RESEARCH ARTICLE

WILEY

A systems framework to analyze the impact of corporate social investment projects with an information technology focus

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Funding information
Airports Company of South Africa; University of Pretoria

Abstract

In South Africa, corporate social investment (CSI) is deployed as part of Broad-Based Black Economic Empowerment (B-BBEE) to assist and empower disadvantaged individuals and communities. Previous research revealed that CSI projects are often short-lived and unsustainable. This study aims to analyze the impact of South African CSI projects that focus on information and communication technology (ICT) in poor urban communities. A case study was conducted comprising four CSI ICT learning centers in poor urban communities in Soweto, South Africa. An indigenous theoretical construct was developed, in the form of a systems framework, combining aspects of soft systems methodology (SSM), Ubuntu philosophy and autopoiesis. The aim of the systems framework was to study the impact of the CSI ICT learning centers in a holistic manner. The framework contributed as follows: the descriptive components of SSM assisted to describe the social systems of interest, in each case. The ubuntu lens helped to portray how the community members supported each other to benefit from the learning centers. Autopoiesis elements showed how the learning centers were able to self-produce and collaborate in order to be sustainable. With the insight of the framework, six guiding principles were derived to inform the successful implementation of future CSI ICT interventions.

KEYWORDS
autopoiesis, corporate social investment, ICT4D, soft systems methodology, systems thinking, Ubuntu philosophy

1 | INTRODUCTION

South African communities are confronted with several socio-economic development challenges such as poverty, extreme inequality, unemployment, and specifically youth unemployment (Cook, 2020, Makoae et al., 2021). To assist with addressing some of these challenges, the South African government-instituted broad-based black economic empowerment (B-BBEE) from 2003 onwards (The Department of Trade and Industry, 2003). One of the instruments of B-BBEE is corporate social investment (CSI), which refers to projects that private sector companies undertake to assist and empower disadvantaged individuals and communities (The Department of Trade and Industry, 2003). In this manner, the private sector becomes the government's agents and partners toward socio-economic transformation. In alignment with B-BBEE, companies have initiated numerous projects in disadvantaged communities through their CSI budgets (Anwana, 2018). CSI projects aim to empower and improve the standard of living in poor communities in terms of education, health, information and communication technology (ICT), entrepreneurship

capacity building, charities, and flagship projects, to name a few (Myres et al., 2018; Tait et al., 2013). This study concerns itself with CSI ICT projects.

1.1 | Challenges

Information and communication technology for development (ICT4D) is a term for research and practice, concerned with using ICT to drive the socio-economic development agenda (Walsham, 2017). Due to the socio-economic goals of CSI ICT projects, they fall under the umbrella of ICT4D. Companies introduce CSI ICT projects in poor urban communities with the premise that they can improve human efficiencies, providing access to information and knowledge, and to improve socio-economic conditions (Roztocki et al., 2019). Unfortunately, there are challenges leading to the failure of CSI ICT projects. According to Musa (2006), CSI ICT projects in general have a high failure rate and associated wastage in developing countries. Some of the challenges incurred include ill-managed projects, unreliable ICT equipment because companies donate their old discarded equipment, the lack of maintenance funds and plans, lack of technical support, donated funds disappearing, and the lack of monitoring and evaluation (Maluleke, 2015; Schneiderman, 2000).

The lack of monitoring and evaluation is regarded as a prime reason behind failed and unsustainable community-based projects (Ndou, 2012; Siyobi, 2015). For CSI projects to make a meaningful contribution, companies need to monitor and evaluate every aspect of the project as well as assess what impact the project is making in disadvantaged communities, and in society.

