

The International Network on Appropriate Technology



Proceedings of the
7th International Conference on Appropriate Technology
“Sustainable Technologies to Empower Communities
– Bridging Theory with Practice”

Hosted at the
Cresta Sprayview Hotel Conference Center
Victoria Falls (Mosi Oa Tunya), Zimbabwe, November 23 – 26, 2016

SECTION VII: POLICY, STANDARDS AND ETHICS

Edited by

Marcel Castro Sitiriche

SPONSORS



Gibela-TUT Partnership
Rail Manufacturing and Skills
Development



International Planning Committee

A. Bakhiet, Sudan
J. Bemley, USA
H. Carwell, USA
M. Castro, Puerto Rico
T. Dalgety, Guyana
C. M. Fadel, Senegal
J. Fortunak, USA
J. Gwamuri, Zimbabwe
G. Kadoda, Sudan
J. Kiplagat, Kenya
M. K-Schutz, Namibia
K. Madzima, RSA
E. Marks, Guyana
C. Mubaiwa, Botswana
M. Muchie, RSA
A. B. Nyoni, Zimbabwe
K. Ngige, Kenya
M. Poe, USA
D. Soumonni, RSA
T. Shurn, USA
V. Sivasubramanian, India
A. Tejansie, Liberia
J. Tharakan, USA
J. Thomas, India
J. Trimble, USA
C. Verharen, USA
M. Zami, KSA

Local Organizing Committee

W. Goriwondo
M.T. Karikoga
A.B. Ncube
S. Ngwenya
N.B. Nhlabano
L.C. Nkiwane
A.B. Nyoni,
L.J. Nyoni
S. Sibanda

TABLE OF CONTENTS

Papers

Session III: Policy, Standards and Ethics

Appropriate Technology and Ethical Obligations of the University: W.E.B. Du Bois on the Africana University Mission **4**

Verharen C.¹, Kadoda, G.², Bugarin, F.³, Fortunak, J.⁴, Schwartzman, D.⁵, Tharakan, J.⁶, Wensing, E.⁷, Middendorf, G.⁸

Departments of ¹Philosophy, ³African Studies, ⁴Chemistry and Pharmaceutical Sciences, ⁶Chemical Engineering, ⁷Biology (Professor Emeritus), ⁸Biology, Howard University, Washington, DC, USA

²Independent Researcher, Khartoum, 13314 Sudan

⁷Department of Human Development, Columbia University, New York, USA

Dynamics of future-thinking for energy security in Sudan: community-based system dynamics modeling for socioeconomic impact of dams in North Sudan **23**

Seed Ahmed, W.¹ and Kadoda G.²

¹Sciences Po Paris School of International Affairs, Paris, France

²Sudanese Knowledge Society, Khartoum, Sudan

Electronic Tendering a 21st Century Necessity in Zimbabwe **32**

Lorraine Chiedza Chitongo, Daniel Musundire and Khesani Chilumani
NUST, Zimbabwe

Appropriate Technology and Ethical Obligations of the University: W.E.B. Du Bois on the Africana University Mission

*Verharen C.¹, Kadoda, G.², Bugarin, F.³, Fortunak, J.⁴, Schwartzman, D.⁵, Tharakan, J.⁶, Wensing, E.⁷, Middendorf, G.⁸

Departments of ¹Philosophy, ³African Studies, ⁴Chemistry and Pharmaceutical Sciences, ⁶Chemical Engineering, ⁶ Biology (Professor Emeritus), ⁸Biology, Howard University, Washington, DC, 20059 USA; ²Independent Researcher, Khartoum, 13314 Sudan, ⁷Department of Human Development, Columbia University, New York, 10027, USA
*cverharen@howard.edu

Abstract

Working on the Encyclopedia Africana under the sponsorship of Kwame Nkrumah in Ghana, W.E.B. Du Bois reversed his conviction that only the 'talented tenth' could profit from a university education. At this point in his life, he held that virtually all humans should have a right to a university education. He further insisted that Africana (African and African in the Diaspora) universities in fact have a particular ethical obligation and are uniquely positioned to spearhead an effort to train students to become professionals who solve problems community members are unable to solve for themselves. Africana universities can, with the aid of appropriate technology and service learning, take the steps necessary to achieve Du Bois's vision. In this paper, we present a practical account of how universities may work with local communities to determine the questions to research and then deploy appropriate technologies through community-based but student-driven service learning projects to help provide sustainable answers.

Keywords: Ethics, Africana Universities, W.E.B. Du Bois, Appropriate Technology, Community Empowerment, Service Learning

Introduction

As he began to develop his philosophy of socialism, W.E.B. Du Bois concluded that virtually all humans should have a right to a university education. Africana (African and African in the Diaspora) universities have a particular ethical obligation to spearhead an effort to train students to become professionals who solve problems community members are unable to solve for themselves (Du Bois 1973).

In this paper, we argue that in order to address Du Bois' admonition, universities in general, and Africana universities in particular, have three critical components to their mission. The first is an ethical obligation to teach research as the solution to unsolved problems. The second is to motivate students to use research to solve the problems of the very communities that justify the continuing existence of Africana universities, attendant sacrifices notwithstanding.

The third component, the most difficult, is to inspire and teach students to become teachers themselves with a primary mission of empowering community members to solve their own problems. For Du Bois, fulfilling these components constituted the first steps on the path to universal university education. While Du Bois was unable to realize this goal in his own time, Africana universities can seek to implement his vision, with the aid of appropriate technology (AT), service learning (SL) and the guidance of community-based research initiatives.

Within the broader context of a novel transdisciplinary research-based curriculum for civic engagement education, we present examples of AT in service learning, describing how students can transfer their problem-solving skills to community members. In this paper, we present a practical account of how universities may work with local communities to determine the questions to investigate and then deploy appropriate technology and service learning to help provide answers.

We explore how the application of AT can range from low to high tech. For instance, environmental data collected in neighborhood surveys can utilize simple check-sheets, sophisticated GPS layering or a combination to provide information for determining and prioritizing community problems and solutions. These approaches provide a diversity of community-based, case-specific assessment data for action research and integration and implementation science (I2S).

The conclusion details how AT engagement makes it possible for universities to assume responsibility for the life-long learning of their graduates and how graduates can establish communities of learning that teach problem-solving skills to community members. Of particular interest is the establishment of university-based, alumni-led learning labs that foster collaborative knowledge integration and co-production between disciplines with the expertise of community stakeholders, NGOs, scholar practitioners, and policy makers.

Such alumni-led learning labs depend on Africana universities' commitments to three principles: first, making 'near-peer' tutoring available to students throughout their careers, as a preparation for service learning in the wider communities; second, requiring service learning components in students' major fields as pre-requisites to graduation; and third, university commitment to take responsibility for life-long, continuing education for their graduates. The expectation is that the service-learning components will inspire students to pass their problem-solving skills to wider community members most in need of those skills. The paper projects possibilities of 'what could be' when learning communities collaborate to highlight the epistemological and pedagogical transformation required to create interdisciplinary space for solutions to real world problems.

Part I Du Bois And African Education And Development: From The 'Talented Tenth' To The 'Guiding Hundredth' In Sudan

Before he turned to socialism, Du Bois believe that the 'talented tenth' had responsibility for guiding their communities. In Sudan over the past sixty years under the guidance of that 'tenth,' Sudan and much of the African continent have remained one of the most impoverished areas of the world in virtually every global index. As a socialist, Du Bois began to believe that the individuals of the 'talented tenth' could not be a source for social transformation. He called for a radical change to the 'Guiding Hundredth.'

The transformation in Du Bois's theory of the 'Talented Tenth' to the 'Guiding Hundredth' involved at its core the concept of group leadership in 'drawing out of human powers' (Du Bois 1973:9). Du Bois made many contributions to Africana philosophy, critical theory, and education (Rabaka 2003, Juncan 2012, King 2013). Can we agree with him that we need to construct a 'different departure point' for an Africana educational system (Rabaka 2003:405)?

Reflection on a philosophy of appropriate technology constitutes such a different point of departure that that swerves away from dominant technological development structures

towards people-centered and context-specific innovation. Du Bois foreshadowed the critical view of technology transfer and development projects that led Schumacher to write *Small is Beautiful*. At the core of both theses is the concern over the skewed global economic order and rising inequality.

This section considers two appropriate technology projects, a rural development project that involved grandmothers from the Nuba Mountains in Sudan becoming community solar engineers, and a pilot project of a university innovation lab that involved students in development problems. The section's purpose is first, to highlight project features that relate to Du Bois's Africana education theories, and second, to discuss the pedagogical transformation required in university education for creating the intermingling space that can engage both 'guiding hundredth' communities together.

The 'Guiding Hundredth', Du Bois describes, are 'not only educated and self-sacrificing, but with a clear vision of present world conditions and dangers,' stressing collaboration and openness while they work 'towards a new world culture' (Du Bois, 1968:168). In his long quest for solutions to the 'Negro Problem', Du Bois initially believed that a few elites should lead the masses. Realizing 'that selfishness is even more natural than sacrifice', he then turned to the 'question of character' that must be built in the 'Guiding Hundredth' through a 'planned program' using new knowledge situated in the present condition of the people to eventually acquire 'all knowledge,' as well as a new understanding of history, race and culture (Du Bois 1948:5). However, the 'Guiding Hundredth' may also become selfish and lack ethical leadership. Even the 'Guiding Hundredth' must be democratized.

The discussion of the appropriate technology projects below will focus on two key ideas in Du Bois's Africana education theories. The first explores the projects in terms of the 'planned program' that Du Bois proposed for Sigma Pi Phi in 1948 to undertake the effort of preparing the 'Guiding Hundredth', and the second considers his description of the 'character' he saw necessary for leadership. This analysis interprets Du Bois's educational reflections for the contributions they can bring to appropriate technology leadership and ideals.

A key to understanding a Du Boisian approach to education through appropriate technology in Africa is the role of the *grandmother*. Throughout African societies, the grandmother is probably the first teacher one encounters. She is a respected figure in the family and known for her resourcefulness. She is also a repository for the family history as well as traditional knowledge. In today's 'modern' early education, one of the foundational lessons addresses the importance of the written word and scientific objectivity, displacing much of African culture and history to the fringes of knowledge production. It is only recently for example, that we have started to see government departments being set up to explore local knowledge. The student and the grandmother can co-exist in a higher education setting and share their specific knowledge. For instance, just as an engineering student can help with typical rural problems (using devices that worked, elsewhere), so grandmothers with indigenous knowledge about materials protective against dust or heat may help the student design a locally appropriate and culturally sensitive device. We view this as an important point of departure for the education of the African that seeks continuity rather than discontinuity.

The Barefoot Project

In this project, the Barefoot College in Tilonia, India partnered with Professor Gada Kadoda as a member of the International Network on Appropriate Technology and two NGOs (Ruya for Women Development and the Association of Small Farmers Group), both based in

the Nuba Mountains region of Sudan. The project trained four rural Sudanese women to be solar engineers in their communities.

The training program at the Barefoot College resembles the idea of the Du Bois's 'planned program' in that it is designed to subvert notions about technology education and women and technology, in discharging its mission of appropriate solutions for rural poverty. One of the solar engineers summed up her own transformation, describing herself as no longer as a 'woman' but as an 'engineer'. The group influence of solar engineers comes close to that of the 'Guiding Hundredth' in a rural setting, though not quite with the organization and detailed plans that Du Bois envisaged in his Sigma Pi Phi paper.

Du Bois explained that he focused on knowledge and grounding but failed to address the 'question of character' of 'The Talented Tenth'. Therefore he emphasized 'self-sacrifice' and 'far-sightedness' in the 'Guiding Hundredth.' The Barefoot College trains teams rather than individuals, thus realizing the 'group leadership' component of Du Bois's theory. The social bonding of the women that took place during their participation was evident. When they left Khartoum for the Barefoot College in India, they were perfect strangers to one another, coming from quite different cultures in the politically polarized Nuba Mountains. They arrived back in Khartoum as a unified team. One of the solar engineers referred to her solar knowledge as 'sacred.' She considered it her duty to keep that knowledge safe for her community.

The College's pedagogy is grounded in the cultural context of 'Alhaboba' (the grandmother). This philosophy extends her role. Already known for self-sacrifice, wisdom, perseverance, resourcefulness, egalitarianism, affection and respect, she is now responsible for the electrification of her village.

