Review Paper

In pursuit of sustainable water solutions in emerging regions
Laura R. Brunson, Lowell W. Busenitz, David A. Sabatini and Paul Spicer

ABSTRACT

While lack of access to consistent safe drinking water is estimated to affect nearly 2 billion people worldwide, many of the efforts to solve this crisis have proven to be unsustainable. This paper discusses some of the reasons for these challenges and suggests interdisciplinary practices that could be integrated from the very beginning of a water intervention to achieve long-term success. Of key importance for sustainable water implementation is an enabling environment that incorporates aspects such as funding, potential for market development, and supportive governance. While this enabling environment is acknowledged, the focus of this work is on the integration of three key areas: (i) social and cultural assessment of behavior and preferences; (ii) market-based implementation approaches that draw on this knowledge; and (iii) technology development for these markets.

Key words | drinking water, interdisciplinary, market-based implementation, safe water, sustainability

INTRODUCTION

The World Health Organization (WHO) and UNICEF estimate that 780 million people lack access to improved water sources (WHO & UNICEF 2012). WHO & UNICEF (2012) also acknowledge that not all water from improved sources is safe for consumption; an estimated 1.2 billion people consuming water from improved sources are still exposed to potential health risks from water (Onda et al. 2012). Pursuit of safe drinking water is further complicated by the fact that 1.4 billion people are living on less than US$1.25 per day, thus increasing the challenge of getting safe drinking water to many communities (United Nations 2009).

The focus of this paper is on the development and implementation of sustainable drinking water solutions for emerging regions. While there are some important overlaps with sanitation, we focus here on safe drinking water since the proposed market solutions we explore are, to some extent, unique to this issue. We acknowledge that improved sanitation plays an important role in access to safe drinking water and that some of the ideas and tools presented in this work are equally applicable to sanitation but because of boundary and space constraints, we only address safe drinking water issues here. We encourage others to extend the ideas presented here to the sanitation sector.

IMPLEMENTATION CHALLENGES

In response to the lack of safe drinking water, numerous governmental, university and humanitarian organizations have attempted to implement solutions ranging from point-of-use (POU) household treatment systems to piped community-scale projects. Despite these good intentions, sustainable water solutions are often not realized and many challenges still remain. Furthermore, global data on...
long-term successes and failures are frequently unavailable because of the expense and challenge of achieving high-quality, long-term monitoring (Onda et al. 2012; WHO & UNICEF 2012). Nevertheless, available data and observations indicate that the water issue is far from solved, in part because of the premature failure of water schemes (Hunter et al. 2010; Foster 2012). For example, over the past 20 years an estimated US$1.2 billion have been ‘lost’ because of wells that have failed prematurely in sub-Saharan Africa (Schouten & de Jong 2009).

There are many reasons why water systems fail in developing countries. One reason is that solutions may not be culturally appropriate or are not selected based on local preferences and practices, which makes it unlikely that the community will readily adopt and/or sustain them (Hokanson et al. 2007; Skinner 2009). For example, if a society believes drinking warm water causes illness then setting up a system that, intentionally or unintentionally, results in warm drinking water may produce water that is safe but is deemed unacceptable by the community (Wellin 1955; Rogers 2003). Some problems are technology related such as when hardware fails or a filter clogs (Hankin 2001; Burr et al. 2012). Another common cause of failure is missing or ineffective supply chains for renewable (breakable) parts, necessary chemicals, or replacement filtration media, or when there is a lack of human capital for maintenance and repairs (Diergaardt & Lemmer 1995; Oyo 2006; Clasen 2009; Hirn 2012). Other frequently mentioned causes of failure include lack of education on the importance of the safe water scheme (Hokanson et al. 2007), minimal capacity and ownership of the intervention in the community (Breslin 2005; Skinner 2009), aesthetic issues such as taste or smell of the treated water (Diergaardt & Lemmer 1995; Hoque et al. 2004; Wood et al. 2012), disruption of daily routine (e.g. time or inconvenience) (Hoque et al. 2004; Gupta et al. 2008; Sobsey et al. 2008), costs to consumers (Carter et al. 1999; Gupta et al. 2008; Sobsey et al. 2008; Wood et al. 2012) and lack of accountability or follow through between stakeholders such as government, community and NGOs (Carter et al. 1999; Harvey & Reed 2006; Hunter et al. 2010). Table 1 summarizes examples of water projects, primarily failures but also a few successes, along with reasons for success or failure and suggestions for improvement.

