

Framework conditions to design sustainable business models for decentralised water treatment technologies in Viet Nam for international technology providers

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ABSTRACT

The expansion of water-intensive industrial activities and the impacts of climate change are jeopardising the sufficiency of safe drinking water in several Southeast Asian countries. One is Viet Nam, where geogenic arsenic contamination further limits the availability of freshwater resources with a simultaneous increase in water demand. Innovative and sustainable water treatment technologies are required to meet these challenges. Equally, we assume that the provision of safe drinking water requires tailored business models (BMs). In this study, we focus on the key stakeholders and framework conditions to design tailored BMs providing safe drinking water to the low-income and middle-income population in Viet Nam. We consider decentralised technologies to be suitable due to their lower investment costs for implementation and the avoidance of strong path dependencies. We therefore conducted a literature review and interviews with international experts in the domain of decentralised water treatment technologies. Our results show that relevant aspects include a lack of financial resources, specific characteristics associated with Vietnamese culture, e.g. the importance of relationships and trust in the business domain, lack of education and vocational training, market saturation suggesting co-operation with existing water suppliers, lack of suitable partners, and deficiencies in the institutional environment.

Key words | base of the pyramid markets, decentralised water treatment technology, emerging markets, sustainable business models, Vietnamese water supply market

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HIGHLIGHTS

- Application of emerging market and base of the pyramid concepts to the case of decentralised water treatment technology in Viet Nam.
- Using sustainable business models as a lens to uncover framework conditions that are relevant to ensure access to safe drinking water across income groups in an emerging country.
- Offering a European perspective on technology supply for decentralised water treatment technologies in Viet Nam.
- Improving the implementation of innovative decentralised water technologies with promise of sustainability using sustainable business models.

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INTRODUCTION

In recent decades, there has been progress made in the access to improved water sources and to basic water services in East and Southeast Asia (WHO & UNICEF 2000, 2017). Improved (drinking) water sources are ‘those which by nature of their design and construction have the potential to deliver safe water’ (WHO & UNICEF 2017, p. 8). Basic water services refer to drinking water from an improved source, provided that the collection time is not more than 30 min for a round trip (WHO & UNICEF 2017). According to WHO & UNICEF (2017), 95% of the population in Eastern Asia and South-Eastern Asia enjoyed access to improved water sources in 2015. In Viet Nam (following the UN, we use the spellings ‘Viet Nam’ and ‘Vietnamese’ in this paper), 94% of the population had access to improved water sources and 91% could access them within 30 min, including queueing. However, regional differences exist as well as differences depending on income levels. In 2015, the regional population enjoying access to basic water services ranged from 84 to 99% (WHO & UNICEF 2017). Inequalities between population groups exist: 100% of the wealthiest population quintile and 80% of the poorest population quintile had access to basic water services (WHO & UNICEF 2017).

Despite the promising progress in access rates, the current availability and quality of water in Viet Nam are jeopardised by increased industrial activity, climate change impacts such as a rising sea level contributing to saltwater intrusion in available freshwater sources (AHK Vietnam 2012; Niederste-Hollenberg *et al.* 2012; Luong *et al.* 2018), and (agricultural) pollutants (Wegner 2015; Reichenbach *et al.* 2018). These developments are endangering the availability of safe drinking water (AHK Vietnam 2012). Regionally, groundwater resources are overexploited, which results in decreasing water tables, land subsidence and saltwater intrusion (Niederste-Hollenberg *et al.* 2012). With the utilisation of groundwater set to increase in the future, these problems are expected to become more severe (Niederste-Hollenberg *et al.* 2012).

The complex challenges of the water sector call for innovation towards more sustainable technologies (Sousa-Zomer & Cauchick Miguel 2018). Solutions are needed that are

innovative and tailored to local conditions (Sousa-Zomer & Cauchick Miguel 2018) as well as affordable for low-income groups (Gebauer & Saul 2014). The importance of affordable and safe drinking water as well as the participation of local communities in water management has even been recognised in one of the current UN development goals: Sustainable Development Goal (SDG) 6 of the Agenda 2030 (UN n.d.). In this context, the research project ‘Modular concept for sustainable treatment of arsenic affected and saline groundwater in Vietnam – WaKap’ (funded by the German Federal Ministry of Education and Research) has developed and piloted a modular, decentralised and innovative process for removing salt and arsenic from ground-, sea- and brackish water (Cañas Kurz *et al.* 2018; Luong *et al.* 2018). The hybrid system consists of modules for decentralised water treatment, which can be combined with renewable energy production modules including storage to form customised system solutions. An important goal was to improve the energy supply of the hybrid process by integrating regenerative energy sources (photovoltaic and wind), in order to enable a self-sufficient and decentralised operation of the plants (without grid connection). In general, decentralised technologies have several advantages: they can be tailored to local conditions and avoid the path dependencies typical for centralised infrastructure, allowing adaptation to changing conditions in the surrounding settlements or the environment (Sartorius 2007). They allow the reduction of environmental and social impacts, enhanced public participation and cost recovery (Domènech 2011).

As technology is not a ‘panacea for sustainability’ (Silvestre & Silva Neto 2014), we consider business models (BMs) an important part of these solutions. BMs are ‘a simplified and aggregated representation of the relevant activities of a company’ (Wirtz *et al.* 2016, p. 41). In this article, the notion of a sustainable business model (SBM) is used. A SBM is defined here as an organisation’s proposition, creation, delivery, capture, and exchange of value in a sustainable way, realised ‘for, and in collaboration with, a broad range of stakeholders’ (Geissdoerfer *et al.* 2016, p. 1219). SBMs are understood as contributing to

society and/or ecology by striving for sustainable social, ecological, and economical values and considering (negative) externalities. However, the water sector lacks sufficient knowledge of innovative BMs, and profit-oriented organisations are often suspected of exploiting the poor by selling them the ‘human right’ to water (Gebauer & Saul 2014).