The Innovation Lab Pilot

This project involved piloting UNICEF's Innovation Lab model and its approach to 'Technology for Development' (T4D) at the University of Khartoum and Sudan University for Science and Technology. The aim of the lab according to UNICEF is to create 'a physical space that allows for collaboration among academia, government and non-governmental organizations, and the private sector' that can eventually 'become national facilities for building local technological capacities to support humanitarian development efforts' (UNICEF, 2012).

The primary goal of the project was to examine the efficacy of the innovation lab model in improving the accessibility of the UNICEF Sudan Country Office and their government partners to local human capacity in higher education institutions. The team at Khartoum University chose to work on developing a monitoring system for the school-kits distribution program at UNICEF, while the team at Sudan was interested in developing a routine-vaccination monitoring system for the national vaccination program supported by UNICEF.

The teams, being part of a network of innovation labs, had access to a range of open source software, technical support, literature on UNICEF's T4D innovation principles and success stories of providing real-time data collection and analysis capabilities using mobile technology. The project included typical courses in the Computer Science/Information Technology curriculum, such as software engineering, database management systems, knowledge management, and involved a popular final year project topic (mobile applications). The mission required the teams to be able to work with an open source framework (RapidSMS). Facts on Sudan's telecommunication coverage, mobile phone ownership, literacy rates, etc. prompted students to think outside their urban environment and explore creative solutions to best utilize the existing infrastructure and users' capabilities.

There are various features of Du Bois 'Planned Program' that this student exercise achieved: knowledge acquisition, contextual grounding, group leadership, and critical thinking. In student reflection on their experience, responsibility was a common theme (Kadoda 2015). One student declared that the project 'gave me a chance to give back a little of what I have been taking for five years from the university.'

Part II: Driving Forces In Educational Reform: A Du Boisian Model

In this section we briefly contrast the visionary aspects of Du Bois's work on the evolution of thought in the scholarly engineering, technology, and scientific research literature. In particular, we highlight how views in engineering, technology, and science have actually evolved to catch-up to Du Bois's seminal thought on the purpose of education in society (Du Bois 1973). In addition, we argue that given the current global context of escalating social and environmental problems, further development and implementation of Du Bois's views are more important than ever in that they can serve to guide and inform much needed education reform at this critical time.

Several forces have driven change in the way policy makers, the general public, and the academy view the role and responsibilities of education, teachers, and academics in society. These driving forces include: neoliberal economic agendas rooted in increasing globalization (Olssen and Peters 2005); recognition that science and the academy must adopt a broader more socially responsible contract with global societies (Gibbons 1999; Lubchenco 1998); the need for improved citizenship and civic engagement at both a local and global level (Lee 2015; Yanus et al. 2015); a need for a new education pathway that seeks to develop 21st-century skills (Pellegrino and Hilton 2013); and, most recently, realization across disciplines that collaborative, interdisciplinary, research-based inclusive participation can address the social and environmental problems of our time, such as global climate change (Hadorn et al. 2008; Johnsen et al. 2015; Pohl 2008; Weaver et al. 2014; O'Rourke et al. 2013; Vazquez-Brust et al. 2014; Wolfson et al. 2015).

While many of the reforms necessary for optimum knowledge integration and implementation have begun to be researched in education worldwide, they currently remain separated as isolated case examples. We take Du Bois's seminal thought on the purpose of education in society as a guiding light in a world of increasing social complexity characterized by mounting globally linked challenges.

The driving forces in educational reform listed above are very much in alignment with Du Bois' vision of a 'Planned Program' for the 'Guiding Hundredth.' Of the drivers listed above, however, perhaps the complex challenge of transitioning societies towards sustainable better futures is currently the most important application of what can collectively be referred to as Du Boisian reforms in education. That is, in a world under increasing duress from social and environmental problems, education to develop the competencies for knowledge integration and implementation that would lead to better global futures for all societies, has the highest priority. Nowhere else might this be more the case than in Africa, where the impacts of climate change and globalization are resulting in wide ranging societal problems.

Education toward a Du Boisian future is best guided by integrating academic scholarship and research with local expertise and experience. Several progressive research-based initiatives have been underway that support this type of education. These include the following: the Service-learning (SL) movement to develop publically engaged scholars (Post et al. 2016); the

Science of Team Science (STS) research initiative that builds interdisciplinary and transdisciplinary research team efficacy (Misra et al. 2011; Stokols et al. 2008); and the P-20 Curriculum for Civic Engagement (C4CE) that utilizes the Global Social Sustainability Hub (GSSH) and targets the cognitive development of skills for effective and ethical multilateral knowledge transfer (Futrell 2010; Wensing 2016).

The SL movement has evolved over the last years from early calls to include research as a key component in all SL initiatives (Cruz and Giles 2000) to more recent calls for learning institutions to implement education that intentionally seeks to develop publically engaged scholars (Post et al. 2016). For instance, in the United States the Franklin Project seeks to make a year of SL compulsory for college students (cf. <http://www.franklinproject.org>).

At the same time, a new discipline called Integration and Implementation Science (I2S) has emerged to help organize real-world, collaborative research (Bammer, 2013). Among other goals, I2S serves as a university-based, community-integrative learning platform for teaching and learning interdisciplinary and transdisciplinary research methods that will practically and ethically engage social and environmental problems. Engagement in various types of I2S research by students is an opportunity for young learners to acquire the cognitive and psychosocial skills that will benefit their lives and careers (Wensing, 2016). In addition it can bring much needed research-based action to communities worldwide.

If the role of education is changing to meet today's complex world, so too must the role of teaching and research institutions. While specific academic disciplines such as engineering are seeking to respond to a changing world (Leal Filho et al. 2015), colleges and universities too must become more targeted toward challenges of global societies (Kirst and Stevens 2015; Leal Filho 2014; Leal Filho et al. 2014; Robinson et al. 2011). Campus-community partnerships can promote civic engagement through service learning that takes an action research approach. Students, faculty and community members can build relationships with integrity, sense of community, and social equity (Bringle et al. 2009), and develop multicultural competence and social justice at the same time (Einfield and Collins, 2008). Thus, in the grander vision education can take on an important empowerment and emancipatory role in societies as described by Ira Shor and Paulo Freire (1987) while at the same time develop and engage the next generation of community leaders and social change agents as described by Du Bois (1973).

Part III: Du Bois's Philosophy In Action In Tanzania And Nigeria: The Kilimanjaro School Of Pharmacy And The Industrial Pharmacy Advanced Training Unity (Iptu)

An example to illustrate the application of Du Bois's philosophy of liberation through the use of appropriate technology can be found in the Kilimanjaro School of Pharmacy (KSP). Its origins date to the late 1970s and a need to broad-based, inexpensive availability of purified water suitable for intravenous (IV) use in regional hospitals in Tanzania (Mackintosh et al. 2016).

Dr. George Kamm of the Kilimanjaro Christian Medical Center (KCMC) in Moshi, Tanzania, linked together multiple filtration systems in series to deionize and remove foreign matter from potable water, followed by a terminal sterilization step. This process proved to be reliable and hospital demand for purified water was so great that the KCMC 'Infusion Unit' was formed in the 1980s to both expand supply and train other hospitals to reproduce this process.

After informally training personnel for a number of years, the Infusion Unit expanded in the late 1990s to become the Kilimanjaro School of Pharmacy (KSP). The National Pharmacy

Board accredited the KSP in 2003. The KSP is now a bulwark for providing trained technical and retail pharmacists, primarily to Tanzania and Kenya.

The KSP incorporated the objective of sustainable pharmaceutical manufacturing into its mission in 2005 with the arrival of Sister Zita Ekeocha from the Medical Missionaries of Mary. Given the urgent need for Artemisinin Combination Therapies (ACTs) for malaria treatment in Africa, Sister Zita lobbied the Global Fund to purchase ACTs from African producers. At that time, however, no African pharmaceutical manufacturers could meet the WHO quality standards for pharmaceutical products.

To meet the urgent need, Sister Zita started the Industrial Pharmacy Advanced Training Unit (IPTU) at KSP in 2006. By recruiting experts from the United States and Germany who possessed the required range of expertise, and by attracting a modest amount of funding from donor agencies, the KSP built a pilot plant for pharmaceutical manufacturing and started a program to train African pharmaceutical professionals to incorporate the principles of quality-assurance in medicines manufacturing and regulation, as well as to detect counterfeit and substandard medicines (Fortunak 2014).

The IPTU now teaches a professional certificate program of four postgraduate courses in drug development, pharmaceutical manufacturing, Good Manufacturing Practice (GMP), quality assurance, and Good Regulatory Practice for pharmaceutical professionals, national drug regulatory association (NDRA) managers, and University faculty.

The successes of the IPTU have been channeled ‘backwards’ to enrich and grow the Technical and Associate’s degrees in Pharmacy at the KSP. These students now take courses in drug manufacturing as part of their basic curriculum. The KSP is a leader in establishing a new (2017) competency-based curriculum for Pharmacy training with the Tanzanian Pharmacy Board, and a Bachelor’s Degree will be offered at the KSP beginning in 2018.

With collaboration from the IPTU, the School of Pharmacy at the University of Ibadan now offers both an updated version of the IPTU Certificate program, and a Master’s Degree for participants who carry on to complete additional courses.

Both the KSP and IPTU’s accomplishments have relied on appropriate technology. United States and Tanzanian faculty collaborated on curriculum with courses targeted to the most urgent needs of African populations through ICT communication such as on-line and email. In addition, United States faculty offer intensive two-week courses at the KSP. Relying on extensive on-line preparation, these courses target the full range of community pharmaceutical needs including manufacture, environmental-friendly disposal of outdated drugs, quality control, and regulatory practice for both pharmacists and national drug regulators (Kunle et al. 2008).

Adapting the KSP and IPTU’s appropriate technologies, the University of Ibadan in Nigeria is using insight gained through these interactions and funding from a MacArthur Foundation Award to implement new practices for quality assurance with Nigerian pharmaceutical manufacturers. The University Hospital at Ibadan is also collaborating with the School of Pharmacy to establish the feasibility of treating mass numbers of Nigerians suffering from hepatitis C virus (HCV) with inexpensive, direct-acting antiviral drugs in combination. This is expected to result in a sustained virologic response (SVR) for >95% of persons suffering from HCV, irrespective of the genotype of viral infection, upon 12-weeks of treatment (Fortunak 2008).

PART IV: DU BOIS'S PHILOSOPHY IN ACTION IN SOUTH AFRICA AND THE GAMBIA

Academic Assessment of Problems in Close Consultation with Communities: A South African Example

In the mid to late 1990s, the Xhosa Archaeological Research Project was established to look at the impact of colonialism on the Xhosa people in the Eastern Cape of South Africa. Located in and around the Double Drift Game Reserve, this project afforded the opportunity to work with, collect oral traditions from, and document oral testimonies of four Xhosa communities within the Middledrift District (a portion of the Keiskamma River Valley). As a result, in addition to being a project focused on the factors that gave way to the loss of independence and power for the Xhosa in the 19th century, it became a project that looked at the 20th century challenges and most pressing problems for the Xhosa living near the game reserve.

Xhosa community members wanted to draw attention to forced removals due to the establishment of the Double Drift Game Reserve, loss of community lands, and new policies that excluded them from sacred, historical, and political sites across the landscape. In the early 1990's, community members were forced at gunpoint to abandon their homes and move out of the area marked for the new game reserve. This project gave voice to that experience and the long-term consequences on the Xhosa within the Keiskamma River Valley (Bugarin 2002, 2009).

In consultation with the communities and game park representatives, the Xhosa Archaeological Research Project worked with Peace Corps volunteers, graduate students, professional colleagues, and other South African volunteers. The Project documented the most pressing problems and priorities of the Xhosa and mapped corresponding features across the landscape. A multi-methodological approach employed a number of appropriate technologies to identify factors that illustrated resource management strategies, cultural activity areas, and political and historical developments manifested through landscape transformations.

Using appropriate technologies, the Project recorded visual and audible data (e.g., oral testimonies of community members as well as observations of students), conducted a helicopter survey of the landscape (i.e., the survey was conducted as game park managers conducted routine aerial surveys and counts of wild game), carried out metal detector and pedestrian surveys, and used aerial photography, a Global Positioning System (GPS), and archival data to map landscape features and cultural activity areas. Community leaders led tours of the landscape in which they identified physical and cultural features. At every stage, the team made efforts to use technology that would capture voices and perspectives of community members in order to later present their understandings and visions of the landscape.