**SUSTAINABLE DEVELOPMENT**

The failure to achieve sustainable safe water solutions is well known, but much remains unknown about how to move forward. Breslin (2010) argues for increased attention to monitoring, including a focus on realistic success metrics over the long term, transparency and accountability, and assessing where funding comes from and how it is leveraged. Hokanson et al. (2007) studied several specific water purification technologies and several geographic regions and made suggestions including: appropriate technologies should be used, community training should be increased, and more efforts should be made to improve community buy-in. Building on these important efforts, we argue that formulation and implementation of sustainable water solutions requires the blending of social science (to understand the human dimensions), business and economic capacity (to aid in market-based implementation and assuring a consistent supply chain), and science and engineering (to aid in technology development). These three components of the system are often discussed individually but rarely integrated in the literature. Indeed, social and cultural assessments are often quite hostile to market-based solutions (e.g. Goldman 2006). While a number of water system approaches provide safe water, the ideas presented in this work apply primarily to POU and community-scale safe water systems. Figure 1 shows how the overlapping disciplines might look when working together within a given enabling environment, as discussed below. This collaborative effort is proposed not as a one-time occurrence in initial product development, but instead as something that should occur throughout the duration of each initiative.

Mihelic & Trotz (2010) argued that the ‘Application of sustainability to engineering projects thus requires more emphasis on integrating and balancing human and societal considerations with technological and economic considerations’. We build on this position and assert that the integration of disciplines should be conceptualized not as three separate sub-projects working in one area, but instead as three distinct areas of thought and expertise working collaboratively on one project with a common goal of building a sustainable solution. Table 2 suggests tasks that fall into each aspect of this integrated approach. We propose an
Table 1 | Examples of water projects in developing countries and possible improvements that could increase sustainability.

<table>
<thead>
<tr>
<th>Projects</th>
<th>Reasons for failure or success</th>
<th>Possible improvements</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells in Africa (nearly 200,000 wells)</td>
<td>Lack of funding for repairs/maintenance and overall lack of physical repairs and maintenance (Reasons implied but not specifically stated in source documents; overall statistic comes from many different projects and various reasons for failure likely exist)</td>
<td>Market-based solutions to encourage supply chains and repair networks</td>
<td>Breslin 2010, Schouten &amp; de Jong 2009</td>
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<td>Water boiling behavior change in Peru</td>
<td>Community members associated warm boiled water with sick people and were therefore, in many cases, unwilling to boil water for drinking, despite the health education provided</td>
<td>Attention to cultural assessment and local information to inform treatment choice</td>
<td>Wellin 1955, Rogers 2003</td>
</tr>
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<td>Household water chlorination in Kenya</td>
<td>Community intervention was conducted with the help of trusted local nurses</td>
<td>Follow up education from nurses or local project staff</td>
<td>Parker et al. 2006</td>
</tr>
<tr>
<td>Chlorination project in Namibia</td>
<td>Lack of consistent supply chain for chlorine</td>
<td>Assess user preferences through social science assessment prior to technology implementation</td>
<td>Diergaardt &amp; Lemmer 1995</td>
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<td>Bone char use to remove fluoride from drinking water in Ethiopia</td>
<td>Community unwilling to use bone char for cultural reasons</td>
<td>Social marketing campaign to raise awareness and encourage use and purchase of treatment technology</td>
<td>Abaire et al. 2009</td>
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<tr>
<td>Public water points were partially broken or completely broken at rates of 44% and 24%, respectively, in Sierra Leone</td>
<td>Lack of supply chain for replacement parts</td>
<td>Ensure active management of water point</td>
<td>Hirn 2012</td>
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<td>Water filtration and safe storage for HIV/AIDS population in Zambia</td>
<td>Implementation in a population already highly aware of health issues</td>
<td>Inclusion of a broader population beyond those that were referred by health clinics</td>
<td>Peletz et al. 2012</td>
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(continued)
integrative vision of these solutions by embedding them in the enabling environment, which incorporates aspects such as politics, economics, available resources, legal frameworks, and funding opportunities. In order for projects to be successful an enabling environment must exist that is conducive to sustainable safe water supply solutions. This cannot, of course, be presumed, but in this paper we assume that such an enabling environment exists and we focus on the other key elements to achieving sustainable water solutions. We focus here on local context, but we expect that this will lead to a more comprehensive approach that will consider these local systems in a global context that includes donor communities and governments (Breslin 2010; Hunter et al. 2010).