This article aims to identify the framework conditions for SBMs that ensure access to safe drinking water for the low-income and middle-income population in Viet Nam using decentralised water treatment technologies. We determine the key stakeholders for such BMs as well as the framework conditions in the low- and middle-income segments of the Vietnamese water supply market. In this paper, we focus on the perspective of European actors and draw upon three concepts for our research design: the base of the pyramid (BoP) concept and the emerging market theory are used to determine the framework conditions specific to the Vietnamese water supply market and the low-income population there. The literature on SBMs (innovation) is used to identify existing innovations in the sector as well as potential BM responses to the determined framework conditions.

Low-income populations in emerging countries are increasingly recognised as a large and attractive market (Ablaza *et al.* 2007). Emerging countries or markets are only loosely defined in the literature. Here, emerging markets are understood as low- to middle-income countries with prospects for rapid economic growth and integration into global markets. They are not yet ‘developed countries’, but are striving for this category and might share certain features. Emerging markets and low-income markets are characterised by specific features and challenges that must be considered when operating in them. One major concern in developing countries that pertains to water technologies is affordability (Gebauer & Saul 2014). While philanthropic approaches that rely on donations can be important for development, they lack self-sustainability in economic terms (London 2008). For this reason, Prahalad & Hammond (2002) propose a market-based approach to serve the poor, changing the perception of the poor from receivers of philanthropic aid to customers. This concept creates a value for both the supplying company and the customers served (Prahalad & Hammond 2002) and is known as the BoP approach (Prahalad 2008). Prahalad (2008)

describe the BoP as a population with an annual per capita income below US\$1,500 (in purchasing power parity (PPP)). While countries such as India, the Philippines and Indonesia have since developed to become lower middle-income countries, the term BoP is still used to describe the poor in these countries (Sánchez *et al.* 2007; Dembek *et al.* 2018).

The SBM concept was chosen for two reasons. First, a sustainability approach is considered to be very important, especially in emerging markets like Viet Nam, where the economic development is often accompanied by detrimental environmental impacts (Niederste-Hollenberg *et al.* 2012). Sustainability here is understood as comprising three dimensions: an economic, a social, and an environmental dimension (White 2013). A sustainable approach is expected to ensure the quality of life of the present generation without impacting that of future ones (World Commission on Environment and Development 1987). Second, as Matos & Silvestre (2013) point out, there is an apparent fit between the SBM concept and the BoP context.

The following section outlines the case and methods applied in this paper. The results describe the special features of the Vietnamese water supply market and potential (BM) responses. The paper closes with the limitations of this study, an outlook and conclusions.

CASE SELECTION AND METHOD

Case description

The next paragraph elaborates some of the country’s economic characteristics and the applicability of the emerging market and BoP concepts.

Viet Nam has developed significantly over the last 30 years. It is now regarded as a lower middle-income country (AHK Vietnam 2012; Niederste-Hollenberg *et al.* 2012) and as an emerging market (Le Hau *et al.* 2013). Nevertheless, in 2016, its BoP consisted of 7,754,664 to 27,141,324 persons – according to data of the World Bank Group – revealing that 8.2% of its total population of 94,569,072 were living on US\$3.20 and 28.7% on US\$5.50 a day (2011 PPP) (The World Bank Group 2019b, 2019c). While this is a very wide range, the income distribution published by the General

Statistics Office of Viet Nam (2018) suggests that the population in the BoP is much closer to the upper bound of this range, as the poorest quintile of the Vietnamese population had an annual income of US\$1,223 in 2016 and the annual income of the BoP is defined as less than US\$1,500 (Prahalad 2008). The annual income of US\$1,233 was calculated based on a monthly income of VND771,000 using a PPP conversion factor of 7,562.939 (The World Bank Group 2019a). This study focuses, in particular, on the less affluent groups of Viet Nam's population, as these are the ones with the poorest access to basic water services (WHO & UNICEF 2017).

Applied methods

This study is based on literature research on SBMs, BM innovation, the BoP concept (Prahalad 2005; Gebauer & Saul 2014; Gebauer *et al.* 2017), and emerging market theory (Sheth 2011; Landau *et al.* 2016; Oyedele 2016). Semi-structured expert interviews are the main method used. We conducted four interviews in 2019 with experts from different fields, i.e. consultants and practitioners. In accordance with Mayer (2013), the sample was purposive and created in advance. Due to the scope of the research project, this study aims at identifying the framework conditions of the Vietnamese water supply market for German (or European) technology providers. For the purpose of our study, we took a European perspective of the problem and only selected European experts for the interviews. In total, we contacted 31 potential interview candidates from 23 different organisations. Fourteen did not respond, six of the originally contacted persons provided contacts to experts they thought to be more suitable, and four declared no interest in or capacity for participation. Three of the contacted experts responded too late to conduct an interview with them. Therefore, four interviews were conducted in total.

The first interview was with the CEO of a foreign NGO operating in the Vietnamese water supply sector, who is referred to as Expert A. The second interview was with Expert B, who has been working in Viet Nam for 4 years as a deputy CEO and a market consultant. The third interview was with the CEO of a German company offering consultancy and planning in the sector, as he has experience of the Vietnamese market (Expert C). Expert D is a German

engineer, who has lived and worked in Viet Nam for more than 10 years on water-related issues.