1.2 | Problem statement

CSI ICT projects are initiated in poor communities to improve their socio-economic well-being. However, there is a risk that CSI ICT projects can become a 'quick fix' means to obtain B-BBEE points, this being a requirement to do business with government (Gherbi, 2015; Watson, 2015). In addition, some companies are contributing to CSI projects for own gain such as tax deductions, public relations or marketing stances. This behavior can result in a "check-box" or "tick-box" exercise for companies. There is a risk that, while companies' images are enhanced, communities are not benefiting, and these kinds of projects are only short-term focused and therefore unsustainable.

To this aim, a qualitative study was conducted to investigate the impact of South African CSI projects with an ICT focus. While it was clear that these projects already had short term benefits for the companies as well as the communities, the aim was to see whether there were also systemic and longer-term benefits to the communities. It was believed that systems thinking could provide an appropriate lens for analysis (Carey et al., 2015; Turpin & Alexander, 2014). Therefore, this article seeks to address the following research question: "How can systems thinking be used to analyse the impact of CSI ICT projects in poor urban communities in South Africa?"

2 | BACKGROUND

2.1 | CSI ICT projects in poor urban communities

The National Development Plan of South Africa (NDP) states that technology should be considered to address socio-economic challenges related to education and health (National Planning Commission, 2012). In other words, government and companies are to use ICT to help alleviate poverty and improve service delivery, health care, and education. The use of ICT such as, mobile phones, home personal computers, tablets, and the Internet has become a fundamental part of modern society and is associated with socio-economic progress (Nawi et al., 2013).

2.2 | Success and failure in ICT4D

Success is a core factor related to the impact of ICT4D. Heeks and Molla (2009) classified ICT4D failures and success as follows. Total failure refers to projects that were never implemented or that were immediately neglected; partial failure refers to projects of which the objectives were not met, or the project had undesirable outcomes; and sustainability failure refers to projects that were initially successful, but that were abandoned after a year or so. Successful implementation refers to a project where the intended beneficiaries and partners are satisfied that the project met its goals and that there are no significant undesirable outcomes.

Roztocki et al. (2019) presented characteristics of positive impacts of successful ICT implementation in rural communities; this includes: access to employment opportunities, access to financial support and services, improved education and healthcare practices and economic growth through sustainable development.

TABLE 1   Frameworks for assessing the impact of community ICT projects.

Author	Research
Uys and Pather (2020)	Provide a benefits framework for public access ICT4D programs based on Sen's Capability Approach.
Kassongo et al. (2018)	Use Sen's Capability Approach to consider adoption, use and impact on the wellbeing of indigent South Africans when they are provided government facilitated access to ICTs.
Mthoko and Khene (2018)	Provide a comprehensive approach to assess outcome and impact of ICT4D projects by analyzing frameworks and theorizing from Social programs, information systems/information technology (IS/IT) programs and ICT4D programs.
Smith (2015)	Develops and presents a framework comprising of three factors (value, sustainability, and scalability) and four key components (digital equity, excellence, opportunity, and empowerment) to analyze Digital Inclusion Projects.
Johnston et al. (2015)	Use four areas identified by Walsham (2010) (better lives for the poor, improved government services, enhanced community activity and improved civil society) to analyze literature to ascertain the value of ICTs for the broader development of South Africa.
Lesame and Seti (2014)	Define and use list of factors contributing to the success and failure of technology access centers to consider the contribution of three Eastern Cape ICT centres to community development.
Ngassam et al. (2013)	Develop and provide a roadmap for Rural Area ICT Solution Deployment based on experience obtained from a case in Kgautswane Community in South Africa. The roadmap starts with the initiation process followed by obtaining an understanding of the socio-economic situation and needs of the community. After implementation, impact assessment is done at different stages of the project. Lastly, an exit strategy should be defined and followed.
Walton and Donner (2012)	Assess and describe the interplay between public PC-based Internet access and private mobile-based access among teenagers.
Pade-Khene and Sewry (2012)	Develop a rural ICT comprehensive evaluation framework to be applied throughout the progression of an ICT4D project. The framework focuses on the assessment of deliverables and contributions in different domains including, the baseline study, needs assessment, the conceptual design of the ICT project, process assessment, outcome and impact assessment, efficiency assessment and scalability assessment.

