to a higher likeliness of people adopting new behaviors, as they were picked-up in their accustomed environments (Camara, 2017).

Due to cholera and Ebola epidemics in 2007 and 2012 the demand for Chlore'C skyrocketed. While it allowed Tinkisso to grow fast and to leverage its production, it however came together with several challenges. As UNICEF was purchasing large amounts of bottles, it let Tinkisso break-even in 2014 but it also hampered sustainable market creation as chlorine flasks were distributed for free. This example shows the complexity of combining humanitarian action with more sustainable market-based approaches and calls for innovation in defining hybrid public private partnership collaboration models to reach scale for HWTS (Duvernay & Camara, 2016).

4. General discussion

Building sustainable and scalable business models to reach low-income rural customers with safe water in developing countries is challenging (Dalberg, 2017; Hystra, 2011). As described by Koh et al. (2014) in their *Beyond the Pioneer* original paper, every step of the social venture construction faces specific limitations and constraints. Three factors specifically seem to be constraining the efforts to scale up promotion efforts for household water treatment and safe water at the BoP: a) the demand constraint - due to lack of consumer awareness many people continue to drink contaminated water; b) the supply constraint - safe water solutions must be available, affordable and easy to use in remote areas and c) the last-mile constraint in the water supply chain - water delivered by private or public utilities or providers in remote areas can be unsafe, and monitoring is weak (Boulloud & Heierli, 2017).

At early stages, the HWTS social business has to make sure its products or services fit the needs and demand of its target customers. Acceptance of the chlorine taste in water for instance has strong cultural component and tends to be more easily accepted in some countries than others. In the latter, convincing people that treating their drinking water with liquid chlorine is worth, is an additional burden. Piloting an idea in the market in order to test the practicability of the product is thus pertinent. By adapting the product to customer's needs the value proposition of the product is increased and higher margins can be captured.

For such an entrepreneurial initiative to be successful, the spirit and motivation of the founding team is key. Marketing products for the BOP is indeed a very challenging task where progress might be slow and where the team might learn step by step about their customers through some initial failures. Being persistent, innovative and flexible are thus a must for such market-based approaches for the BOP to succeed.

As discussed in the previous sections, margins of chlorine flasks, and more generally on BOP products, are small. The social venture must thus consider bundling their products with other positive impact products and enlarge their product portfolio. It will allow both retailers and HWTS producers to have more attractive margins by reducing the distribution and marketing costs.

Another important factor that has to be taken into account while building a HWTS social business is the importance of social marketing and its costs. As for BOP customers the difference between clear and clean water might not be obvious, the need for social marketing is even more important for safe water than in other markets, like solar lighting or hygiene items. It is important also to keep in mind that awareness raising to improve public health is a public authorities' responsibility. Social marketing thus offers potential to be executed together with governments and other public institutions.



After scaling up, new challenges arise for the successful social venture. If the original initiative stemmed from an NGO, a clear distinction should be made between the social and commercial activities. The NGO should actively communicate on this topic. Should this not be the case, there is a risk of misperception by different actors, in particular in the humanitarian or public sectors. The NGO reputation has to be kept up and shall not *per se* be associated with commercial activities. An option to meet this challenge is the launch of a for-profit company to harbor the more commercial activities of the social venture. The challenge of transitioning from an NGO to a limited company should however not be underestimated. External bureaucratic hurdles might arise, while internally a proper management of the transition will be needed in order to allow the right mind-set and skills to develop within the team. The social venture might also have to adapt to fast changing environments. The political or humanitarian context might indeed radically change the way the product has to be marketed or distributed and the social business has to retain enough flexibility in order to adapt to these changes.

Alternative models to reach last-mile customers with safe water should also be considered. The delivery of chlorinated water to customer's doorsteps by water kiosks for instance could allow higher margins through aspiration and convenience. Water filters also have the potential to be distributed through sustainable business models. While the local demand of such filters might be stronger or easier to create, they present the significant drawback of not protecting the water over the "last-meter", i.e. against the important risk of recontamination between filtration and point of use.

5. Conclusion and perspectives

These different case studies show the potential of Antenna's approach to reduce the burden of waterborne diseases. While still challenging to implement, these models allow to reach last-mile customers in a sustainable way and to create value locally. The production of chlorine with the WATA® technology indeed strengthen the local economy through jobs and technology transfer. In the future, Antenna will remain committed to develop innovative models for contribute to the UN SDG 6, and partners have been identified to adapt and test its model in the Democratic Republic of Congo and Burkina Faso for instance. In order to leverage its lessons-learned and make them broadly available, Antenna developed a safe water toolbox built on practical tools and case studies. The toolbox, adapting the business cycle concept "from blueprint to scale" developed by Koh, Karamchandani and Katz (2012), aims at contributing to overcome the "pioneer gap" for reaching scale and to share its experimental learning with the community of safe water practitioners and entrepreneurs.

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