We applied a semi-structured design to allow interviewees the freedom to answer without pre-categorising or limiting their responses. An interview guideline provided some degree of data comparability and structure and served as orientation during the interview (Mayer 2013). The interview questions specifically addressed decentralised water treatment technologies in Viet Nam and the experts were briefed accordingly. The guideline was not used as a static template, but more flexibly as proposed by Meuser & Nagel (2009). The interview guideline was developed based on and in parallel to the literature research, and translates the research question(s) into interview questions. For the interviews with German experts, the interview guideline was translated into German. The interviews were subjected to qualitative content analysis as proposed by Kaiser (2014). The first step was to transcribe the recordings. MAXQDA and Express Scribe (NCH) were used for transcription. Literal transcription was conducted according to the rules of 'simple transcription' developed by Dresing and Pehl and provided by Pädagogische Hochschule Freiburg (n.d.). The introduction, de-briefing, and off-topic passages were not transcribed. Prior to the coding, categories were developed based on the results of the literature research. The categories included all the factors identified during the literature review as specific to or important for emerging markets, the BoP context, SBM design, or Viet Nam. They belonged to the topics 'target group', 'institutional framework', 'stakeholders', 'business models for sustainability', and 'success factors and obstacles'. The transcripts were coded using MAXQDA, and new categories were created when necessary based on the transcripts to ensure the openness of the analysis (Kaiser 2014). As proposed by Kaiser (2014), the transcripts were mainly coded based on paragraphs. In a second step, the statements of each expert were summarised within each category and redundancies eliminated. According to Kaiser (2014), categories that are not used need to be revised. After condensing the material of each interview, the contents of all interviews were merged within the same category and the key messages of the different categories were identified. Finally, the results of the interview analysis were used to verify the results of the literature research with regard to the specific target market – i.e. decentralised water

treatment technologies in Viet Nam. The findings are therefore presented in a combined manner.

RESULTS AND DISCUSSION

The utilisation of available water sources in Viet Nam varies across regions (GSO 2008). These include bottled water, tap water, rainwater, water from dug and tube wells, spring water, surface water (without rainwater), and other sources (GSO 2008). While tap water is favoured in urban areas, tube wells, dug wells, and rainwater are more popular in rural areas (GSO 2008). Rainwater is used extensively during the wet season, but in their study of the Tra Vinh province in the Mekong River delta (MRD), Li et al. (2016) showed that other water sources experience an upswing during the dry season. The literature shows that most Vietnamese treat their drinking water, for example, by boiling or straining it (Li et al. 2016). The differences regarding the utilisation of existing water sources, their treatment, as well as context-specific features need to be kept in mind when designing a BM to introduce innovative water treatment technology in Viet Nam.

Special features and potential (BM) responses

While the attractiveness of the low-income populations in emerging markets is now recognised (Ablaza et al. 2007), these markets differ from those of developed countries (Prahalad & Hammond 2002). The literature describes various features specific to emerging markets and the BoP markets, which are shown in Figure 1. We assume that successful operations in these markets must acknowledge and respond to these special features and challenges.

Features specific to emerging markets include a lack of resources including finance, energy, and skilled labour (Sheth 2011) as well as the heterogeneity of the target group regarding economic, geographic, and cultural variables (Rangan et al. 2007). The lack of energy and transportation infrastructure might be an obstacle, particularly in rural areas (Prahalad 2005). Landau et al. (2016) highlight the role of the institutional environment. Institutions comprise formal and informal laws, constitutions, traditions, cultural patterns (Landau et al. 2016), and the organisations themselves (Hodgson 2006). In emerging markets, important institutions tend to be

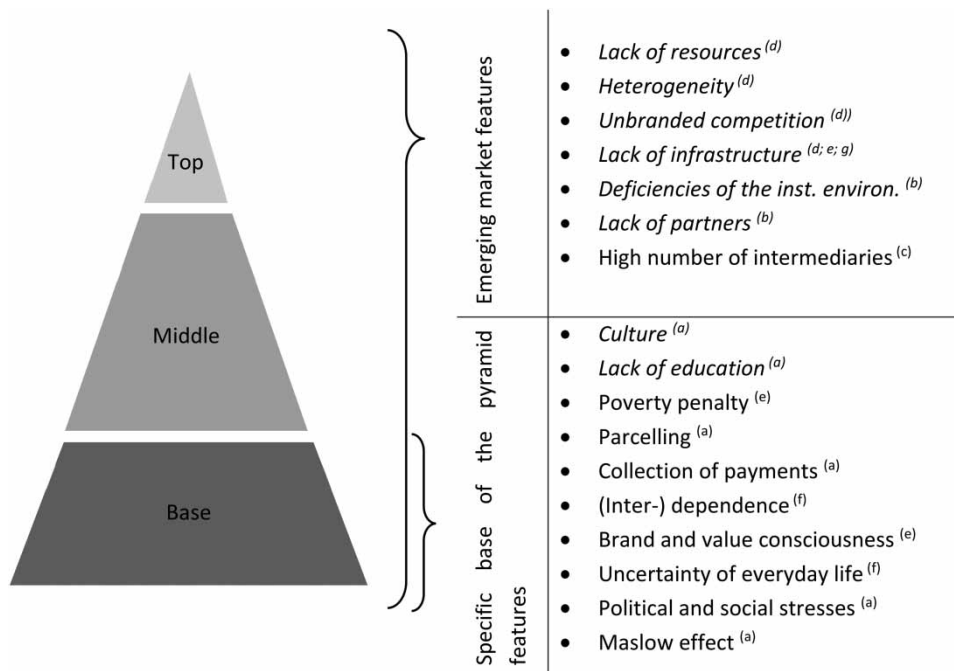


Figure 1 | Features of emerging markets and the BoP. Own illustration based on (a) Ablaza et al. (2007), (b) Landau et al. (2016), (c) Oyedele (2016), (d) Sheth (2011), (e) Prahalad (2005), (f) Viswanathan et al. (2009), and (g) Hoskisson et al. (2013).

absent or of poor quality (Khanna & Palepu 1997). Furthermore, suitable partners are often missing (Landau et al. 2016), a high number of intermediaries make operations expensive, and brands are rarely used in competition (Oyedele 2016).