**SOCIAL AND CULTURAL ASSESSMENT**

Critiques of development initiatives abound within the social sciences (e.g. Ferguson 1994; Scott 1999; Goldman 2006) especially criticisms of the failure to consider local social and cultural realities. Unfortunately, these critiques

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**Table 1 | continued**

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<tr>
<th>Projectsa</th>
<th>Reasons for failure or successb</th>
<th>Possible improvementsc</th>
<th>Sources</th>
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</thead>
<tbody>
<tr>
<td>Intervention to improve safe water access through sale of PUR sachets in Guatemala</td>
<td>• Time required for use of water treatment product&lt;br&gt;• Cost (a possible but less supported cause)</td>
<td>• More technology development to reduce time required for treatment&lt;br&gt;• Reduce costs&lt;br&gt;• Alternative marketing strategy based on more than health outcomes</td>
<td>• Luby et al. 2008&lt;br&gt;• Jones Christensen &amp; Thomas 2008</td>
</tr>
<tr>
<td>Ceramic water filters for point-of-use water treatment in Cambodia</td>
<td>• Broken ceramic filter components&lt;br&gt;• Filters were considered slow&lt;br&gt;• Concern that filter life had expired</td>
<td>• Technology development to reduce breakage rates&lt;br&gt;• Increased supply chain access and knowledge of where the supply chain exists&lt;br&gt;• Increased education in user households&lt;br&gt;• Amend expectations for life of the filters</td>
<td>• Brown et al. 2009</td>
</tr>
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Text in bold indicates projects with a high level of success.

Most examples listed here are not of complete failure or success but partial (e.g. 200,000 wells failed in Africa though some are still functioning and 69% of ceramic water filters are no longer operational while 31% are still in use). Shading indicates water interventions that were primarily successful.

Reasons for failure are stated or implied by the source document.

Possible improvements are in part suggested in the original source documents and in part suggested by the authors of this work based on insights gleaned from reviews of failed and successful projects.
Table 2 | Tasks that fall into each component of synergistic research towards developing sustainable research and water access or treatment implementations

<table>
<thead>
<tr>
<th>Social and cultural assessment</th>
<th>Market-based implementation</th>
<th>Technology development</th>
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<tbody>
<tr>
<td>Assessment of local practices regarding drinking water</td>
<td>Business models research</td>
<td>Lab testing</td>
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<td>Assessment of willingness to pay</td>
<td>Market research</td>
<td>Field technology assessment</td>
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<tr>
<td>Assessment of drinking water aesthetic preferences</td>
<td>Economic assessment</td>
<td>Improved or new technology development</td>
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<td>Investigation of values inventory</td>
<td>Implementation through social entrepreneurship</td>
<td>Life-cycle assessment</td>
</tr>
<tr>
<td>Determination of health needs, goals, beliefs, and behavior</td>
<td>Cost assessment using life cycle costs approach</td>
<td>Assessment of locally available materials and processing capabilities</td>
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</table>

have seldom been applied in improving development initiatives such as access to safe water. Understanding the social and cultural context in which people may care about drinking water quality is an obvious, but often neglected, dimension of any sustainable safe water scheme. In a development context, technological and market-based approaches presume certain forms of social and cultural orientation, which may not always be warranted. For example, Mary Douglas, a social anthropologist, points out that sometimes apathy of communities, often caused by helplessness and an inability to envisage a way out of the current life situation, can be a major deterrent to implementation and success of development projects (Douglas 2004). When properly designed and implemented, social and cultural assessment should help us better understand the human system in which an initiative is attempting to intervene.

Social and cultural assessment is commonly conducted by anthropologists, sociologists, or psychologists (and at times engineers) using methods such as observations, surveys, interviews and focus groups. Huber et al. (2012) discuss a method that can be used to conduct this research and McConville & Mihelcic (2007) provide a sample list of information to gather. These tools can reveal where people get affirmation or criticism of their behaviors, what beliefs cause people to accept or reject ideas, and information about attitudes, preferences, aspirations, and other factors that influence current and potential behavior. Formative research is needed to assess needs as well as community wishes. This process can be daunting and several helpful sources of information are available that offer guidelines and approaches for this. The Participatory Hygiene and Sanitation Transformation (PHAST) approach is one method for working with a community to plan a project, and a helpful guide is available from WHO titled PHAST step-by-step guide: A participatory approach for the control of diarrheal disease. Safe Water Systems for the Developing World: A Handbook for Implementing Household-Based Water Treatment and Safe Storage Projects from the Centers for Disease Control and Prevention offers information about how to conduct a focus group and includes sample questions. Knowledge, Attitudes and Practice (KAP) studies are another method for gathering data: Two helpful resources, though not specific to water, are ‘The KAP Survey Model’ from Médecins du Monde and ‘A Guide to Developing Knowledge, Attitude and Practice Surveys’ from WHO.