2.3 | Defining impact and sustainability in ICT4D

ICT4D projects are implemented to improve the socio-economic conditions of local communities and it is important for these projects to positively impact the lives of the intended beneficiaries. Heeks and Molla (2009) defined impact as a process of assessing the influence of developmental projects. Assessing impact of ICT4D projects is crucial because it provides the donors, partners, and beneficiaries with a clear picture of the use of ICT in communities (Amariles et al., 2006). The partnership on measuring ICT for development developed core ICT Indicators to assist developing countries in assessing the impact of ICT4D projects (The United Nations Conference on Trade and Development, 2011). The indicators have been grouped into four categories, namely, (1) ICT infrastructure and access; (2) access to, and the use of, ICT by families and individuals; (3) the use of ICT by companies; and (4) ICT sector and trade in ICT goods.

Sustainability is a process of interlinking and harmonizing social, environmental, and economic efforts, while sustainable development can be regarded as a set of milestones toward achieving sustainability (Global Reporting Initiative, 2016–2020). Sustainability is a crucial element of long-term development (Mudziwepasi, 2015). Sustainability can also be regarded as the ability of an intervention to continue for an extended period of time without interruptions (Breitenbach, 2013). In the domain of information systems, the term sustainability has been defined to include design and implementation of IT projects (Nawi et al., 2013). Roode et al. (2004) defined sustainable development as self-reliant human-centered development at the community level, regional and national level which is horizontally interdependent and vertically complementary. The definition of Roode et al. (2004) will be adopted for this study, since its notions of self-reliance and interdependence fits with adopting a systems view.

2.4 | Frameworks for assessing the impact of CSI ICT projects

Several frameworks have been developed over time to assess the impact of ICT4D projects. Table 1 presents examples of South African studies published in the past decade on assessing the impact and benefits of community ICT projects (Johnston et al., 2015; Kassongo et al., 2018; Lesame & Seti, 2014; Mthoko & Khene, 2018; Ngassam et al., 2013; Pade-Khene & Sewry, 2012; Smith, 2015; Uys & Pather, 2020; Walton & Donner, 2012). This includes framework developed and implemented in a South African context.

One of the messages emphasized by the authors in Table 1, is that frameworks produced and successfully implemented in developed countries are not necessarily appropriate for developing countries such as South Africa because of differences in context.

When assessing impact and sustainability of CSI ICT projects there is a need to consider relevant holistic approaches that deal with complex situations related to sustainable development in South Africa. This need served as a motivation for this study. The frameworks presented in Table 1 also recognize this need and attempt to provide comprehensive evaluation frameworks for ICT development projects, considering views from different stakeholders. For example, Mthoko and Khene (2018) considered frameworks and models from various disciplines (social, IT/IS and ICT4D programs) to suggest an assessment framework for CSI ICT project impact. None of these frameworks use system thinking whereas Zlatanović and Mulej (2015) considered a soft system approach as particularly suitable and relevant to deal with the complex situations of CSI and sustainable development in a holistic way. The objective of the study was therefore to develop a suitable framework for the analysis of the impact of CSI ICT projects in poor urban communities in South Africa from a systems thinking perspective.

3 | THEORETICAL FRAMEWORK

3.1 | Motivating for the use of systems thinking

Systems thinking has contributed to the domain of CSI by recognizing that companies and communities are social systems that must deal with cultural, environmental and organizational uncertainties. Since they are influenced by external forces and environmental conditions, companies and communities cannot control their own behavior in isolation (Cummings & Worley, 2004).

Systems thinking provides a means to investigate the effectiveness of a system as a whole (Daellenbach & McNickle, 2005). Applying systems thinking in CSI ICT projects requires understanding the systems by exploring realities, relationships, and interactions among the system elements. Systems thinking is capable of addressing socio-economic situations that are complex, and promotes meaningful insights into dealing with socio-economic issues (Patel & Mehta, 2017).