By overlaying data (collected from oral testimonies, surveys, interviews, and site visits) with mapping technologies, we were able to illustrate how discriminatory practices in the form of environmental policies shaped the physical and cultural contours of the landscape over time. While a well-managed balanced ecological zone flourished in the game reserve, the pastoralist Xhosa lost lands and were forced to overgraze their limited resources. Migratory patterns of Xhosa cattle and thus their feeding practices were restricted. The adapted strategies of the Game Reserve consequently contributed to underdevelopment and increased poverty in the area. Today, the Eastern Cape remains one of the poorest provinces in South Africa.

As relations between the Game Park and local community members became untenable, representatives of the Double Drift eventually took steps to rectify the situation. They began

hiring and training local community members to work in the park. Cultural facilitators were employed to mend relations between community members and game park staff. They learned environmental strategies and in turn they returned to their communities to train other community members.

While the research design for this project began with an academic researcher, community members became more comfortable revealing their priorities, concerns, and most pressing problems as community consultation and collaboration unfolded throughout the research process. The community members were indispensable to shaping research directions. Research evolved from a theoretical investigation of colonialism as a foundation for Apartheid to a practical project solved community problems.

Service Learning: A Gambian Example

The Kunte Kinte Archaeological Project (formerly the James Island Project) was established to look at the conditions of slavery in The Gambia on the coast of West Africa. Kunte Kinte Island was home to Fort James, part of a UNESCO World Heritage Site that is well known for being the focus of Alex Hailey's research for the book, *Roots: The Saga of an American Family*. While the main purpose of archaeological research was to understand the everyday practices of enslaved populations stationed on the island, the broader purposes of the project included assessment of environmental and cultural resource management strategies, documenting tourism and heritage education, and observing related informal economies.

The site is not only important for its historical and cultural significance, but it also represents a vital resource for the local communities. Its status as a pilgrimage destination for many African Americans draws revenue to support the local communities. Student participation in the research process illustrates the positive impact service learning can have.

In the summers of 2009 and 2010, Dr. Flordeliz Bugarin and Howard University students traveled to the site to conduct archaeological excavations. Our duties included both archaeological research and reaching out to the local community and the general public, including tourists attracted to the UNESCO World Heritage Site. The project offered students the opportunity to discover the region's history by working side by side with community members, training volunteers and crewmembers and regularly presenting their findings to tourists.

Students, local community crewmembers, and the project director were all equally responsible for training tour guides and explaining good practices of heritage management and environmental and cultural resource management. We collected data and assessed preservation and conservation strategies of archaeological properties. We trained community members to conduct environmental assessment in tandem with cultural resource assessment. Students learned how to collect and identify data, analyze findings, and interpret the past. Simultaneously, through hands-on experiences, they helped train local community members to do the same. As they worked to identify artifact clusters and process artifacts, they engaged in collaborative discussions and creative sessions focused on best conservation strategies.

The symbiotic relationships formed between students and community members, ones in which they relied on, educated, and learned from each other, can be applied to a broader plan. Any project that entails understanding the local cultural and environmental conditions and collecting field data may benefit from the unique skills brought to the project by different participants. Encouraging close collaboration among students, teachers, and community members only promises to intertwine the specialized skills and knowledge of each participant

for more nuanced results. As each learns from the project over a long period of time, connections and trust between students and community members may deepen. Once students graduate, they will have established an invaluable rapport with community members/partners that is sustainable and mutually beneficial for the success of future projects. Alumni-led projects are thus more feasible when students become committed to their community partners and rapport is established at the beginning of students' undergraduate careers.

This example illustrates that for many African communities, environmental and cultural resources are a primary source of revenue. Informal economies are often based on tourism, and thus rely heavily on the preservation of these resources to maintain community livelihoods. They offer a means for individuals to escape extreme poverty. As community members, working with students and faculty, work together to protect resources, they simultaneously work to alleviate poverty. Learning basic archaeological methods and conservation strategies, as well as the academic interpretations of the site and regional history, allowed community members to better manage their cultural resources and ensure the protection of related informal economies or small businesses. In the long run, this service-learning and collaborative approach promises to better address the challenges facing local communities.

Part V: Putting Du Bois' Approach to Work at Historically Black Colleges and Universities in the United States: The Case of Ecology

Teaching Research in Ecology

One of the difficulties teaching ecology material in an urban university is the limited opportunities to access 'natural history', largely due to the unavailability of 'field' sites. Historically, this was addressed by taking students out of town—to locations where material and sites were readily available. Over the years, this has become increasingly difficult due to time, financial and safety constraints. No longer able to easily take classes on field trips, faculty developed exercises utilizing urban materials and sites. For instance, variation in the numbers and abundance of car types in student, faculty and administration parking lots substituted for field studies of species diversity (Wisconsin Environmental Education Foundation, 2016). Similarly, a class exercise for population ecology was developed using human demographic data collected in local cemeteries (Horn, 1991). Data on lichen abundance illustrated the impact of urban pollution (Savage, 2005).

At Howard University, a 1980-1981 NSF funded project involving students focused on the collection and analysis of lichens, both archived historic samples (1843 to 1943) and recently collected from the greater Washington DC region, for lead and cadmium derived from airborne pollution (Kasim et al., 1982). Margaret Kasim received a Master of Science from the Department of Geology and Geography (Kasim, 1985). This research laid a foundation for further studies resulting in publications involving student and faculty co-authors (Tera et al., 1985; Schwartzman, 1990; Schwartzman et al., 1987, 1991).

Drs. Schwartzman and Tharakan were also involved in a project involving summer school students at Bancroft School, Washington DC, in July 2009, funded by a community grant 'Is Our Community Hazardous to Our Health' to the DC Metro Science for the People. The effects of air pollution on lichen growth in the Mt. Pleasant neighborhood near this school were discussed with these students (details can be found at <http://www.dcmetroftp.org/>).

The science of ecology expanded its focus from studies in remote, anthropogenically unaffected locations to include urban areas and to consider the ecological impact of humans.

Interestingly, while both involved and fulfilled Du Bois's first component of 'teaching research', neither addressed his second concern, that of 'motivating students to use research to solve community problems'.

Motivating Students to Use Research to Solve Community Problems

Over the past several decades Dr. George Middendorf and several colleagues have developed a teaching module that not only focuses on urban ecology but also illustrates how to fulfill Du Bois's mission to link universities to their surrounding communities. Middendorf and Nilon (2005) developed a class field module, a crosstown, transect walk to assess environmental changes and quality of life differences along an urban socioeconomic gradient. Originally developed and tested as an ecology course exercise in the US (Washington, DC and Columbia, MO; Middendorf and Nilon, 2005), it has been expanded to other classes (e.g. Political Science) and other US cities including Tuskegee, AL and Ft. Lauderdale, FL.

The model is now in the process of being expanded to other countries as part of an Urban Biodiversity Research Coordination Network that brings researchers, practitioners and students together to discuss, share data and collaborate on topics relevant to urban biodiversity research, management, design and planning (see Anderson, 2016, for an example in South Africa).

The 'walk' is an urban-ecology teaching tool in which students walk a pre-determined route that cuts across a socioeconomic gradient in their home city or town. During the initial phase of the walk students examine the environment and develop questions via an active-learning approach. They then exchange and discuss questions as a group, focusing on the dominant ecological and social patterns across the gradient with a goal of developing hypotheses that they can assess through data collected along the gradient. The specific data can be almost anything ranging from insects observed, condition of gardens, numbers and conditions of trees, house condition, makes of cars on the street, etc. The key is that the data must be readily-observable and must address some hypothesized relationship between the environment and some social, economic, or cultural aspect.

Because the studies have most often been conducted in communities surrounding the students' institutions, the result is an interrogation of the university-community relationship using the environmental variable. Over the past decade, one undergraduate and two graduate Howard University students have taken this approach further, producing research with direct application to the surrounding community by relating the abundance of arboreal vegetation to air quality along a socio-economic gradient. Their data suggest that not only does vegetation affect the spatial distribution of small particulate matter but perhaps influences the likelihood of asthma. Recent changes in the underlying gradient as a result of gentrification, may provide opportunities to determine the reliability of these observations. Such examples suggest that the cross-town walk model may inspire students to become teachers who can help empower their communities.

Part VI: Service Learning Across United States and African Universities

Service learning (SL) is characterized by the engagement of students in a course-based and credit-bearing educational experience, where students engage in a service activity and develop a framework for mentored reflection on the service activity. Engineering pedagogies

underpinned by experiential SL and utilizing appropriate technologies contribute to community development. These SL activities lend themselves to incorporation into engineering curricula (Tharakan, 2011). Kapucu and Petrescu (2006) at University of Central Florida and Eastern Michigan University have demonstrated the success of service learning for university/community capacity building.

Their SL focus is the promotion and sustenance of the common good through civic engagement. SL projects help foster a sense of caring about others and positively impact civic participation, sustaining social capital. The rationale for SL underpins appropriate technology philosophy, focusing on empowering communities to address their own development needs in the longer term.

A Howard University (HU) SL example is a rural site project in the Choimim District of western Kenya. The project is conducted in collaboration with the international organization, Engineers without Borders (EWB). The multidisciplinary team of students and their faculty advisor engaged in a broad range of local and rural community-based service activities under the direction of EWB guidelines. At the heart of the project was the inclusion of the community members in the assessment, evaluation and strategic planning. With its various proven benefits, such as improved student retention in school (Arnaud 2015), many are now seeking to make SL a required part of the curriculum for young learners (Bender 2007; Bennett et al. 2016; Cameron et al. 2011; Hatcher and Bringle 2012).

The EWB-HU team designed and developed modules to educate the selected community members on clean water production and source water collection technologies. The approach selected a set of community members who would engage in the training and technology transfer. These community members were selected based on their willingness to be actual partial monetary contributors to the project and/or the agreement to serve as 'community engineers' (CEs).

The EWB-HU engaged an in-country NGO to provide materials locally for the implementation of bio-sand filters (BSF's) for water purification. BSF components, including the shells and the filter materials, were then transported to the individual CE's homes. The CEs and the EWB-HU team assembled and deployed the BSFs. In the process, the community member became a community engineer. CEs and local NGO representatives were then trained in assessment of the BSF's. Input and output water samples were collected and analyzed for pH, total suspended solids and for fecal coliform and *E. Coli*.

The community was also trained in rainwater harvesting (RWH) technologies and methodologies. This training was done through a 'service learning' project for the CEs. The EWB-HU implementation visit included the installation of two 10,000L tanks that enhanced the community's water storage capacity.

Capacity building within the communities served was possible if the service learning project was designed and developed with appropriate mentoring that ensured that community education, outreach, engagement and empowerment was an integral part of the service project design and implantation plan. Community engagement has been shown to be critical for development intervention sustainability and success as outlined in the survival ethics models for development (Verharen et al., 2012, 2013).

Part VII: Getting the Lead Out: A Case Study In Appropriate Technology Emergency Deployment

In the 1980s Professor David Schwartzman and his students in the Department of Geology and Geography found high lead levels in first flush water coming from water fountains in Howard University buildings, as well as in street dust in the District of Columbia. After the 2001 to 2004 lead in water scandal emerged in DC, a Howard University press release announced on April 6, 2004 that Howard's water was 'safe to drink'. Professor Schwartzman and Professor John Tharakan requested the data for this conclusion, and were accused of claiming the opposite was true.

After supporting resolutions were passed by faculties of the Howard University College of Arts and Sciences and the Graduate School demanding the release of the alleged lead in water data, the University finally released a report in 2004 with analyses of lead in water from the Howard campus. Of 151 water samples analyzed for lead, 63% were sampled after April 6, 2004, the day the University officially assured us that the water was safe to drink with respect to lead levels. The most recent listing was January 12, 2005. 14 water samples that were above the chosen safety level of 20 ppb were identified as 'Retest'.

The shocking revelations regarding the contamination of water supplies in Flint Michigan have triggered new investigations demonstrating the ongoing exposure of people, especially children, to lead around the nation. Here in DC, elevated lead levels were recently reported in water available to children in three schools (Stein, 2016). Some 12,000 lead pipes for water delivery to homes remain in the District. The recent offer of DC Water to replace lead pipes on private property for an average cost to a homeowner of \$2,500 (Frostenson, 2016) is a shocking disregard of the fact that thousands of families would not have the income to pay for such replacement. Other sources of lead include residues in urban soil and old lead paint in dwellings. All pose potential sources of lead to children.