In BoP markets, culture, lack of education (Ablaza et al. 2007), and uncertainties of daily life (Viswanathan et al. 2009) can influence purchase decisions. The poor often pay a poverty penalty, i.e. higher prices due to a lack of accessibility, local monopolies, and intermediaries (Prahalad 2005). Limited financial resources mean that the poor can only afford small quantities, and products need to be parcelled accordingly (Ablaza et al. 2007). The collection of payments, especially in post-paid models and in cases of delinquency, can be expensive and a matter of security (Ablaza et al. 2007). The relationship of customers and suppliers in BoP markets tend to be characterised by high dependence (Viswanathan et al. 2009). Out of necessity and for aspirational reasons, BoP customers tend to pay close attention to values and brands (Prahalad 2005). Political and social stresses may jeopardise the operations of companies in BoP markets (Ablaza et al. 2007). Finally, the poor may feel entitled to the satisfaction of basic needs and may engage in theft if these needs are not met (Ablaza et al. 2007). This phenomenon is known as the Maslow effect and increases the costs of doing business (Ablaza et al. 2007).

These characteristics of BoP and emerging markets were scrutinised during the interviews. The features confirmed in the interviews for decentralised water treatment technologies in Viet Nam appear in *italics* in Figure 1. Features not in italics are general BoP and emerging market characteristics, but were neither confirmed nor excluded during the interviews. Therefore, no statements can be made about their existence in this market. In the following, we address the confirmed features for the Vietnamese water treatment sector in detail and suggest possible (BM) responses in Table 1.

Lack of financial resources

During the interviews, experts pointed out the lack of two resources regarding decentralised water treatment

technologies: financial resources, which are addressed in this section; and skilled labour, which is addressed in the following section on *culture and the lack of education*. As heterogeneity was only confirmed as a relevant feature in the field of financial resources (Expert A), it is included in this section.

Constraints on financial resources exist in all markets to some extent, but this problem is much more severe in BoP markets (Ablaza et al. 2007). Financial means may be limited and also very volatile (Gebauer et al. 2017). A lack of financial resources was confirmed concerning potential customers such as local water producers (Expert A) and communities, districts and provinces (Experts B and C), as well as final consumers. While the interviews showed that shortages of financial resources remain a problem even for decentralised technologies, these technologies still have advantages compared to centralised infrastructure (Sartorius 2007). Financial shortages can be managed by specific BM elements. In urban areas, financial resources are heterogeneous, whereas *heterogeneity* is less common in rural areas (Expert A). More affluent people can afford to buy well-known and trusted brands, while the less affluent population has to trust local retailers from whom they buy most products (Expert A). While price is important for the latter group, the most important selling proposition for the former group is convenience (Expert A). In this *unbranded competition*, existing distribution channels can be utilised to gain the trust of final consumers (Expert A). For example, the organisation of Expert A collaborates with existing local water producers, whereby the distribution channels are maintained and the person(s) from whom the water is bought stay(s) the same.

In response to financial constraints, BM design suggests that customers contribute to value creation (Gebauer et al. 2017). In the case of water treatment technologies, the value created for the customer is *access to safe drinking water*. The customer might contribute to installing, operating, and maintaining the technology and to downstream distribution activities, i.e. delivering or collecting the treated water. Other eligible options include the combination of a 'market-based approach' with fund-raising, and local sourcing or assembly, i.e. procuring and assembling components locally (Gebauer & Saul 2014).