A growing number of water researchers have gravitated toward cognitive and behavioral theories of behavioral change, often derived from health psychology, to understand problems in international water development (e.g. Heierli 2008). Others have found the inductive community-based approaches of anthropology to be central to their efforts (e.g. Mihelic et al. 2007; Ramaswami et al. 2007). Thus, social and cultural assessment plays a key role in safe water development because the research in this area assesses community knowledge, beliefs, behaviors and desires and then influences the education, information sharing, and motivational tools for health behavior change that have been argued to be a critical component of water treatment projects as a whole (Hokanson et al. 2007). Health behavior change is a difficult topic at times because it can seem paternalistic or offensive. However, it is possible to motivate, as opposed to force, positive health-related behavior modification with a minimum level of community change or invasiveness if researchers and practitioners gain a solid understanding of the community and its history and beliefs, and follow ethical development guidelines (e.g. Gasper 2004, 2012; the International Development Ethics Association http://secure.pdcnet.org/idea/About-Us).
Social and cultural assessment, if well done, should also inform both market analysis and technology selection and development. If we take seriously the idea that a community or family should be able to have a voice in selecting their water treatment technology or water source, social sciences are essential to cultivate this participation (McConville & Mihelcic 2007; Skinner 2009). Heierli suggests one of the most important things to do in determining implementation methods for a community is to gain a thorough understanding of the culture and values of the community in which practitioners and researchers are working (Heierli 2008). Rogers (2003) suggests new technologies are better disseminated if the change in behavior required is minimal when compared with previous behavior; thus, understanding patterns of behavior, behavior stimuli, and habits of the community members is key. In direct relation to water, we know that household water treatment technologies are more likely to be accepted and used if they are easy to use and require minimal time (Sobsey et al. 2008). Thus, social and cultural information gathering and assessment is a critical aspect of an integrated water implementation. The knowledge gained about local communities is crucial to understanding the local markets that should inform the selection or design of technologies.

**MARKET-BASED IMPLEMENTATION**

There are growing signals that market-based solutions may be an important avenue through which sustainable drinking water issues can be addressed. For example, Pralahad (2009) noted that there are millions of people living in poverty that are becoming viable consumers of scalable consumer items sold through sales techniques and appropriate marketing. For the world’s 4 billion poorest people, the water market is approximately $20 billion (Hammond et al. 2007). Thus, in the larger ecosystem, utilizing market approaches can be beneficial for poverty reduction and global economic growth along with increased sustainability of access to safe water.

There are several areas where an entrepreneurship perspective contributes to water research and implementation. The process of analyzing how the various pieces of a business model could work or how they need to be adjusted to better facilitate the customer value proposition, the inter-workings of the various exchange partners and how money flows, can be highly constructive (McGrath 2010). Rural Water Supply Network (2010) and Foster (2012) suggest that exploration and testing of market-based solutions for rural safe water in developing countries is helpful for addressing water sustainability concerns. Markets readily benefit people by offering competition, which drives down prices and encourages continued innovation based on customer demand (Wolff 2012). Furthermore, market-based systems provide strong encouragement to maintain, repair and upgrade existing systems as individual livelihoods depend on ongoing operations. The use of market-based models for water implementation also has the potential to solve issues such as missing supply chains, willingness to use technologies, and marketing concerns (Foster 2012). Skinner (2009) suggests it is helpful to have a viable market that ensures availability of a repair person(s) and replacement supplies to encourage fair pricing and options for consumers. Oyo (2006) indicates that, while private operation of supply chains for well and pump spare parts in Africa is not currently the norm nor always the best option, it could be the ideal option for sustainability if certain operating criteria are met.