For this study, a systems approach was considered when developing the theoretical framework for analysis. The systems framework was developed during an iterative process of theory development and data collection/analysis of the four case studies. The combination of systems thinking lenses that comprise the systems framework are soft systems methodology (SSM), Ubuntu and autopoiesis, as discussed below. The systems framework builds on and extends the work of Turpin (2012, 2017) who developed a framework that included SSM and autopoiesis, to perform a systems-based impact assessment in ICT4D. Turpin's framework was operationally applied in a rural ICT4D setting in South Africa, and provided operational guidance for the implementation of the systems framework presented in this study. The framework for this study is shown in Figure 1.

3.2 | Soft systems methodology

Checkland's (2000) SSM sought to understand the social construction of reality by engaging people, within the context of their own problem situation, with the view of improving the situation (Checkland & Scholes, 1990). Its strength lies in its ability to uncover the perspectives of different role-players and their underlying world views and assumptions. This research used SSM concepts to gain a better understanding of the problem situation and the roles of the multiple parties involved. The root definition (CATWOE analysis) was used to provide a descriptive summary of the four learning centers in the case study as social systems, while considering their respective CSI ICT projects. In other words, SSM was used when first engaging with the empirical settings, in a descriptive mode and for the sake of understanding the social systems of interest.

In SSM, the CATWOE mnemonic (Checkland, 1999) assists in identifying the role players in the systems, and their actions toward transformation as follows. *Customer/Client* (C): These are the people who stand to benefit or suffer due to a change in the system. *Actors* (A) are the people involved in making changes to the system. *Transformation* (T) is central to the root definition, as it encompasses the concepts of the system and articulates any significant activities that "transforms input into output" (Hardman & Paucar-Caceres, 2011). *Weltanschauung* (W) also known as "Worldview," is the roleplayers' view of the transformation that will impact the system. *Owner* (O): these are the people who own and have the authority to make changes to the system. *Environment* (E) refers to the broader system of which the action is a part. It refers to the constraints and boundaries that will impact the resolution. To conclude, the use of SSM provides a holistic means to investigate the diverse, contrasting views and positions of stakeholders.

3.3 | Ubuntu

Ubuntu is an African philosophy that is practiced rather than theorized. It can be understood by observing the daily lives of people in a community, where the community values are inculcated through interactions with families and friends, and in places where people gather to share and assist each other (Bhengu, 1996). Ubuntu philosophy emphasizes that an individual is an individual through other people. Ubuntu epitomizes some
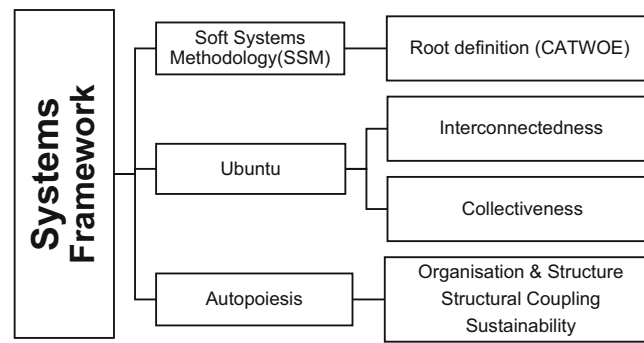
FIGURE 1 Social Systems Framework.

of the general concepts of systems thinking such as interconnectedness, collectiveness, wholeness including caring, respect, sharing, openness, and kindness (Mbigi, 1997; Mugumbate & Nyanguru, 2013). Ubuntu views a community as a social system with meaningful interconnections and collectiveness among its members. Abubakre et al. (2021) considered the shared values of humility, benevolence and reciprocity as significant elements reflected by interconnectedness and collectiveness. During initial data collection, evidence of Ubuntu was observed and hence it was included in the systems framework. Ubuntu was included in the framework by means of the concepts of interconnectedness and collectiveness.