It is imperative that universities and colleges, particularly Historically Black Colleges and Universities in the United States, collectively take action to insure our community members, especially children, are not subject to ingesting lead in water supplies in public facilities. In the District of Columbia and Baltimore, HBCUs like Howard University and Morgan State University should work together with local governments to immediately insure closure of all water fountains and faucets and other water sources in public facilities that have not passed a robust lead test. Bottled water which has passed this criteria should be supplied to the same facilities. Installing filters even with robust monitoring of their effectiveness and integrity is control not prevention. The sources of lead must be eliminated permanently.

Conclusion: Universal University Education Via Collaborative Communities Of Learning Enhanced Through Educational Technology

Du Bois's commitments to universal university education and university responsibility for community welfare could not be realized in his own time. Advances in appropriate technology now make it possible to achieve Du Bois's goals. Information and Communications Technology (ICT) now make the global distribution of universal knowledge possible. Universal broadband access is now both a moral and economic imperative. Even Facebook founder Mark Zuckerberg imagines a world with universal broadband access, though his motive may be more commercial than ethical (Kizza, 2013).

Du Bois's great ideal, teaching that helps students become researchers capable of solving their communities' problems, is not possible without the service of teachers who are themselves researchers. The key to realizing Du Bois's goal lies in the transformation of existing university practices in three ways. First, universities must incorporate 'near-peer' tutoring into virtually all their instructional activities. 'Near-peer' tutoring is a teaching model that secures the services of students who have performed exceptionally well in courses and who have excellent communication skills to serve as tutors for students who are having difficulty in their courses.

Two universities, Xavier in New Orleans and the University of Maryland, Baltimore Campus (UMBC), have relied on this model to increase their retention and four year graduation rates. The model requires professors to remand students who are having difficulty in their courses to near-peer tutors. Both the tutors and the professors track student performance throughout the semester. Currently the models are restricted to pre-medical students at Xavier, and science students more generally at UMBC. Universalization of this method has the potential dramatically to increase student performance. The model follows Du Bois's insistence that 'each one teach one'. Encouraging students to put their problem-solving skills to immediate use within the university community will establish a platform a service learning in the wider communities that justify the continuing existence of universities (Du Bois, 1973).

Second, universities must make service learning a universal requirement for graduation for all degrees in all fields. The guidelines universities establish for these SL projects must be clearly sustainable, demonstrating community empowerment and capacity building as necessary outcomes. To be effective, service learning must be deeply embedded in appropriate ICT technology. Community members must have on-line access both to the curriculum materials used in the respective disciplines. Community members must also have direct email access to the advanced students offering their expertise in problem-solving. Community members must also have access to university library systems so that they may pursue their own independent research after they have acquired basic problem-solving skills. This combination of service learning and appropriate technology follows from Du Bois's insistence that students take their problem-solving skills acquired in their major and minor course work out into their communities, so that community members could begin to learn to solve their own problems (Du Bois, *ibid.*). Appropriate technology in the near future will rely on personalized computer teaching programs to reduce the numbers of student contact hours required for increasing community member participation.

Third, universities must begin to take responsibility for the life-long learning of their alumni. Utilizing appropriate technology, Africana universities may deliver their own material especially targeted to their alumni. ICT resources may direct alumni to MOOCs and other on-line information available from universities throughout the globe. They may also facilitate alumni communication with faculty for more intensive research and development. With their life-long learning facilitated by their home institutions, alumni throughout the world may form communities of learning whereby they accomplish two objectives. First, alumni may keep themselves current and amplify their own capacities for solving problems within their professions. Second, molded by Du Bois's sense of their ethical responsibilities to their communities and their experiences in service learning, alumni will be motivated to extend their alumni communities of learning to the communities most in need of the problem-solving skills. These global communities of learning can become the first step on the path to realizing Du Bois's final dream of universal university education (Verharen et al., 2014).

Du Bois believed that '[s]ome day every human being will have college training' (Du Bois, 1973:106). He insisted that 'institutions of learning are the property of the community (ibid. 81). Their purpose is to empower the communities in which they are embedded: 'The aim of the higher training of the college is the development of power, the training of a self whose balanced assertion will mean as much as possible for the great ends of civilization' (ibid. 29). In fact, Du Bois is so bold as to say that African American colleges and universities together with a Pan-African movement should show the wider world the way forward. Such a movement will not be 'merely a narrow racial propaganda'. Africans peoples 'sense the coming unities: a unity of the working classes everywhere, a unity of the colored races, a new unity of thinking men' (ibid. 179).

Du Bois believed that technology has created the potential for liberation. In the 1800's, 'there came a tremendous mechanical development. So that never before have so many of the physical wants of the world been so well satisfied with so small an expenditure of human energy' (ibid. 27). At the same time, technology since Du Bois's death in 1963 is moving the world toward the sixth mass extinction (Kolbert 2014).

We can only hope that Du Bois's dream of a Pan-African movement promoting universal university education through appropriate technology can help stop the accelerating course of a globalized, unethical technology in the service of wealth and destructive individual power.

References

- Anderson, P. (2016), 'Crosstown Walk Goes Global: Reflections From a Recent UrBioNet Workshop', available at <http://www.thenatureofcities.com/2016/02/23/crosstown-walk-goes-global-reflections-from-a-recent-urbionet-workshop/>.
- Arnaud, V. (2015), 'Institutionalized Service Learning Promotes Engagement and Builds Social Integration', *Journal for Civic Commitment*, 23(1): 1-13.
- Bammer, G., (2013), *Disciplining Interdisciplinarity: Integration and Implementation Sciences for Researching Complex Real-World Problems*, Canberra, Australia: ANU Press.
- Bender, C. (2007), 'Pathways of Change for Integrating Community Service-Learning into the Core Curriculum', *Education as Change*, 11(3), 127-142.
- Bennett, D., Sunderland, N., Bartleet, B. and Power, A. (2016), 'Implementing and Sustaining Higher Education Service-Learning Initiatives Revisiting Young et Al.'s Organizational Tactics', in *Journal of Experiential Education*, 39(2): 145-163.
- Bowen, W. (2013), *Higher Education in the Digital Age*, Princeton, NJ: Princeton University Press.
- Bingle, R., Clayton, P. and Price, M. (2009), 'Partnerships in service learning and civic engagement', *Partnerships: A Journal of Service Learning and Civic Engagement*, 1(1): 1-20.
- Bugarin, F. (2002), 'Trade and Interaction on the Eastern Cape Frontier: An Historical Archaeological Study of the Xhosa and the British during the Early Nineteenth Century', Ph.D. Dissertation, Gainesville, FL: University of Florida.
- Bugarin, F. (2009), 'Embracing Many Voices as Keepers of the Past', in *Postcolonial Archaeologies in Africa*, ed. P. Schmidt, 193-210, Santa Fe, NM: School for Advanced Research Press.

- Cameron, D., Wolvaardt, L., Van Rooyen, M., Hugo, J., Blitz, J., and Bergh, A. (2011), 'Medical Student Participation in community-based experiential learning: reflections from first exposure to making the diagnosis. *South African Family Practice*, 53(4), 373-379.
- Centers for Disease Control and Prevention (2016), 'Number of Children Tested and Confirmed BLL's ≥ 10 $\mu\text{g}/\text{dl}$ by State, Year, and BLL Group, Children < 72 Months Old', available at: http://www.cdc.gov/nceh/lead/data/Website_StateConfirmedByYear_1997_2014_01112016.
- Cruz, N. and Giles, D. (2000), 'Where's the Community in Service-Learning Research', in *Michigan Journal of Community Service Learning*, 7(1): 28-34.
- DC Appleseed. (2016), 'As Flint Shows, Lead Remains a Health Risk', available at: <http://www.dcappleseed.com/2016/02/19/as-flint-shows-lead-remains-a-health-risk/>.
- Du Bois, W. E. B. (1948), 'The Talented Tenth', *Boulé Journal* 15(1):3-13. Available at: <http://www.sigmaphiphi.org/home/the-talented-tenth.php>.
- Du Bois, W. E. B. (1968), *The Autobiography of W. E. B. Du Bois: A Soliloquy on Viewing My Life from the Last decade of its First Century*, New York: International Publishers.
- Du Bois, W. E. B. (1973), *The Education of Black People: Ten Critiques, 1906-1960*, H. Aptheker (ed.), New York: Monthly Review Press.
- Fortunak, J., de Souza, R., Kulkarni, A. and Miranda, L. (2014), 'Active pharmaceutical ingredients for antiretroviral treatment in low- and middle-income countries: a survey', in *Antiviral Therapy*, 19(0 3): 15–29.
- Fortunak, J. (2008), 'Process Development in Developing Countries', in *Current Opinion in Drug Discovery and Development*, 11(6):751-3.
- Frostenson, S. (2016), 'A Detailed Lead Pipe Map, Washington, DC', available at: <http://www.vox.com/2016/6/10/11894934/washington-dc-lead-pipes-map>.
- Futrell, M. H. (2010), 'Transforming Teacher Education to Reform America's P-20 Education System', in *Journal of Teacher Education*, 61(5): 432-440.
- Gibbons, M. (1999), 'Science's New Social Contract with Society', in *Nature*, 402: C81-C84.
- Hadorn, G. H., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. (2008), *Handbook of Transdisciplinary Research*, Zurich: Springer.
- Hatcher, J. and Bringle, R. (2012), *Understanding Service-learning and Community Engagement: Crossing Boundaries Through Research*, Charlotte, South Carolina: Information Age Publishing
- Horn, C. (1991), 'Cemetery demography', available at: <http://www.esa.org/tiee/vol/expv1/cemetery/cemetery.pdf>.
- Johnsen, H., Torjesen, S., and Ennals, R. (2015), *Higher Education in a Sustainable Society*, Zurich: Springer.
- Juncan, M. (2012), "'The Tenth Talented' v. 'The Hundredth Talented': W. E .B. Du Bois's Two Versions on the Leadership of the African American Community in the 20th Century', *American, British and Canadian Studies Journal* 19(1): 27-44.
- Kadoda, G. (2015), 'Software Engineering Ethics Education: Incorporating Critical Pedagogy into Student Outreach Projects', in *Contemporary Ethical Issues in Engineering*, Sethy, S. (ed.), IGI Global, 228-250.
- Kapucu, N and C. Petrescu. (2006), 'Capacity Building Through Service Learning', *Academic Exchange Quarterly* 10(1): 132-139.
- Kasim, M., Givens, D., Schwartzman, D., and Johnson, J. (1982), 'Lead and Cadmium Biogeochemistry: A Case Study Using Lichens as Monitors of Airborne Pollution',

- Geological Society of America, NE/SE Section Meeting, Abstracts with Programs 14(1-2): 29-30.
- Kasim, M. (1985), '210Pb, Pb, Cd, V, and Zn Levels in Pseudoparmelia Baltimorensis: Implications to the Use of Lichens as Monitors of Airborn Pollution', Masters of Science Thesis, Howard University.
- King, L. (2013), 'The Relevance and Redefining of Du Bois's Talented Tenth: Two Centuries Later', in *Interdisciplinary Journal of Undergraduate Research*: 2(9):1-6. Available at: <http://digitalcommons.northgeorgia.edu/papersandpubs/vol2/iss1/9>.
- Kirst, M. and Stevens, M. (eds.), (2015), *Remaking College: The Changing Ecology of Higher Education*, Stanford: Stanford University Press.
- Kizza, J. (2013), 'Mobile Money Technology and the Fast Disappearing African Digital Divide', *African Journal of Science, Technology, Innovation and Development*, 5(5): 373-378. DOI:10.1080/20421338.2013.829298.
- Kolbert, E. (2014), *The Sixth Mass Extinction: An Unnatural History*. New York: Henry Holt.
- Kunle, O., Fortunak, J. and Rogers, R. (2008), 'Workshop in Green Chemistry Production of Essential Medicines in Developing Countries', in *Green Chemistry*, 10(1): 823-824.
- Leal Filho, W. (ed.). (2014), *Transformative Approaches to Sustainable Development at Universities: Working across Disciplines*, Zurich: Springer.
- Leal Filho, W., Azeiteiro, U., Caeiro, S., and Alves, F. (2015), *Integrating Sustainability Thinking in Science and Engineering Curricula*, Zurich: Springer.
- Leal Filho, W., Brandli, L., Kuznetsova, O., and do Paço, A. (eds.). (2014), *Integrative Approaches to Sustainable Development at University Level: Making the Links*, Zurich: Springer.
- Lubchenco, J. (1998), 'Entering the Century of the Environment: A New Social Contract for Science', *Science*, 279(5350): 491-497.
- Mackintosh, M., Banda, G., Tibandebage, P. and Watu, W. (2016), *Making Medicines in Africa: The Political Economy of Industrializing for Local Health*, New York: Palgrave Macmillan.
- Middendorf, G. and C. Nilon. (2005), 'An Environmental Crosstown Walk to Assess Changes along an Urban Socioeconomic Gradient', *Teaching Issues and Experiments in Ecology*, 3: Experiment #3. Available at: <http://tiee.ecoed.net/wol/v3/experiments/crosstown/abstract.html>.
- Misra, S., Stokols, D., Hall, K., and Feng, A. (2011), 'Transdisciplinary Training in Health Research: Distinctive Features and Future Directions', in M. Kirst, N. Schaefer-McDaniel, S. Hwang, and P. O'Campo (eds.), *Converging Disciplines: A Transdisciplinary Research Approach to Urban Health Problems*: 133-147, Zurich: Springer.
- Olssen, M., and Peters, M. (2005), 'Neoliberalism, Higher education and the Knowledge Economy: From the Free Market to Knowledge Capitalism', in *Journal of Education Policy*, 20(3): 313-345.
- O'Rourke, M., Crowley, S., Eigenbrode, S. D., and Wulfhorst, J. D. (eds.). (2013), *Enhancing Communication and Collaboration in Interdisciplinary Research*, New York: SAGE Publications.
- Pellegrino, J. and Hilton, M. (eds.), (2013), *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century*, New York: National Academies Press.
- Pohl, C. (2008), 'From Science to Policy through Transdisciplinary Research', in *Environmental Science and Policy*, 11(1): 46-53.