Table 1 | Emerging market and BoP features and potential (BM) responses

Features	Potential (BM) responses
Lack of financial resources <ul style="list-style-type: none"> • Customers^(b, c, d, e) • Final consumers^(b, e) 	<ul style="list-style-type: none"> • Cost reduction: <ul style="list-style-type: none"> ○ Co-creation^(g), e.g. customer contributes to/is responsible for installation, operation, maintenance (self-service) or downstream distribution ○ Local sourcing^(f) ○ Life-cycle cost assessment^(f) ○ Outsource R&D^(f) • Enhancing funding and enlarging the revenue base: <ul style="list-style-type: none"> ○ Combination of a market-based approach with fund-raising^(f) ○ Customisation^(g) ○ Expansion towards middle-income segment^(g) ○ Diversification^(f)
Unbranded competition <ul style="list-style-type: none"> • Low-income segment of final customers^(b) 	<ul style="list-style-type: none"> • Co-operation with local distributors trusted by the final consumer^(b)
Collection of payments	<ul style="list-style-type: none"> • Deferred payment schemes and micro-credits^(f) • Credit and pre-paid cards^(f) • Mobile payment^(f)
Culture <ul style="list-style-type: none"> • Relationships^(b, c, d) • Word of mouth^(c) • Customers' taste^(e) 	<ul style="list-style-type: none"> • Collaboration with local partners and intermediaries^(c, d) • Utilisation of existing value chains^(b) • Gain understanding^(b, k)
Lack of education <ul style="list-style-type: none"> • Basic knowledge^(b, d) • Vocational expertise^(b, d) 	<ul style="list-style-type: none"> • Education of children^(d) • Vocational education and training (of caretakers)^(b, d, f) • De-skilling (redesign operational activities to reduce the skills needed to perform them)^(e, f) • Maintenance services^(b)
(Lack of) infrastructure <ul style="list-style-type: none"> • Access to (final) customers 	<ul style="list-style-type: none"> • Social networks, television, and direct contact^(e) • Collaboration with women's unions and community chiefs^(e) • Utilisation of existing distribution channels to the final customers^(b)
Market saturation ^(b)	<ul style="list-style-type: none"> • Utilisation of existing distribution channels to the final customers^(b)
Deficiencies of the institutional environment <ul style="list-style-type: none"> • Fragmentation of duties^(a, e, i) • Flexibility of regulatory framework and importance of local level^(b, c, d, e) • Lack of enforcement^(b, d, e, i) • Centralised governance^(d) • Various illegal practices^(b, c, d, e) 	<ul style="list-style-type: none"> • Top-down approaches^(d) • Co-operation with local level^(d) • (Local) intermediaries^(c)
Lack of partners <ul style="list-style-type: none"> • Lack of high-quality products and services^(c) 	<ul style="list-style-type: none"> • Collaboration with local intermediaries^(c) • Joint ventures^(c) • Import high-quality products^(b)

Own table based on (a) Du *et al.* (2016), (b) Expert A, (c) Expert B, (d) Expert C, (e) Expert D, (f) Gebauer & Saul (2014), (g) Gebauer *et al.* (2017), (h) Landau *et al.* (2016), (i) Nguyen (2013), (j) Reichenbach *et al.* (2018), and (k) Viswanathan *et al.* (2009).

Life-cycle cost assessments and outsourcing research and development (R&D) might also be advisable to improve transparency and cost recovery (Gebauer & Saul 2014). More ambitious solutions could include customisation and expansion towards middle-income segments (Gebauer et al. 2017). The rationale behind this is the assumption that the low-income segment observes and aspires to the consumption of the middle-income segment (Gebauer et al. 2017). To enlarge the revenue basis and reduce dependence on external funding, additional services inside and outside the water sector can be offered in the spirit of diversification (Gebauer & Saul 2014). In the case of community approaches, it is key to reduce the (financial) dependency of the less affluent on the wealthier strata (Funder et al. 2012).

Closely related to the lack of financial resources is the *collection of payments*. To secure payment, the BM innovation literature proposes deferred payment schemes, micro-credits, pre-paid and credit cards, or mobile payments (Gebauer & Saul 2014).

Culture and the lack of education

Purchase decisions of the BoP are not only dependent on financial aspects, but may also be guided by culture and the lack of education, which have important implications for doing business with the BoP (Ablaza et al. 2007).

In terms of *culture*, the importance of relationships, word of mouth, networks, and trust were pointed out (Experts A, B, and C). Contrary to western culture, contracts are less important and trust is not built by signing a contract, but is based on personal relationships (Expert B). Viet Nam's cultural characteristics make it difficult for foreign entrants to build networks and earn trust (Expert B). However, the importance of trust and relationships can be utilised by collaborating with local partners and intermediaries (Experts B and C), i.e. people or organisations that are able to provide contacts or negotiate on one's behalf. Another option is to utilise the existing value or distribution chains, especially to gain access to the final customer (Expert A). Cultural-based differences to western customers were also described regarding advertisements and product design (Expert D). Due to the lack of relevant intercultural studies, Expert B suggests an orientation towards China, since this

country is closely connected to Viet Nam by a long history of colonialism. The cultural and historical differences between Viet Nam's north and south should also be acknowledged (Experts B and C). A deep understanding of the culture, the market, the target group, and their life circumstances is required (Expert A; Viswanathan et al. 2009).

Lack of education is problematic at different levels. Knowledge of the importance of safe (drinking) water was described as regionally dependent (Expert A) and rather limited in rural areas (Expert C). Even where awareness does exist, this rarely translates into an adoption of healthy practices. Water treatment is rather haphazard, based on neighbours' practices rather than independent information (Expert D). While the issue of saltwater intrusion is quite obvious, other contaminations are not (Expert B). Due to their long-term effects, it is difficult for the affected population to trace health issues back to contaminated water (Expert A). Thus, people continue to buy cheap bottled water, which might be contaminated by heavy metals or pesticides (Expert A). The Vietnamese population has developed a very critical attitude towards the quality of piped water (Experts B and D). Educating children is a promising avenue to counteract ignorance, as they are able to transfer knowledge to older generations (Expert C). Furthermore, the lack of trust in piped water can be an advantage for decentralised technologies, and the consumption of bottled water has important implications for the distribution of decentralised treated water. Treating the water locally may, in turn, contribute to education about the importance of clean water, as demonstrated by the collaboration of Expert A's organisation with schools.

Regarding the value chain, a lack of skills and expertise was pointed out (Expert A; Expert C), which often causes malfunctions, for example, due to inadequate maintenance (Gebauer & Saul 2014). However, the Vietnamese show a high willingness to learn (Expert B), enabling training (of caretakers) (Expert C). In this context, Expert A points out that compliance with practices is more important than technology itself to ensure high water quality. The interviews showed that vocational training and education are particularly important for decentralised technologies to ensure proper operation and maintenance. De-skilling, i.e. re-designing operational activities to lower the skills needed to perform them, is another approach proposed to

eradicate malfunctions (Expert D; Gebauer & Saul 2014). Contrary to cost minimisation approaches, which may result in self-service (Expert D; Gebauer & Saul 2014), the lack of skills and expertise calls for maintenance services, for example, by the technology provider (Expert A).