While market-based implementation is certainly gaining traction, constraints include political instability, corruption, and lack of literacy (Hokanson et al. 2007). Government or NGO projects often run out of funding because of political or economic shifts, thereby jeopardizing the success of the project (Banerjee et al. 2007). In contrast, market-based solutions that are financially self-sustaining have the potential to be much more enduring without concerns about donor or government funding. In market-based systems, including POU or community scale, financial concerns must be addressed to remain operational. The means of economic exchange and payment systems between suppliers and users must also be accommodating and fluid. Therefore, aside from studying business model alternatives, business experts on water research teams need to understand what can add value for customers, how it can be delivered in a way that meets the needs and wants of customers, and cost/payment mechanisms. Fonseca et al. (2011) and Burr et al. (2012) offer an in-depth discussion of the life cycle costs approach and suggest that it takes into consideration
water point/treatment costs including minor operations and maintenance and major capital maintenance, capital investment and both direct and indirect support. Fonseca et al. (2011) provide information on accounting strategies and guidance on how to conduct a life cycle cost assessment.

There is increasing movement towards charging water consumers enough such that full cost recovery becomes a viable option, but in many cases users do not have the ability to pay at this level (Banerjee & Morella 2011; Foster 2012). Thus, subsidies may be needed to complement local systems in certain cases (Banerjee et al. 2007; Kremer et al. 2010; Foster 2012). Due to the diversity of funding sources and the complexities of implementation, options such as hybrid organizations, subsidies from governments or NGOs, paying in installments, and other creative solutions could be explored for the implementation of some market-based solutions (Gupta et al. 2008). Further discussion of issues with willingness to pay, costing and potential options for private water business can be found in Foster (2012) and Kols (2011) and there is an ongoing need for research on private sector water options (Harvey & Reed 2006).

Market-based solutions can improve sustainability of water supply as well as benefit communities by employing local people and expanding markets. However, it is important to acknowledge that market-based approaches are not ideal in every situation. For example, willingness to pay for water treatment in some areas can be quite low, and it was reported by Null et al. (2012) that the short-term uptake of water treatment options was much higher if items were given away free or were very inexpensive, thus not supporting a market-based approach. However, Baumann (2006) suggests that the market for boreholes in Africa is massive and increasingly the private sector, in particular indigenous drilling companies, are best suited for meeting this need. Additional research on payment options is needed to inform market-based solutions and the ‘best option’ no doubt depends on local culture, habits, preferences, markets, etc.

Related to these market-based approaches is social marketing. Social marketing is the application of marketing principles to influence social behaviors and accomplish a social good (Andreasen 1994). Furthermore, social marketing seeks to benefit the target market and even society as a whole, not the marketer as done in commercial marketing. Kotler & Zaltman (1971) were among the first to characterize social marketing as ‘A bridging mechanism which links the behavior scientist’s knowledge of human behavior with the socially useful implementation of what that knowledge allows’. With public health issues, social marketing has been employed to help implement programs aimed at broad-based behavioral change (Andreasen 1994; Rogers 2003).

Social marketing is a tool that allows us to consider ways of combining social and cultural assessment with market-based implementation and dissemination of treatment technologies or safe water sources. Social marketing can be powerful when used by the private sector or by NGOs, such as Population Services International, for marketing safe water solutions based on careful social and cultural assessment, though it should not necessarily be considered a complete substitution for other behavior change activities (Banerjee et al. 2007; Foster 2012; Wood et al. 2012). Sometimes combining more than one health-related initiative together can be beneficial. For example, Peletz et al. (2012) found that implementing household water treatment filters with HIV-positive mothers who had young children resulted in an 82% use rate and improved drinking water quality, confirmed by bacteriological improvements. The authors suggest this may have resulted from an increased awareness of health-based concerns in HIV-positive populations, thus, leading to an increased willingness to use health improvement interventions (Peletz et al. 2012).

Good market-based approaches have the best chance of success when they are built on a solid assessment of the culture. Furthermore, to have water treatment products that are effective, efficient and culturally acceptable is imperative for developing market-based systems. At the same time, social and cultural assessment and market analysis are useless without sustainable technology, to which we now turn.

TECHNOLOGY DEVELOPMENT

The ability to supply or treat water is essential to addressing the safe water availability issue, which is the focus of this paper. But if we are to take seriously the critiques of water development that formed the departure for this essay, it is clear that technology development is just one piece of the
interdisciplinary effort. There are two key aspects to a discussion of technology in the framework of building sustainable water solutions.