- Rabaka, R. (2003), 'W. E. B. Du Bois's Evolving Africana Philosophy of Education', in *Journal of Black Studies* 33(4): 399-449.
- Robinson, J., Berkhout, T., and Campbell, A. (2011), *The University as an Agent of Change for Sustainability*, Toronto: Policy Horizons Canada.
- Savage, S. (2005), 'Learning with lichens: using epiphytic lichens as bio-indicators of air pollution', on-line: [Weblink](#).
- Schwartzman, D. (1990), 'U.S. Exports of Gasoline Lead Additives to the Third World: A Crime against Children', Report prepared for Greenpeace, 11/13/90, 14pp, available from author.
- Schwartzman, D., Kasim, M., Stieff, L., and J.H. Johnson, Jr. (1987), 'Quantitative Monitoring of Airborne Lead Pollution by a Foliose Lichen', *Water, Air and Soil Pollution* 32(1): 363-378.
- Schwartzman, D., Stieff, L., Kasim, M., Kombe, E., Aung, S., Atekwana, E., Johnson, J. Jr. and K. Schwartzman. (1991), 'An Ion-Exchange Model of Lead-210 and Lead Uptake in a Foliose Lichen: Application to Quantitative Monitoring of Airborne Lead Fallout', *The Science of the Total Environment* 100(1): 319-336.
- Shor, I., and Freire, P. (1987), *A Pedagogy for Liberation: Dialogues on Transforming Education*. London: Greenwood Publishing Group.
- Stein, P. (2016), 'Elevated Lead Levels Found in Water at Three D.C. Schools', in *Washington Post*, April 21; Available at: [Weblink](#).
- Tera, O., Schwartzman, D. and Watkins, T. (1985), 'Identification of Gasoline Lead in Children's Blood Using Isotopic Analysis', in *Archives of Environmental Health* 40(2): 120-123.
- Tharakan, J. (2011), 'Institutionalizing a Student-Centered Community-Based Service Learning Engineering Education Experience', in *Proc. Int'l Engineering and Technology Education Conference, IETEC 2011*, 85-91. Kuala Lumpur, Malaysia.
- UNICEF. (2012), 'Innovation Lab Do-It-Yourself Guide', Available at: [Weblink](#)
- Vazquez-Brust, D. A., Serkis, J., and Cordeiro, J. (2014), 'Collaboration for Sustainability and Innovation in the Global South: A Cross-Border, Multi-stakeholder Perspective', in *Collaboration for Sustainability and Innovation: A Role For Sustainability Driven by the Global South?* 1-23, Amsterdam: Springer.
- Verharen, C., Gutema, B., Tharakan, Bugarin, F., Fortunak, J., Kadoda, G., Liu, M. and Middendorf, G. (2014), 'African Philosophy: A Key to African Innovation and Development', in *African Journal of Science, Technology, Innovation and Development* 6(1): 3-12.
- Verharen, C, Tharakan, J., Middendorf, G., Kadoda, G. and Castro, M. (2013), 'Introducing Survival Ethics into Engineering Education and Practice', in *Science and Engineering Ethics* 19(2): 599-623.
- Verharen, C, Tharakan, J., Middendorf, G., Kadoda, G. and Bugarin, F. (2014), 'Survival Ethics in the Real World: the Research University and Sustainable Development', in *Science and Engineering Ethics* 20(1): 135-154).
- Weaver, C., Mooney, S., Allen, D., Beller-Simms, N., Fish, T., Grambsch, A., Winthrop, R. (2014), 'From Global Change Science to Action with Social Sciences', in *Nature Climate Change* 4(8): 656-659.
- Wensing, E. (2016), 'Applied Transdisciplinary Civic Engagement Education Research', Ms. in Preparation.
- Wisconsin Environmental Education Foundation. (2016), 'Ecology in your backyard,' Available at: <http://eeinwisconsin.org/content/eewi/101364/Ecology%20in%20your%20Backyard.pdf>.

- Wolfson, A., Mark, S., Martin, P., and Tavor, D. (2015), *Sustainability through Service: Perspectives, Concepts and Examples*, Zurich: Springer.
- Yanus, A., Kifer, M., Namaste, P., Elder, S., and Blosser, J. (2015), 'Turning Civic Education into Engagement: Evaluating the Efficacy of the Democracy USA Project', in *Journal of Political Science Education*, 11(3): 279-300.

Dynamics of future-thinking for energy security in Sudan: community-based system dynamics modeling for socioeconomic impact of dams in North Sudan

Seed Ahmed, W. and Kadoda G.

Sciences Po Paris School of International Affairs, Paris, France

Sudanese Knowledge Society, Khartoum, Sudan

e-mails: wigdan229@gmail.com, gadoda@gmail.com

Abstract

More than one billion of the world's populations are currently without electricity and more than 95% of them live in sub-Saharan Africa and Southeast Asia. Predominantly around 80% of the world's total population live in rural areas. Surpassing Asia, Sub-Saharan Africa has become the most electricity poor region in the world in terms of the share of its overall population (IEA, 2016). Hydroelectric power generation from large centralized dams has been implemented in Sudan and many other Sub-Saharan countries as a solution for increasing the electrification rate and pushing industrial development forward. In this paper, we explore the multiple interacting feedback mechanisms involved in the dynamic behavior of social, ecological, technological, educational, and political systems driving the constructions or abandonment of dams. Using the past and current data on Sudan's energy, we project different future scenarios to understand the dynamics of energy policy design in the country, as well as identifying endogenous and exogenous variables, and investigate underlying causes and effects.

Keywords: Community-based system dynamics modeling, energy security, dams, casual loop diagram, innovation

Introduction

“There are decades where nothing happens, and there are weeks where decades happen” Lenin

The meaning of energy security has evolved in recent years in response to the challenge of climate change from thinking about reliability and affordability of energy sources, and away from its origin in the oil crisis in the 1970s, to thinking about a wide range of energy sources as well as environmental and societal concerns. This shift in thinking is reflected in the differences between classic and contemporary energy studies, seen in the re-examination of the concept beyond oil supplies (Yergin, 2006) and considering its linkages to other energy policy problems, such as equitable access to modern energy and climate change mitigation (Goldthau, 2011). Governing global energy: systems, transitions, complexity. *Global Policy*, 2(1), 75-88. Cherp and Jewell (2011) discuss the influences on energy security theories from political science, engineering and economics, yielding three main perspectives on energy security, “sovereignty, robustness, resilience”; and argue that the response to the challenge of energy security requires interdisciplinary methods to investigate the interconnectedness of risks and integrate the different perspectives. There is a wide range of models for assessing energy security, different approaches for studying it, and ample literature on parameters, frameworks, country case studies and national or regional strategies. Globally, the International Energy Agency's evaluates energy security over time or between different countries (IEA, 2015). In their critique of the “four A's of energy security” (availability, accessibility, acceptability, and affordability) that is prominent in IEA thinking among other major players like the Asia Pacific Energy Research

Centre (APEREC, 2007), Cherp and Jewel (2014) note that important questions like “Security for whom? For which values? Or From what threats?” are not explicit in international energy literature. In their review of energy security assessment methodologies, Månssona et al (2014) highlight a gap in future-oriented approaches.

An important emerging debate in national and international development arenas considers the diversification of energy sources as an imperative for sustainable development but also a mechanism for energy security. In corroborating the argument that energy source diversification and localisation is so far the best possibility for achieving sustainable development, Li (2005) uses the analogy in the concept of biodiversity, to conclude that this requires the “adverse impact of each energy system” to be “sufficiently small and well within the tolerance limit of the environment.” With increasing demands on energy for economic growth, coupled with the fact that the energy sector is responsible for the bulk of CO₂ emissions, renewable energy is increasingly regarded as the alternative to fossil fuels supply which currently supplies most of the world’s energy demand, with nuclear energy and large-scale hydropower also making significant contributions. The challenge in Paris last year and at previous global discussions on climate change is how to limit energy demand while giving people everywhere a good quality of life. The challenges to reach a North-South global climate pact will persist according to Roberts and Parks (2006) unless larger issues of inequality are addressed and a global bargain on environment and development is found.

While the scope of this paper is not on the intricacies and politics of world climate negotiations, they provide a preamble to discussing energy security in Sudan being one of the countries, that currently experience conflict over oil, loss of fresh water and productive land, as well as hardly secure given that less than a third of the population have access to electricity (USAID, 2010). For electricity, Sudan relies mainly on hydropower for two-thirds of its supply followed by fossil fuel (31%) (CIA, 2014). With its proven vast renewable energy sources (Omer, 2002), the country only produces 3% of its electricity using them. Moreover, Sudan is vigorously pursuing an ambitious set of dams (Dal and Kajbar) on the Nile River in the country’s northern region of Nubia that is being resisted by affected communities. Violent clashes between protestors and riot police over the past decade led to death, prosecution, and displacement, but also to increasing mobilization of Nubians against the dam projects. At a conference in Khartoum in 2015, Herman Bell, a notable Nubia historian, explained his pragmatic solution to develop a prioritization mechanism of which heritage sites to save given the impossible task of saving everything that will be lost because of the dams.

Despite evidence that questions the economic viability and climate dependence of dams, developing countries like Sudan seek to fund for large hydropower projects (World Commission on Dams, 2000). The availability of funding, from China and the Middle East, is probably not the only reason why dams are still prominent in poor countries energy security thinking. Harry Verhoeven (2015), in his hydro-political analysis of the Dam Programme in Sudan, notes the dominance of one knowledge domain (engineering) and, in particular, engineers from the University of Khartoum, home to the oldest engineering school in the country, a Faculty that historically held the view that “Dams are Development.” He goes on to highlight how the water control ambitions of the government “connect to a deep history of thinking about water, civilization, and power but also how joint education and socialization stimulate group thinking and thus shape state institutions in ways that mix ingrained patterns of knowledge production with contemporary political exigencies”. What might happen if the complex issues of climate change and vulnerability of energy systems are made more accessible to the public

and policymakers? Hughes (2009) developed the “four ‘R’s of energy security” to support individuals or entities to assess and reduce their specific energy vulnerabilities. The model draws from waste management field to review vulnerability, reduce energy use, replace with an alternative source, and restrict (new demands). Community-based and interactive approaches (e.g. C-ROADS, a climate change simulation model (Sterman, 2012)) to understanding problems and exploring solutions, to mitigate the consequences of climate change or political decisions (like in the case of dams in Sudan), can perhaps be considered a pragmatic approach for empowering communities to deal with the complexity of systems and life in the 21st century.

With this backdrop, the approach proposed in this paper combines several features that ensure addressing questions of whose security and what values, that is forward looking, and that allows for the complex set of parameters and indicators that define energy security in a specific context to be investigated. Integrating futures thinking and system dynamics, to look at factors driving change (the futurist view) and to identify what that change entails (the systems view). The factors, identified by the community in futures thinking exercise, can help that community to explore how the factors interact, and the ways by which they can reduce negative impacts or accelerate positive possibilities.