Lack of infrastructure

Beyond issues of affordability, education, and culture, the relevant infrastructure is necessary to gain access to a potential target group (Sheth 2011). Neither the literature used nor the interviewees addressed a lack of physical infrastructure such as transportation or telecommunications for the Vietnamese market. However, the term infrastructure is understood here as not solely comprising physical constructions, but also the possibility to gather information about and gain access to the target group. A lack of market data was described for the Vietnamese water supply market, and Expert A suggests in-house research as a response. To gain access to the target group, several channels were suggested for decentralised technologies including social networks, television, direct contact, and collaborations with women's unions and community chiefs (Expert D). Expert A described the Vietnamese water supply market as saturated, meaning that many producers are operating on the market resulting in a situation in which new suppliers of drinking water are not needed to satisfy demand. However, these existing suppliers might not be offering what would be considered safe drinking water. Considering the *market saturation*, it might be sufficient to use the existing distribution channels to the final consumers and this approach has the additional advantage of already having the trust of the final customers (Expert A). Utilising existing distribution channels might mean collaborating with local water producers or retailers, and decentralised, modular technologies are particularly suitable for customisation (Sartorius 2007). BMs should be tailored to the diversity of local conditions and the existing structures of the water supply market. Trade fairs were assigned virtually zero importance for gaining market access (Expert B). Gebauer & Saul (2014) suggest a multi-channel approach, optimising the utilised channels, and enhancing the role of distribution centres.

Deficiencies of the institutional environment

Emerging markets tend to lack institutions such as specialised intermediaries, a well-functioning regulatory system and mechanisms to enforce contracts (Khanna & Palepu 1997). These deficiencies can make transactions very expensive or severely impede them (Khanna & Palepu 1997).

Several impediments were described regarding authorities. Firstly, the fragmentation of duties between the Ministry of Natural Resources and Environment (MoNRE), the Ministry of Agriculture and Rural Development (MARD), and the Ministry of Construction results in conflicts (Expert D). A major problem exists concerning MARD and MoNRE (Niederste-Hollenberg et al. 2012). When the MoNRE was introduced in 2002 and assigned some of MARD's former functions, ambiguities, gaps (Nguyen 2012), overlaps (Du et al. 2016), and conflicts (Molle & Chu 2008) occurred (Niederste-Hollenberg et al. 2012), which are still not entirely resolved (Expert D). While various tasks were reassigned from MARD to MoNRE, employees were largely not (Du et al. 2016). As a result, insufficient personnel capacity in MoNRE in particular is a major problem, especially on the provincial level (Niederste-Hollenberg et al. 2012). In general, the authorities complain about the lack of international experience and knowledge of modern techniques, inadequate training and experience, missing technical equipment and inadequate monitoring networks, inadequate analysis of the monitoring data, and a lack of financial resources (Niederste-Hollenberg et al. 2012). Smets et al. (2017, p. 170) criticises a 'lack of coordination between government agencies and inadequate information sharing'.

There are four levels of administrative structure in Viet Nam: central, provincial, district, and communal (Tu n.d.). On all of these levels, governmental authorities deal with different topics concerning water (Wegner 2015), and coordination and consultation between them is problematic (Expert D). There is a general lack of financing (Experts B and C). Overall, local levels were described as decisive for the implementation of decentralised water treatment systems (Experts A, B, C, and D). The old saying: 'the power of the emperor stops at the village gate' was mentioned and transferred to modern times: today, the village gate seems to be the gate to the province (Expert B). However,

people at the local level might lack the necessary expertise to truly understand the proposed concepts, meaning convincing them will be more difficult (Expert C). Interaction with the national level might thus be more fruitful (Expert C). In addition, Expert C pointed out that Viet Nam is organised as a centralised state, so the national level is very important, and that it has a flat hierarchy, enabling interaction with higher levels. A top-down approach combined with the involvement of local levels was therefore described as promising (Expert C).

Another challenge pertains to the sector's regulatory framework. While the regulatory framework including the rules for drinking water production is described as straightforward (Expert A), the laws are rather flexible (Experts B and C) and their application may be regionally dependent (Expert B). In general, all laws, decrees, and other legal documents are available online and minor obstacles can be overcome via co-operation with local partners (Expert B). A consistently described issue is the lack of enforcement (Experts A, C, and D), including the monitoring of drinking water quality (Expert D) and the prosecution of non-compliant producers of drinking water (Expert A). This deficiency is due to insufficient staffing, knowledge and laboratory equipment, and in some cases, insufficient engagement and corruption (Experts A and D). Nevertheless, Expert A stressed the necessity of strict compliance for foreign actors and predicted stronger enforcement, which might require adapting practices accordingly. Local partners such as intermediaries or customers might possess the necessary practical experience with the regulatory framework (Expert B).

Informal institutions are an additional impediment to operations in emerging markets (Oyedele 2016). The term informal institutions refers, for example, to conventions, norms, and customs, which shape human interactions (North 2009) and may include illegal practices such as corruption (Oyedele 2016). According to Oyedele (2016), informal institutions add to the complexity of emerging markets and need to be taken into account when designing BMs. Some of the practices observed in the Vietnamese water supply market are pointed out in the following.