3.3.1 | Interconnectedness

Where Ubuntu is practiced, it teaches people from an early age that they are interrelated and that sharing and giving is a way of living. Already at that age, it is entrenched that an individual belongs to a bigger system, and that benevolence create and maintain interconnectedness among members (Broodryk, 2002). As a result, humility as a shared value, inspires members within a social system to help others within and outside their own system (Abubakre et al., 2021).

3.3.2 | Collectiveness

Ubuntu is based on an orientation of collectiveness, which recognizes the worth of collaboration, togetherness, cooperation, sharing and community (Shutte, 2001). Reciprocity is reflected in a community, by members depending on each other and helping each other, especially in conditions of need (Abubakre et al., 2021). Their behavior is largely geared to maintain a communal way of living. This shows that people do not live in a state of independence but rather as part of a community where there are relationships based on mutual interdependence (Msengana, 2006). Ubuntu represents a collective viewpoint, collective responsibility, and collective empowerment.

3.4 | Autopoiesis

The theory of autopoiesis was developed by Maturana and Varela (1980) and is concerned with the self-production of living systems. It arose from the field of biology and argues that a cell remains alive because of its ability to produce its own building blocks; autopoiesis literally means self (auto)—production (poiesis) (Turpin, 2017). The theory of autopoiesis has several constructs that are valuable to apply in a social context, such as structural coupling and sustainability. It is included in the systems framework because it provides a means to describe the organizational identity and structural coupling of the social systems, and how these social systems continue to self-produce in order to make them sustainable. Moreover, the researchers considered autopoiesis because it provides a perspective from which to conceptualize what to include and what to exclude, in order for a system to self-produce and maintain its elements along with the relationships.

For the purpose of this study, the use of autopoiesis in the systems framework is informed by the work of Turpin (2012) where concepts of autopoiesis are motivated for and applied in an ICT4D context. The study is therefore guided by a previous practical application of autopoiesis in an Information Systems and ICT4D context (Turpin, 2012; Turpin, 2017; Turpin et al., 2013). The concepts of organization and structure, structural coupling, and sustainability (as used in autopoiesis literature) were considered to be relevant for inclusion in the systems framework.

3.4.1 | Organization and structure

A system's organization relates to its identity and is practically manifested in its structure. While the structure interacts and changes over time, it maintains the organization and the system retains its identity (Maturana, 1970). The structure is observable, while the organization is something that is unobservable; it is the abstract arrangement (or "design") of the system. Organization refers to the relations between elements that give a system its identity (Magalhães & Sanchez, 2009).

3.4.2 | Structural coupling

Structural coupling is concerned with systems interacting with their environments to yield structural congruency between the systems. The systems themselves determine the interactions in which the system can participate (Mingers, 1994). Structural coupling occurs when there are structural changes in the systems due to interaction between the systems, as well as systems interacting with their environment (Maturana & Varela, 1980). Structural coupling was applied when investigating the interdependence between the learning centers, their partners and the environment.

3.4.3 | Sustainability

In social autopoiesis, a prominent feature is self-maintenance based on a process of self-production from within the boundary. Luisi (2003) acknowledged that, while this thinking was from the analysis of living systems, it can metaphorically be applied to social systems. Social systems maintain their own identity, because they reproduce themselves within their own boundary. Therefore, the activities that are taking place inside the boundary are seen as self-sustaining (Hofkirchner, 2012).

We now revisit Roode et al.'s (2004) definition of sustainable development, namely self-reliant human-centered development at the community, regional and national levels, which is horizontally interdependent and vertically complementary. In systems thinking, the development of a social system is demonstrated in the system's ability to self-produce and have interdependent relationships with other social systems. The researchers argue that the social system's development is dependent on adequate functioning of self-production processes, which may lead to a strengthened and more self-reliant system. In the case of the CSI ICT projects in the study, sustainability plays a significant role in that initiatives must meet the needs of the affected communities in such a manner that the projects are impactful and self-reliant, while being part of an interdependent whole.