First, technology research, development, and assessment can be more effective and powerful when guided by information learned through social and cultural assessment (i.e. local cultures and taboos) and when, in consideration of the local economy, technology’s place in local markets is taken into consideration. As mentioned in Table 1, sometimes projects fail because a technology is not appropriate for the local community. For example, research using bone char to remove harmful fluoride in a community that has a cultural preference against animal bones is not appropriate, even if the approach is technically viable (Abaire et al. 2009). Assessment of community preferences should guide technology selection/development with the assumption that a community or family may be responsible for funding operations and maintenance as well as physically collecting/treating water. Selection of locally produced versus imported technology is often a discussion of cost and availability of materials, but it is imperative to also consider community members’ preferences as they will influence what technologies will actually be utilized. Additionally, depending on what the local market situation is, the ‘best’ answer may be one that does the most to facilitate not only increased access to safe water but also to boost the local economic market.

A second key aspect of research and selection of technologies is that in some cases the necessary technologies either do not exist or would benefit from continued research for improvements. The literature presents some cases where projects fail as a result of technical issues or where technologies could be improved to make them more user-friendly, sturdy, effective, etc. For example, Hokanson et al. (2007) point out that UV disinfection is highly effective for pathogen removal, but that there are several drawbacks including: the necessity of a power source, the requirements for quality of the source water, and the fact that no visible change occurs during the treatment process. Gupta et al. (2008) suggest the need for additional engineering to make chulli water filters more durable and reliable, and Baumann (2006) suggests that decreasing the cost and increasing the efficiency of borehole production, specifically in Africa, would improve access to safe water in Africa.

**Sustainability tools**

A number of tools can guide the kind of integrations we propose here. The work by McConville & Mihelcic (2007), which develops a framework for looking at factors that affect sustainable development of water and sanitation projects, provides practical steps to be utilized – specifically their Table 1 which suggests helpful tasks within five life stages of a project. The Triple-S (Sustainable Services at Scale) initiative website, led by the International Water and Sanitation Center, contains tools, ideas, case studies, and training options and is available at http://www.waterservicesthatlast.org/. Finally, Skinner (2009) discusses ways to make Africa’s waterpoints more sustainable including focusing on quality control of implemented technology, waterpoint management and ownership, and use of local markets to support maintenance and repairs. This work offers a table containing 30 elements that are suggested as necessary for success for sustainable safe water in African communities.

**PRACTICAL IMPLICATIONS**

There are many lessons to be learned from the individual disciplines discussed above, but more important than the individual disciplines learning from one another in isolation is the synergistic impact of collectively designing, evaluating and implementing sustainable solutions for access to safe water. We have argued for the importance of including at least the three disciplines (social science, business and technology) into a safe drinking water initiative from the very inception of the project in order to ensure that each step of the process is influenced by all areas. We argue that failure to collectively include multiple areas from the onset will lead to suboptimum solutions. For example, through this literature review the importance of conducting a thorough market analysis of the target communities or households has emerged. This type of analysis could be done in isolation, but to be most effective requires a solid social and cultural understanding of human behavior, desires and motivations, the willingness/ability to pay for safe water, and social marketing to better inform the targeted populations. At the same time, social and
cultural assessment could be done by a social scientist who does not fully understand the business/supply chain/entrepreneurial elements and thus would fail to incorporate critical information necessary to assess these aspects. Finally, this step, even if forged by both of these disciplines, may lack knowledge of what technologies might be available or feasible. We strongly encourage researchers and practitioners to fully adopt this integrated approach into their program design, implementation and assessment, and have provided a number of tools that can facilitate these processes in most initiatives, even in the absence of specialized expertise on a team. We further suggest that funders and government organizations look for these elements in project proposals or evaluations and consider funding and supporting activities in part based on evidence showing careful consideration of these aspects of sustainable development.

**CONCLUSION**

Identifying a successful solution that is appropriate for each context is certainly a challenge. While a multitude of excellent organizations have been implementing solutions to the water crisis for decades, an alarming number of past projects are not demonstrating long-term sustainability. We argue that it is imperative that researchers and practitioners work to find best practices, integrate skills and ideas from many fields, and put them together to research and create synergistic solutions for safe water needs in communities around the world. We posit that the combination of social and cultural assessments, market-based solutions and technology development can provide a powerful approach for achieving sustainable safe water solutions by allowing each approach to bring unique tools and methods to the project that inform and influence the direction and outcome of the project as well as the actions of the other disciplines. Future research on the methods and outcomes of designing, implementing and assessing this integrated approach will be helpful to the water community as it seeks ways to further improve sustainability of water supply/treatment implementation.

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