Theoretical Framework

Community-Based System Dynamic (CBSD) modeling is a participatory system model technique that includes the community in understanding and analyzing the problem from the feedback perspective of system dynamics, using system dynamics. CBSD strength lies in the model's capacity in capturing knowledge that can be used to identify the problem and policy levers. CBSD also allows the community to come up with self-developed alternative solutions in an attempt to integrate scientific knowledge with the local knowledge and provide a shared representation of the problem and appropriate and politically feasible solutions. Different CBSD models allow a verity of involvement levels for stakeholders in developing the models and decision-making, depending on the participatory model design (Hovmand, 2014). In this paper, the methodology intends to involve stakeholders to collectively participate in developing and analyzing the model as well as producing policy recommendations.

The model utilizes future scenarios developed in Karima, north Sudan, at a workshop organized by the UNDP as part of their Sudan 2030 project in December 2014. The methodology used in the workshop belongs to the Institute ForThe Future (IFTF). The authors of this paper co-facilitated (with IFTF colleagues) and documented the workshop as part of consultancy assignment for UNDP. The workshop involved an ice-breaker (Polak Game) that was intended to highlight different positions about the future of Sudan and engage participants in the workshop in discussing those varying views. Other activities in the workshop included a number of sessions for participants to identify key descriptions of the present, rooting, emerging issues identification, and to perform the process of “backcasting” that allows participants to map the route to each of the possible futures they identified. For this paper, the developed scenarios are used as a source of information to develop a Casual Loop Diagram (CLD). The methodology is conceptualized as a hybrid between CBSD modeling and Future Thinking. The scenarios developed were participatory in nature, due to the different stakeholders involved. Participants were all inhabitants of the northern region in Sudan, but they come from a diverse background in terms of gender, occupation, and political orientation. Participants included men and women in various categories, such as, university students, youth (employed and

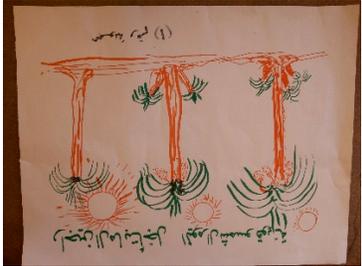
unemployed), elders (retired or in service), government workers, entrepreneurs, social activists, etc.

Due to the complexity and interrelations of the issues mapped out during the scenario building sessions, the paper follows a number of steps to better articulate and communicate the complexity accompanying the socioeconomic impacts of dams constructions or abundant in north Sudan. First, a Causal Loop Diagram (CLD) is developed according to the scenario building workshops outcomes. This CLD explores subsystems that drive decision making, according to the participant's experiences and perspectives. For instance, the CLD uses future scenarios to test assumptions about the desirable and undesirable futures illustrated in the creative representations outcomes that were produced by participants. The second step involves plotting the CLD according to the projections and future scenarios.

The Karima Workshop Scenarios

Three of the four scenarios involve environmental issues (that are the focus of the paper) and therefore used in the analysis [2]. The excluded scenarios focused on religious extremism. Table (1) presents the scenarios and their descriptions (as presented after group work at the end of the workshop).

Table 1. Future Scenarios for North Sudan

		
<p>Declining in Agriculture, but solar power utilization by 2030.</p>	<p>Illegal gold mining activities that has killed many inhabitants due to pollution and the nuclear waste buried underground slowly killing the future of the region (represented by the child holding the sign).</p>	<p>"Future is in Education" representing the burden good education will lift from the backs of the people in North Sudan by 2030.</p>

The scenarios have been developed after two days scenario building a workshop with the community in Karima. The issues represented in the artwork are issues brought up by the community during the first day of the workshops in the processes of identifying the key descriptions of the present and emerging issues. The output from the discussions was grouped and classified into either a negative or positive motion. The next day, the participants formed different groups and each group was given two notions, a positive and a negative one. The groups were then asked to develop creative scenarios with the notions that represent their hopes and fears. An extensive strategy that is most relevant to policy reforms and call for action were developed by the groups using the backdating tool. The participants developed a 15 years

strategy and forecast that includes both the negative and positive outlook from, starting from 2015 to 2030.

The first creative representation's motions were an increment in the utilization of solar power in the region (positive motion +) with a declining in Agriculture (negative -). The declining in agriculture is contributed to the sequence events of palm trees fires the majority of participants affiliated with the government. The palm fire thought to be frequent and deliberate, and the participants linked it to the government's attempts to forcefully evacuate and displace residents of the villages where it is planned to construct the dams. While the utilization of solar power reflects the participants hope of a future where no dams are built for the purpose of generating power. The second representation demonstrates the numerous deaths that happened in the state because of unsafe unregulated gold mining. It also illustrates the danger of the nuclear waste that the participants believe it was buried there and it is affecting their health. The last picture is the positive illustration of representation. It illustrates how participants think of education as a tool to solve their problems and a pathway to a better life. Participants did not specify which kind of education needed in the drawing yet the most thematic education fields that came up was vocational training and health education.

The issues raised by the creative representations for north Sudan's future scenarios delineate the policy failure to promote growth in the perspective region. Furthermore, the participant's accusations illustrate the underlying causes of private property vandalism and continue violations of human rights by the government. Thus that puts the policy implemented nationwide in general, and in the Nubian region in particular, in a grey area. Therefore a new approach towards policy design, policy implementation, and policy analysis needs to be utilized (McConnell, 2010).

Causal Loop Diagram (CLD)

Causal loop diagrams are the language in which complex issues are being explained. They explain the interrelations between the different contributors to the problem and the dynamics of the . CLD are commonly first developed previous to the simulation analysis, this to outline the basic causal mechanisms hypothesized to underlie the reference mode of behavior over time. These are necessary for expressing dynamic hypothesis of the system as endogenous consequences of the feedback structure ([Randers, 1980], [Richardson, 1999], [Sterman, 2000]). There are multiple stages prior to developing a mature system dynamics model that starts with plotting Labeled CLD, Structured CLD, followed by Stock and Flow Diagram (SFD). CLD does not contain enough pieces of information that allow the system dynamics model to function, thus the technical decision of transforming the Structured-CLD into SFD needs to be studied carefully. The following in are labeled-CLD where Stocks and Flows and Causal relations has been identified and plotted out of the foresight workshop outcomes for two different scenarios discussed below.

Theme (1): Understanding socioeconomic impacts of constructing three new dams in the Nubian region (northern Sudan)

Description - The more Loans the government of Sudan has, the more the participants believe that the government is going to spend on funding the Dams Construction. This along with the increasing Energy Demand will increase the likability of justifying the dams' construction. When the dams are put into place participants expects a sharp declining in the Illegal Mining activities because of the government censorship around the dams' areas. The government

ensorship will allow more Nuclear Waste dumping in the region which will negatively affect the agricultural around the lakes to be created by the dams. Moreover, the energy supplied by the dams will decrease the need for energy mix.

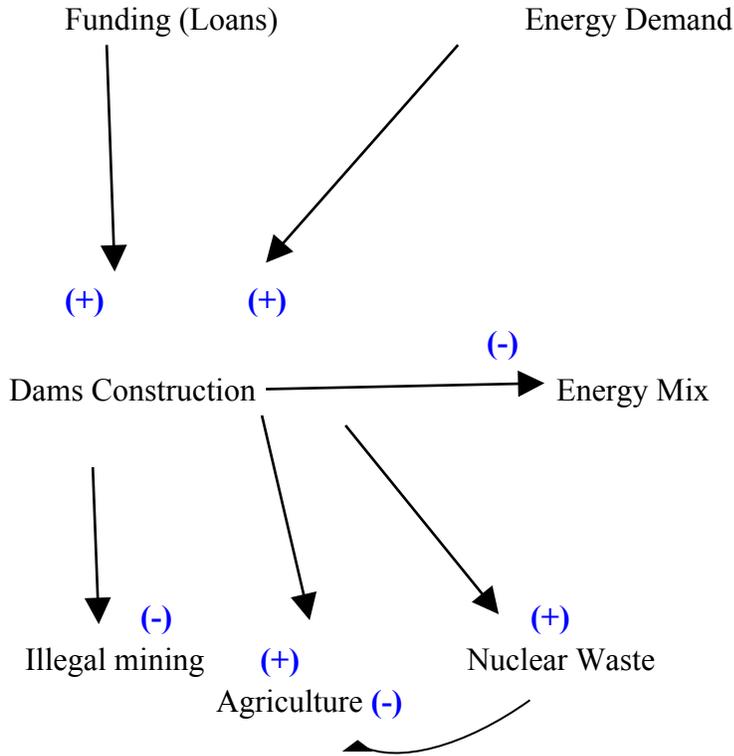


Figure 2. Dams Adoption Scenario:

Theme (2): Understanding socioeconomic impacts of the abandonment of dams construction in the Nubian region (northern Sudan)

Description - The participants believe that the abandonment of the dams’ projects will lead to energy sources diversification which leads to vocational training opportunities. The education development will lead to better farming practices on the banks of the Nile. Moreover, the participants think that the abandonment of dams will not allow more nuclear waste to be buried in the Nubian region. Yet the participants’ foresight an increasing number of illegal mining activities.

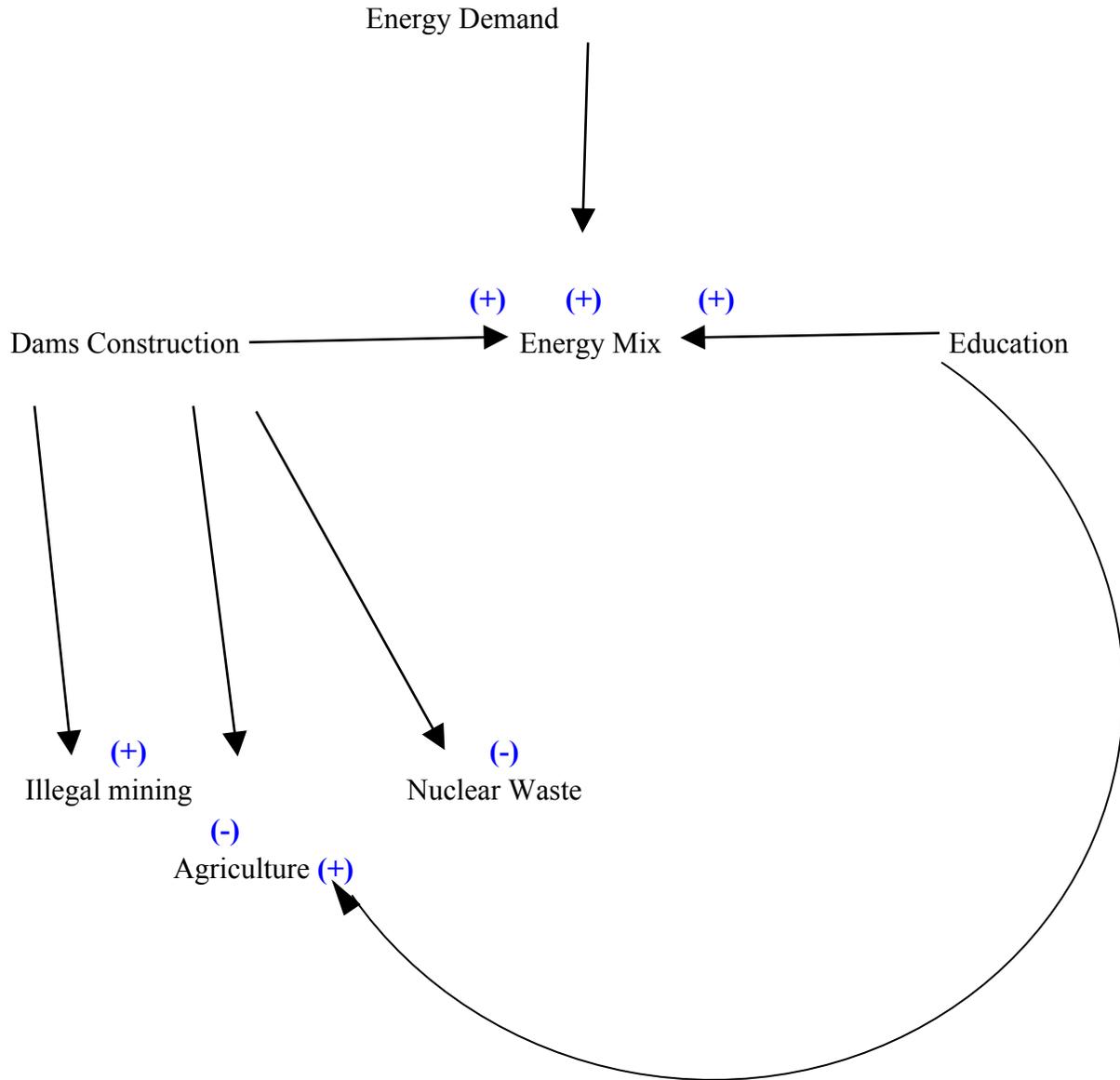


Figure 3. Dams Abandonment Scenario:

Discussion

The first diagram explores the multiple interacting feedback mechanisms involved in the dynamic behavior of social, ecological, technological, educational, and political systems driving the constructions of the dams from the community's perspective. Even though one of the government's justifications of constructing the dams in the region was the increment in agricultural productivity, residents are subjected to forced displacement which some of the participants believe that the lands surrounding the dams will be given to investors, not for residence. The other group of participants was concerned that even if the government distributed land for agricultural purposes, the nuclear waste they believe the government barriers in the ground will make it impossible to lead a healthy life or carry out agricultural

activities in the areas most subjected to radiations. Thus no technological advancement in agriculture, in their region would be applicable in case the dams is to be constructed. The underlying causes driving the dams construction are arguably political, while the most problematic are "funding". Furthermore, the CLD explains that negative ecological impact of dams' constructions on the agricultural and educational sector as well as adverse consequences on the possibilities for energy mix and sensible planning for energy security.