In the context of socio-cultural practices, traditions and rules, the lack of intercultural studies (Expert B), and data on the Vietnamese water supply market were criticised

(Expert A). According to Experts A and D, bottled water is used by the lower income population. The quality of local brands of bottled water was described as very variable, depending on the brand and the season (Expert A). The usage of household water filters by the middle- and high-income urban population was also described (Expert D). Depending on a household's financial resources, they are used to treat all the water consumed by a household or only its drinking and cooking water (Expert D). Furthermore, water boiling was identified as a deeply ingrained habit that is still practised, even for filtered water (Expert D). There is widespread mistrust of piped water (Experts B and D). In line with the literature and the expert interviews, these practices need to be taken into account when designing BMs for decentralised water treatment technologies. The lack of trust in piped water could support decentralised technologies depending on their design. The widespread use of local brands of bottled water suggests collaborations between the suppliers of decentralised water treatment technology and the producers of these local brands.

Several illegal practices were identified, including the following: the distribution of non-functional decentralised water treatment technology (Expert D) and contaminated bottled water (Experts A and D), non-licensed withdrawal of water, illegal discharge of sewage (Expert D), and corruption (Experts A, B, C, and D). Expert B points out the risks of corruption: dependency and its use as leverage. Local intermediaries can function as a firewall (Expert B).

Lack of partners

Organisations operating in emerging markets often face a lack of suitable partners along their value chain (Landau et al. 2016). The lack of partners includes suppliers of high-quality inputs such as machinery components and services (Expert B). Intermediaries and joint ventures might be able to counteract this (Expert B); otherwise, the required products need to be imported (Expert A). Collaboration with all kinds of actors is suggested to access valuable resources, competencies, and knowledge (Sánchez et al. 2007). The following section addresses the question of key stakeholders. Table 2 shows a summary of the potential partners and their competences. These comprise Civil Society Organisations (CSOs), education and research (E&R)

organisations, international organisations (IOs) and funders, and local intermediaries.

Civil Society Organisations such as water use groups, i.e. groups that coordinate water-related activities, play a dominant role in the country's society (Du et al. 2016). CSOs are 'all non-market and non-state organisations outside of the family in which people organise themselves to pursue shared interests in the public domain' (OECD 2009, p. 26). The participation of communities in the water sector has a long tradition and is specified in the Law on Water Resources (Du et al. 2016). Recent decisions attempted to clarify the roles of CSOs and increase their incorporation into the political process and society's development (Du et al. 2016). They may become active as technical consultants and advocates (Du et al. 2016). Nevertheless, implementation lags behind and there is no adequate legal basis for the incorporation of marginalised groups (Du et al. 2016).

One of the sector's CSOs is the Vietnam Water Supply and Sewerage Association (VWSA n.d.). The VWSA can assist in establishing contacts to and dealing with local stakeholders (Expert C). CSOs are also active in water resources analysis, technology transfer, educational work (Expert D), and may allow others to share their distribution

channels (Gebauer & Saul 2014). Women's unions and community chiefs are able to assist by providing access to potential customers (Expert D).

Public and private *education and research organisations* play a key role (Du et al. 2016). They can provide R&D and data (Du et al. 2016; Expert A; Gebauer & Saul 2014) on suitable technologies as well as information on the target market and train staff for the sector (Du et al. 2016). The latter is particularly valuable as the lack of skills and expertise has been pointed out as a major impediment for operations and maintenance, and as a risk factor for decentralised technologies (Expert A). Finally, these organisations might engage in local endorsement (Expert A). The organisation of Expert A, for example, works together with schools to provide free drinking water to the students. While this is undoubtedly a philanthropic act, it could also function as an educational activity, creating awareness of the necessity and advantages of safe drinking water and as a marketing activity.

International organisations and funders might be valuable in terms of supporting operations technically and financially (Du et al. 2016; Experts B and C; Reichenbach et al. 2018). The World Health Organization (WHO), the World Bank Group, the Asian Development Bank (ADB), the Danish International Development Agency, the Kreditanstalt für Wiederaufbau (KfW), and the Japan International Cooperation Agency offer financial and technical support (Du et al. 2016; Reichenbach et al. 2018). One problem is the lack of overall strategic co-ordination of the projects (Du et al. 2016; Reichenbach et al. 2018). Furthermore, it is often not possible to upscale pilot projects (Du et al. 2016; Reichenbach et al. 2018).

According to the OECD (2018c), Viet Nam received net official development aid (ODA) worth US\$2,894.8 million in 2016 and US\$2,376.4 million in 2017. ODA is '[G]overnment aid designed to promote the economic development and welfare of developing countries. Loans and credits for military purposes are excluded' (OECD 2018b). The largest share of ODA came from Japan, followed by contributions from the International Development Association (IDA), the ADB, and Germany (OECD 2018c). In 2016, US\$2,992 million ODA were earmarked for water issues in Asia (OECD 2018a). Viet Nam was the top recipient, receiving US\$531 million (OECD 2018a). About 51% of the received

Table 2 | Potential partners and their competences

Potential partners	Competences
CSOs	<ul style="list-style-type: none"> Establish relationships and deal with local stakeholders^(d) Access to customers^(e) Education^(a, e) Sharing distribution channels^(f)
E&R organisations	<ul style="list-style-type: none"> R&D activities and data^(a, b, f) Training^(a) Local endorsement^(b)
IOs and funders	<ul style="list-style-type: none"> Technical support^(a, c, d, g) Financial support^(a, c, d, g)
Local intermediaries	<ul style="list-style-type: none"> Identify potential partners and suppliers^(c, d) Access to customers and potential partners^(c, d) Build relationships and networks^(c, d) Language and cultural expertise^(c, d) Expertise on customer taste^(c, d)

Own table based on (a) Du et al. (2016), (b) Expert A, (c) Expert B, (d) Expert C, (e) Expert D, (f) Gebauer & Saul (2014), and (g) Reichenbach et al. (2018).