4 | RESEARCH METHODOLOGY

This study adopted an interpretive stance, which recognizes a human-centered approach (Oates, 2006). The approach followed was qualitative, with the view of using various forms of inquiry. The study used a multiple case study strategy, investigating four Learning Centres in impoverished communities around Soweto that implemented CSI ICT projects.

4.1 | Setting (Soweto)

Soweto is located in South Africa's Gauteng province. Soweto derived its name from the first two letters of each word in the phrase 'South-Western Townships' (So-We-To). Its population is predominately black African (98.5%) (Statistics South Africa, 2011). Considering income, 62% of households have an average income of less than R1 500 (roughly USD 100) a month, highlighting that the majority of the population live below the breadline (City of Johannesburg, 2018). Many parts of Soweto are among the underprivileged in the greater Johannesburg metropolitan area; however, individual suburbs comprise a mix of middle class and poorer residents. Soweto can be viewed as a community of extremes, with squatter areas that personify utter poverty, contrasted against extraordinary wealthy suburbs such as Diepkloof Extension, where residential properties are valued at over R1 million each (Briscoe, 2002).

In terms of economic activity, spaza shops that operate from residential houses and sell essential groceries in small amounts are the pillar of South African townships' informal economy, including that of Soweto. In the late 1990s, Soweto's first shopping mall was opened in Dobsonville, followed by other shopping centers. In 2007, the affluent market segment was targeted by the opening of the Maponya Mall. It can be seen from the demographics, economic and cultural overview that Soweto is a diverse community with economic challenges.

TABLE 2   Selected cases.

Cases	Learning center	Technology partner	Community within Soweto
Case 1	Orlando Pirates Learning Centre (OPLC)	Acer	Orlando East
Case 2	Southern African Association of Youth Clubs (SAAYC)	Intel	Orlando West
Case 3	Nanga Vhutshilo	Liquid Capital	Dhlamini
Case 4	Boys and Girls Club	Blue Label	Protea Glen

4.2 | Sampling and recruitment

The four learning centers that were included in this study were selected as follows. Using the Brainstorm 2015 CIO directory the researchers identified 24-listed ICT companies that implemented ICT projects in poor communities between 2002 and 2018. The sampling process commenced with the exclusion of projects that focused on ICT in schools as there is already a plethora of research on CSI ICT projects in schools. As such, 11 CSI ICT projects that targeted school learners and unemployed youth were identified. The researchers approached the 11 ICT companies to request access to their CSI ICT projects, however some challenges were experienced. Some of the challenges included companies not responding to the researchers' request even after various attempts, as a result, they were excluded from the study. Using the geographical location approach, four companies with CSI ICT projects in Soweto, South Africa, that agreed to be part of the study were selected. Throughout the selection process, the researchers proceeded with the assumption that these projects still exist and that the communities are still benefitting from these interventions.

The learning centers are the Orlando Pirates Learning Centre (in Orlando East), Southern African Association of Youth Clubs (in Orlando West), Nanga Vhutshilo (in Dhlamini) and Boys and Girls Club (in Protea Glen).

The four studies that formed the case sites are introduced below. Each case comprised a learning center, an associated corporate technology partner, a CSI ICT project, and a participant/beneficiary community as illustrated in Table 2.

Case 1: Acer (Orlando East community). The Orlando Pirates Learning Centre (OPLC) in Orlando East is supported by Acer Africa. It is designed to benefit school going children as well as unemployed youth living in and around the Orlando East area, by improving their numeracy and literacy skills (Orlando Pirates learning Center, 2017). In addition, the aim of the center is to bridge the digital divide while contributing to the education of young people living in the area. The facility is fitted with state-of-the-art equipment and high-tech computers that were donated by Acer.