The second CLD highlights the liberation from the loans the government has to take to build the dams as well as the pressure that imposes on diverse energy sources to meet the energy demand. The more pressure put on energy mix, the more trained craftsmen/women needed which will make vocational training an attractive venture not only for solar energy utilization but on best practices on farming simultaneously. The inhabitation of the Nubian region will decrease the likelihood of nuclear waste dumping but it will increase the illegal gold mining activities. The limitations of these CLDs are the fact that they are built on narratives, and even though the participants were handpicked to ensure representation yet the views out of the workshops were mostly dominated by activists and participants working in civic society.

Conclusion

The final variables represented in the CLDs maybe be subjective to the community's perspective yet the impact of dams' construction has found to have multilateral consequences on the community, energy security in Sudan, and on agricultural. Moreover, SFD is to be developed as a base for a complete system dynamics module to further examine the proposed methodology. A testing system dynamics model is to also be developed from future thinking sessions against a conventional CBSD model for the results to be compared.

References

- APERC, A. (2007). quest for energy security in the 21st century. Institute of Energy Economics, Asia Pacific Energy Research Centre, Tokyo.
- Binder, T., Vox, A., Belyazid, S., Haraldsson, H., & Svensson, M. (2004, July). Developing system dynamics models from causal loop diagrams. In Proceedings of the 22nd International Conference of the System Dynamic Society.
- Cherp, A., Jewell, J., & Goldthau, A. (2011).
Energy access database. (n.d.). Retrieved September 15, 2016, from [Weblink](#)
- Hovmand, P. S. (2014). Community based system dynamics. New York: Springer.
- Jewell, J., Cherp, A., & Riahi, K. (2014). Energy security under de-carbonization scenarios: An assessment framework and evaluation under different technology and policy choices. *Energy Policy*, 65, 743-760.
- Kim D, Guidelines for Drawing Casual Loop Diagrams, *The System Thinker*, Vol 3, No 1, pp 5-6 (February 1992).
- Li, X. (2005). Diversification and localization of energy systems for sustainable development and energy security. *Energy policy*, 33(17), 2237-2243.
- McConnell, A. (2010). Policy success, policy failure and grey areas in-between. *Journal of Public Policy*, 30(03), 345-362.
- Månsson, A., Johansson, B., & Nilsson, L. J. (2014). Assessing energy security: An overview of commonly used methodologies. *Energy*, 73, 1-14.
- Omer, A. M. (2002). Overview of renewable energy sources in the Republic of the Sudan. *Energy*, 27(6), 523-547.

- Parks, B. C., & Roberts, J. T. (2006). Globalization, vulnerability to climate change, and
Sternman, J., Fiddaman, T., Franck, T., Jones, A., McCauley, S., Rice, P., & Siegel, L. (2012).
Climate interactive: the C-ROADS climate policy model. *System Dynamics Review*, 28(3),
295-305. perceived injustice. *Society and Natural Resources*, 19(4), 337-355.
- UNDP, Foresighting Scenario Workshops Report. Sudan 2030 Project. Karima, North Sudan,
December 2014.
- Verhoeven, H. (2015). *Water, Civilisation and Power in Sudan: The Political Economy of
Military-Islamist State Building* (Vol. 131). Cambridge University Press.
- Yergin, D. (2006). Ensuring energy security. *Foreign affairs*, 69-82.

Electronic Tendering a 21st Century Necessity in Zimbabwe

Lorraine Chiedza Chitongo, Daniel Musundire and Khesani Chilumani

NUST, Zimbabwe

e-mail: lchiedza@gmail.com

Abstract

The tendering process is a set of activities which require fairness and thorough scrutiny of mandatory requirements during the entry selection of participants such as clients and suppliers. In the process, organisations place a call to other businesses to respond to a particular need that includes supply of goods and services. Thereafter, they select a tender that meets their needs and has the best value for money. Zimbabwe has a well-defined tendering process, and processes to govern the opening, evaluation and final selection of tenders. However, the tendering system is still paper based and the existence of counterfeit documents has compromised greatly the effectiveness and quality of the results of the process. In June 2004, the World Bank implemented a methodology on how to measure the performance and the standard of procurement systems as well as following up on how such standards develop over time. They said procurement standards aimed at providing a road map for development and improvement of procurement systems around the world, which would have a great impact on the tendering process as it is the basic foundation of procurement. This methodology necessitated the use of technologically effective mechanisms that ensure set standards are met. In Zimbabwe some initial steps towards adopting this strategy has been registered in terms of technologies suggested to further improve the tendering process. Tendering is a cumbersome process that requires a lot of concentration during evaluation and selection of the winner. There is a need to strategically manage the tender analysis and evaluation process to identify the right people for the right service arising at a given time. The main focus of this research was to determine the state of the current tendering system and establish the areas of higher concern for an electronic tendering system in Zimbabwe. The study also seeks to establish the state of the environment in terms of Information and Communication Technology infrastructure and necessary resources to support electronic tendering. The research survey targeted different tendering professionals in Zimbabwe. The methodology used included an extensive literature review and field survey conducted on sixty-two tendering professionals. The field survey used the questionnaire instrument and targeted sampling of the tendering professionals. The results of the field survey confirmed the issues raised in the literature review and highlighted inefficiencies of the traditional paper based tendering system. This research of developing an e-tendering system is inspired by the need to address most if not all, of the concerns here highlighted in the findings.

Keywords: Electronic, Electronic Procurement, Electronic Tendering, Procurement, Tendering.

Introduction

As different business organisations engage a number of partners in projects, a well-structured tendering system is critical for the success of their projects. The electronic tendering system enables policies, standards and ethics to be uniformly enforced while promoting a sound documentation, sharing and supply chain management practices that are grounded in theory. Delays in project completion due to inadequate standards and failure to meet requisite specifications is very costly and constrains the value and quality of the tendering system. Musanzwikwa, (2013) asserts that malpractices in the existing tender system in Zimbabwe

manifests itself in the inside dealings, bribery, wrong computations of costs by evaluation teams leading to shoddy commodities, goods and services. Paper based tender systems, if well managed could be efficient but are subject to a lot of influence and fraud from third parties in tenders being awarded. Information processing arising out of tender documentation evaluation usually takes a longer time and is resource restricting.

The inputs to the existing tender system include: specifications of equipment to be procured, bidders details-contact person, and Ministry of Information Communication Technology (ICT) details-contact person. Processes of the existing tender system include: making quotations requested by ministries, carrying out tender evaluation and selection, announcement of existence of tenders and publishing of winners, delivery of goods or services by the winner and testing of delivered services by Central Computing Service (CCS) Department under the Ministry of ICT. The outputs include: report containing results of tender evaluation and the winner and report containing available tenders and the specifications of required equipment.

An electronic tendering system is a vital system especially to the Zimbabwe tender board as it evaluates bids according to specifications of individual tenders which reduces the time taken in decision making on the winning tender. The system assists in providing an analysis on the tender documents forwarded by the suppliers by filtering the qualified contractors that have completed all tender documents properly. The system also helps promote the local brand market as there would be adequate market inquiry in awarding of tenders.

The State Procurement Board initiates the tender process by sending the request for service proposal to the CCS a department under the Ministry of ICT. The proposal has details which describes what the State Procurement Board needs to accomplish in the tender process and how CCS may assist in accomplishing the task. CCS then sets specifications of the equipment or services that suits the stated service from the proposal. The existence of a tender is then published in the press and it will be an open tender, any willing company can participate. A Request for Quotation (RFQ) or Request for Proposal (RFP) would be sold at a given price to any willing company and for any company to participate in the tender process. There are mandatory requirements for every tender that are independent of buying the RFP or RFQ and these requirements includes: Value Added Tax (VAT) Certificate or Valid proof of tax registration with the Zimbabwe Revenue Authority (ZIMRA), price in \$US and validity period of quotation.

Companies would then bring bid documents containing specifications provided by CCS. Evaluation and selection would follow and the winner will be published in the press. The winning company would be informed by the State Procurement Board and goods or services are to be delivered to the State Procurement Board on or before the stated date. CCS would then make a follow up to see if the winning company has provided services specified in the bid document and test to see if that delivery is working correctly.

This paper discusses the benefits of an electronic tendering system to the tender board in terms of securing tender documents, reducing tender administration in terms of workload and paperwork, thus increasing productivity and efficiency in their daily responsibilities. There would be improved supplier relationships due to the increased efficiency of the tendering cycle and increased trust in the fairness of the outcome facilitated by increased transparency of the process backed up by an audit trail. This paper focuses mainly on enhancing procurement in Information Technology (IT) government departments.

Literature Review

The start of the 21st Century has seen a strong trend towards e-business, including e-government, e-commerce, and other e-services over the Internet. Most governments are in a transition from traditional government services to efficient e-government services as a major step towards moving to the digital economy. The advent of Information and Communication Technology (ICT) has opened up a broad exploration to the use of Web-based technologies in tendering processes (Maizura, 2005). This can be seen from various existing electronic tendering applications in many countries such as United States, Canada, Australia, Singapore, Japan, Europe and Taiwan (Liao, 2002). Online tender management systems have been developed using Internet technology such as ePerolehan, Tender Direct, e-Construction, MERX, e-Procurement System and Tender Electronic designed for managing government tenders (ePerolehan, 2009). In Britain, several major projects are now being procured through the e tendering process this includes the multibillion pound development for the Olympic Games in London 2012. The researcher also discussed some e tendering case studies in literature.

Project Services eTender System

Project Services, a commercialised business unit of Queensland Department of Public Works (QDPW), developed a web based electronic tender system to manage their building industry tender processes. The e-tender system, incorporates the tendering and selection process for government building projects, covering both building industry consultants and contractors by encompassing the invitation to tender, access to tender documentation and lodgement via a secure internet site. Project services provided unrestricted access to a demonstration tender project within the e-tender system, allowing project researchers to undertake a more detailed review of the system.

The e-tender system incorporates both open and select tenders. In the case of open tenders, information regarding current invitations to tender which includes project title, description and closing date or time, can be viewed by consultants or contractors without a password. The contractors can then register interest in tender or submit an offer on any of the projects on which they are eligible. Once eligibility is confirmed, based on QDPW's prequalification registration status, a password is issued to the contractor for that project. In case of a select tender, the contractors are notified of the tender by email, and are supplied with password to the system.

The QDPW's Prequalification System provides a comprehensive central register of prequalified building industry contractors, offering clear and consistent performance requirements and guidelines for the selections of all building industry service providers who are eligible to tender on government building projects using the e-tender system. Prequalification involves self-assessment against the prequalification criteria of experience, systems, people and business together with statutory and referre checks undertaken by the Department.

Commonwealth Electronic Tender System

The Commonwealth Electronic Tender System (CETS) allows agencies to conduct tendering and quotation processes online. CETS enables all invitations for tender to be placed on the Web and anyone wishing to submit an application can download the tender specification file and respond using a secure encrypted connection. When the tender response file is uploaded to the website, it is then encrypted using a digital certificate. The encrypted tender response file sits on the server until the tender deadline when it then becomes available to the agency. The

administrator of the CETS can download the files using agencies corresponding private key to decrypt the information. The system relies on a Secure Sockets Layer session at 128-bits for the initial encryption of confidential tender responses from suppliers.