ODA was given by the IDA and 39% came from Japan (OECD 2018a).

Local intermediaries can fulfil several functions. Compared with other members of the Association of Southeast Asian Nations (ASEAN) countries, Viet Nam has a low localisation rate. Most of its machinery is imported from China, Japan, South Korea, and Germany (Expert B). This assessment is supported by Expert A, whose organisation is dissatisfied with the efficiency, level of automation, and remote monitoring possibilities of the machinery sourced in the MRD. Local intermediaries can identify potential partners and suppliers, enable access to customers and potential partners, build relationships and networks, and have good knowledge of the local language, culture, and customer tastes (Experts B and C).

Outlook and limitations

It remains to be determined exactly where and for which water suppliers saltwater intrusion and arsenic contamination are an issue. Against the background of existing solutions and planning, Expert D suggested an assessment of the technically and economically feasible options for the different water suppliers. To design tailored SBMs, we recommend studying the existing BMs in the Vietnamese water supply market, for example, by conducting more interviews with experts from organisations in the sector. We suggest the scope of such a study should go beyond decentralised water treatment technologies, the water supply sector, and the geographic boundaries of Viet Nam, because (the elements of) BMs from different industries might be applicable, too. This is for example proposed in the St. Gallen Business Model Navigator developed by Gassmann *et al.* (2014). A trial-and-error approach should be taken to adjust and customise the SBM elements in practice. In order to ensure the actual state complies with the targeted one, sustainability aspects must be incorporated and assessed when designing and implementing the SBM.

Viet Nam was chosen as the location for the project WaKap, because it is considered representative for many countries in Southeast Asia. Nevertheless, the water markets of Myanmar and Cambodia, for example, may be very different. When trying to replicate a SBM developed for the

WaKap technology, factors such as market saturation, different governmental structures, and different cultures need to be taken into account. Studying the framework conditions and stakeholders in these countries could contribute to the design or adoption of SBMs for decentralised water treatment technologies. Another or complementary option is to study the geological conditions in these countries to determine whether the specific treatment system developed in WaKap is suitable for application there.

Finally, we consider the limited selection of experts in this study to be a major limitation, and suggest a larger and more diverse sample to obtain additional insights and different perspectives. The Vietnamese perspective, in particular, would provide essential insights into the framework conditions and stakeholders for the design of (sustainable) BMs of decentralised water technologies. Future research should focus on their perspective. This study also suffers from the typical limitations of qualitative research, such as limitations in the transferability and generalisation of the results.

CONCLUSIONS

In this article, we determined the features that are specific to the BoP markets and emerging markets in the case of decentralised water treatment technologies in Viet Nam from the perspective of European actors. We assume that a successful design of SBMs to ensure access to safe drinking water for the low-income and middle-income population in Viet Nam must consider and respond to these framework conditions. We utilised the existing literature on emerging, BoP, and water markets and conducted interviews with experts to determine these features. Recommendations for designing tailored BM can be derived from them.

The lack of financial resources described in the literature was relevant for the potential customers of decentralised water treatment technologies such as local authorities or water producers. This suggests that low-cost solutions and/or adequate financing schemes should be developed. Unbranded competition, market saturation, and cultural features such as the importance of word of mouth and relationships call for collaboration with local partners and the utilisation of existing value chains. New entrants with decentralised water treatment technologies can exploit

what looks like an obstacle at first sight. They can target and collaborate with local partners, especially at the point where customer interaction happens. This can include offering the treated water to local retailers instead of distributing it themselves, or offering their technology or services to existing water producers. This may have implications regarding the technologies themselves, which might need to be adjusted to the scale and conditions of these local water producers.

Apart from and possibly more important than technology, adopting the right practices ensures safe water and a long technology lifetime. Vocational and *on the job* training may therefore yield high returns. De-skilling and providing maintenance services are additional approaches. These points seem particularly important for decentralised technologies as opposed to large-scale centralised operations, as these have different needs regarding on-site operation and maintenance. Furthermore, following the suggestion of targeting local water producers, adequate operation and maintenance skills are key to providing safe water in the long term. Educating children is key to raising awareness, among the adult population as well. Regarding the institutional set-up, Viet Nam's communist, centralised governance structure makes top-down approaches appealing. However, the local levels are also important, especially when implementing decentralised technologies. This is valid not only for authorities, but also for further collaboration with CSOs and local intermediaries. Particularly when targeting local water producers as potential clients of decentralised water treatment technologies, local intermediaries play an important role in finding and interacting with them. The proposed approaches for dealing with illegal practices range from engaging in them to 100% legal compliance. Sage advice here might be to rely on local intermediaries. These know and respect the local rules and can function as a firewall against corruption.

Finally, we want to point out that although the Vietnamese water supply market is complex, access to safe drinking water is vital to human development and worth joining forces to achieve. Governments, CSOs, E&R institutions, and local and multinational enterprises of all sizes should seek to collaborate and support each other to ensure people everywhere have access to the human right of clean water regardless of their country of residence or income level. To make this happen, obsolete ideas about the strict division of tasks between these different actors

need to be abandoned. Business needs to be understood as a vehicle of development. Research needs to be fostered that goes beyond technical feasibility towards the implementation and dissemination of sustainable technology. Efforts need to be combined to make SDG 6 and the Agenda 2030 for people, planet, and prosperity a reality.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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