CETS aims to provide a facility for suppliers to download tender to download tender documents relating to advertised business opportunities. After locating an opportunity that interests the supplier, all documents relating to that request relating to that request can be downloaded. All uploaded tender responses will be date and time stamped upon receipt and held within the system until the bid closes. The supplier can then complete their responses and upload the completed documents.

Most of public sectors offer tender advertisements, online tender forms as well as download and upload related tender documents through online Web services. However, none of these applications include evaluation of tender documents electronically and with support of decision making process. This only benefits clients and consultants for example in terms of reducing printing costs but the evaluation part requires group of decision makers to do the assessment process manually. Lack of computerized evaluation tools in current Web-based tendering applications requires decision makers to manually screen for criteria to be evaluated for each tender document. Thus the adoption of the ICT in the technology industry remains low and at the same time encourage to the increasing use of large volume of unstructured tender documents (Du, 2009).

Materials and Methods

In order to gain a clear picture on the current state of tendering in Zimbabwe government ministries, an analytical descriptive qualitative and descriptive quantitative study was undertaken through a sampling frame of tender professionals who were in the tender field as profession. This type of approach was chosen because of the nature of the study that calls for descriptive research methods and analysis of documents, people's views and opinions on the current tendering system. The sampling technique used was targeted sampling. The research tools used in gathering data were questionnaires, which were supplemented by interviews and document analysis. After necessary data was gathered, SPSS tool was used to critically analyse the gathered data. Descriptive statistics of the questionnaires was done which summarised the findings into tables of frequencies and graphs. The total population of the survey was sixty-two tender professionals who responded both to questionnaires and interviews.

Interviews

Interviews were conducted with sixty-two tendering professionals in Zimbabwe in a bid to establish the desired functionality of the Zimbabwe tendering system and how we can improve the current system to meet the actual needs of their company. The interviews were conducted to the respondents of the questionnaire after completing the questionnaire. The interviews were semi-structured interviews which consisted of several key questions that helped to explore the area of interest. These interviews assisted the researcher in getting an understanding on tendering in Zimbabwe. The flexibility of this interview approach allowed for the discovery and elaboration of information that is essential in this research that may not have been thought of by the researcher.

Questionnaires

A draft questionnaire was pre-tested on the pilot study. The design of the questionnaire was based on the input from the literature review. The purpose of the investigative study was based on the hypothesis that an electronic tendering system enables policies, standards and ethics to be uniformly enforced while promoting a sound documentation, sharing and supply chain management practices that are grounded in theory. The research question is do tendering system require automation? The pilot study in the literature review helped modify the research instrument for the empirical study and made it more effective in capturing data that would best answer the research questions. The study which utilized questionnaire survey of tender professionals was carried out in May 2015. This indicates that the respondents were very familiar with the tendering system due to their involvement in tenders.

Results and Discussion

The research survey targeted different tendering professionals in Zimbabwe. The field survey which used the questionnaire instrument was conducted on sixty-two tendering professionals. The sampling technique used was targeted sampling on tendering professionals. An analysis of the questionnaires was done using the SPSS tool to critically analyse the findings and results of the findings.

From the data collected from the 62 respondents, most suppliers are facing challenges in the current tendering system. It was noted that tenders are advertised in the print media but 66.1% of the respondents argue that most suppliers are not seeing the advertisement whilst 24.2% say most suppliers are not responding because they are not confident of the result outcome of the tendering system. 87.1% of the respondents agreed that intensive administrative tasks such as printing, collating, binding and distributing tender documents to all interested suppliers is strenuous and time consuming. This leads to erroneous results and delays in the tender process.

83.9% respondents further agreed that the tendering system is vulnerable to corruption and fraud activities as well as third party influences which affect the decision making of the winning tender though more than five people have the role of administering submitted bid documents. Although the current tendering system is prone to corruption, there are security measures being employed such as authenticating bid documents, ensuring confidentiality of supplier information and the use of an audit trail report though most respondents say there is no management review of the report. The empirical findings of the research agree with the issues highlighted in the literature review in regards to the inefficiencies of the current tendering system. There is need to adopt the technological way and take advantage of technology in tendering.

The research also gathered that as of now only rules governing the paper based tendering system are in place, if electronic tendering is to be adopted, there is need to review rules governing the tendering process to reflect the new dawn of the ICT technology in the tendering process system.

Currently available tenders are being advertised in the print media, but though this has been the most used way to flight tender advertisements there are several issue that where noted in the research. The most registered challenge being many suppliers do not see the advertised tender in this form of communication as shown in Figure 1.

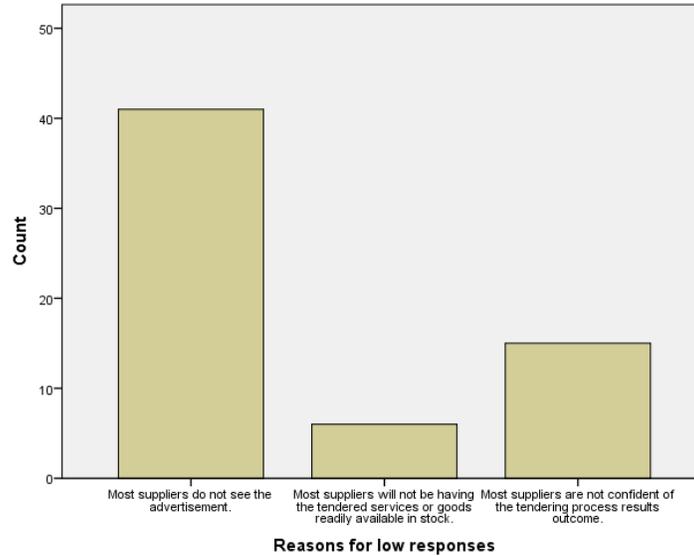


Figure 1. Reasons for low responses to tender advertisements.

Other challenges were highlighted during the research which the suppliers are facing which includes the effects of distance between the location of suppliers and the procurement board offices. This has led to many bid documents arriving later than the deadline of submission mostly due to courier delays and other factors. Other suppliers also highlighted how there are not confident with the tendering process results outcome generally. This is mainly due to the fact that the current tendering system is still paper based and relies on human abilities to do the whole process. The tender process includes strenuous administrative work which are printing, collating, binding and distribution of tender documents to all interested suppliers. Most tender administrators, pointed out how the administrative work is prone to erroneous results and it seems to be the most time consuming process.

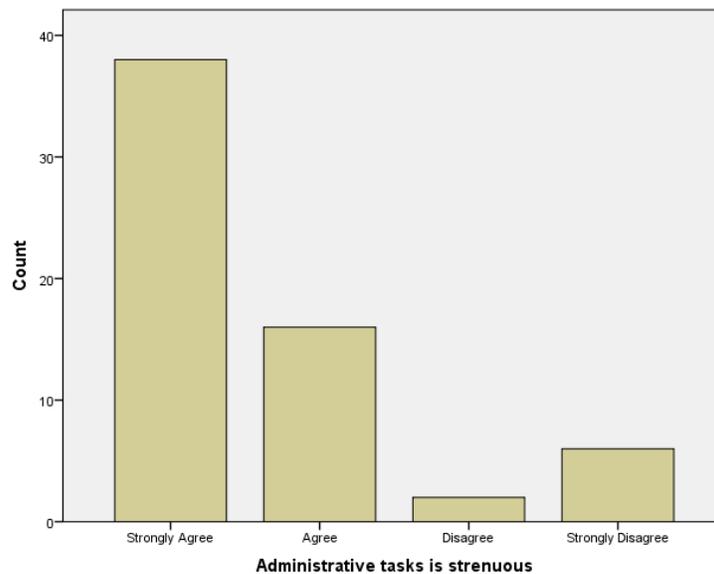


Figure 2. Administrative tasks are strenuous

Though there are security measures being employed in the current tender system such as ensuring that submitted bids are in a locked box, enforcing confidentiality of information of suppliers and submitted bids, this research gathered that there is still a risk of third party influences since tender administration is done by more than five people for each tender.

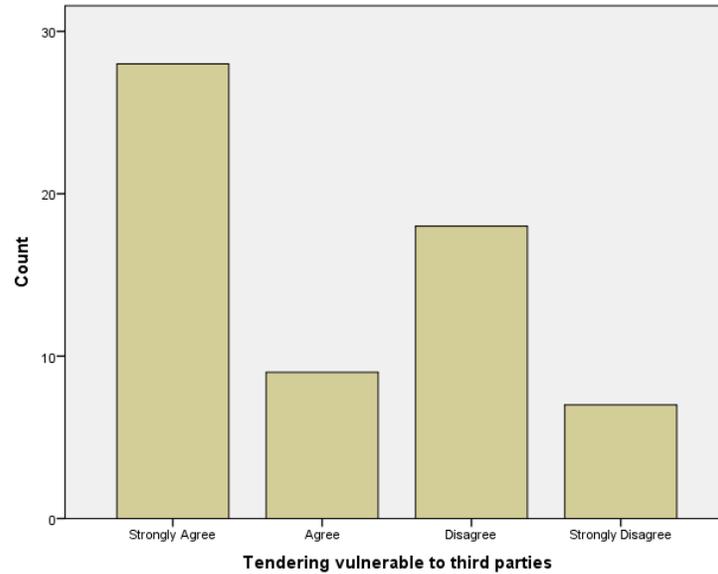


Figure 3. Tendering is vulnerable to third parties

Generally, the research findings gathered that more than 90% of the tender professionals feel the tendering system requires automation as going the electronic way is more advantageous. Electronic tendering system would reduce risks of errors, increase visibility of responses of all interested suppliers, reduce the tendering period, improved transparency of the tendering process and produce an improved audit trail.

The study revealed that most suppliers are facing challenges in the current tendering system. The findings of the research agree with the issues highlighted in the literature review in regards to inefficiencies of paper based tendering system. The study showed that moving to an e-tendering system from the paper based system is more advantageous.

Conclusion

With the rapid development of information and communication technology within the Zimbabwean industry, the development of an electronic tendering system is one of the many applications that would have a positive impact in the Zimbabwe IT environment as it would quicken the tendering process, the supply chain at large and hence secures the economy of scale.

E-tendering technology has been received in different parts of the world as a move to implement the World Bank procurement system standards. Some countries hold the view that e-tendering has more advantages compared to the traditional paper based tendering system whilst others are still conservative to adopting technology because of the unresolved fundamental technical concerns to render technology.

The findings of the research agree with the issues highlighted in the literature review in regards to inefficiencies of paper based tendering system. It pointed out inefficiencies in administrative tasks, suppliers not seeing the tender advertisement in the print media, need for

large storage capacities for storing tender documents, possibilities of late submission of tenders and tender handling errors.

This research finding also pointed out on several advantages of using an e-tendering system which includes a reduction in labour intensive tasks of receipt, recording and distribution of tender documents, reduction in errors and solves the problem of the need of large storage rooms for tender documents. The system also provides a fast and accurate pre-qualification and evaluations of bid documents. It eliminates the need of double or triple entry of the same information and also reduces potential disputes that arise from responses arriving late as a result of courier delays. There is also improved quality management of tender information and improves audit trail of the tender. It also reduces tendering period as it enables a fairer assessment of tenders.

References

- Du, T. C. 2009 "Building an Automatic e-Tendering System on the Semantic Web," Decision Support Systems.
- ePerolehan. "ePerolehan: Ministry of Finance," accessed at <http://home.eperolehan.com.my/> [accessed on 28th February 2014].
- Liao, T. S., Wang, M. T. and Tserng, H. P. 2002 A Framework Of Electronic Tendering For Government Procurement: A Lesson Learned In Taiwan, Automation In Construction.
- Maizura, M. N. Noor Papamichail, K. N. and Warboys, B. 2005 "A Web-Based Decision Support System for Tendering Processes, Springer Netherlands.
- Musanzwika, 2013 Public procurement system challenges in developing countries: the case of Zimbabwe, International Journal of Economics, Finance and Management Sciences, Volume 1, 2013. Makerere University, Uganda.
- Vaishnavi, V. and Kuechler, W. 2004 Design Science Research in Information Systems.
- Vrush Rapid Application Development Model. Accessed at: <http://javatechig.com/others/rapid-application-development-model> [Accessed on 17th February 2014].