Case 2: Intel (Orlando West community). In 2003, Intel donated a Computer Clubhouse to the Southern African Association of Youth Clubs (SAAYC) in Orlando West, in Soweto to provide IT education and training for disadvantaged people, predominantly the youth. The Computer Clubhouse has 14 multimedia workstations that are connected to a network with access to the Internet. The machines are preloaded with software, including animation and multimedia; electronic publishing and graphic design; three-dimensional design; robotics and science exploration; Web design; computer programming; and electronic music and video editing. Moreover, the clubhouse has a music and video-editing studio boasting two high-end server systems, keyboards and sound-mixing system, digital video camera, and video editing software suite (Van Rooyen & Chetty, 2003).

Case 3: Liquid Capital (Dhlamini community). Liquid Capital, previously Neotel, opened one of their 14 internet cafés in 2011 in the Nanga Vhutshilo community Centre, an organization that services over 100 families and more than 230 children, in Dhlamini, Soweto (Neotel., 2011). The aim is to provide community members with the opportunity to invest in their education. Liquid Capital donated computers, printers and scanners, unlimited access to the Internet, and in-depth computer training courses to selected participants. The company installed electrical infrastructure, lighting, cabling, furniture as well as air-conditioners, computers, printers, software, and networks. Moreover, they provided free connectivity for 6 months, including entrepreneurship training, mentorship, and IT support.

Case 4: Blue Label Communication (Protea Glen community). Blue Label Telecommunications, through their CSI program, launched the Boys & Girls Club in Protea Glen, in 2016 (Blue Label Telecom, 2015). The facility accommodates young people aged between 6 and 19 after school hours. The center is managed by trained educators who provide structured programs and activities. The company has also made an undertaking to support the facility financially.

4.3 | Data collection

Prior to data collection, the researchers obtained ethical clearance to ensure that, when collecting data, there would be no harmful effects of the study on the lives of the participants and consent forms were provided to all the participants. Data were collected during 2019 and 2020 through participant observation, eight individual interviews, three focus group interviews and documents. Purposive sampling (Oates, 2006) was used to select the participants, who included the intended beneficiaries, namely community members between the aged of 5 and 35, parents of the center's minor users, CSI Managers and Learning Centre Managers.

5 | CASE STUDY ANALYSIS

Data analysis was performed using the systems framework presented in Figure 1. The analysis started by defining the social systems of interest for each of the four cases, to describe the system using SSM. Subsequently, the systems were analyzed using Ubuntu concepts and autopoiesis. The analysis process aimed to present the data in an interpretable manner with the view of identifying relations and providing meaning while addressing the study objectives. In particular, the analysis sought to investigate the sustainability and impact of the ICT4D projects on the four cases.

According to Checkland and Holwell (1988), an information system entails two systems: a system served and a serving system. Similarly, Hirschheim (1986) claimed that information systems are social systems that depend on information and communication technology to function. In this study, each case has multiple social systems of interest, namely, a participant/beneficiary community, a learning center and a CSI ICT project. For the purpose of the study, each participant community is regarded as a system served, while learning centers and CSI ICT projects are referred to as serving systems. Learning centers are established centers in the community where the CSI ICT projects are implemented.

Each of the four cases was investigated and documented separately; however, the researchers looked for similarities or differences between the cases.

5.1 | Systems analysis using SSM

The first part of analyzing the cases by means of the systems framework (Figure 1) entailed applying concepts from SSM, in particular a CATWOE analysis. The CATWOE analysis depicted the root definition for each serving system (learning center), including the customers, actors, transformation process, worldview, the owner(s), and environmental constraints. Table 3 outlines the CATWOE analysis for each serving system.

Transformation (what a social system intends to achieve) helps to understand the essence of a social system. Identifying its intended transformation process is therefore the first step in developing the root definition; this is then followed by specifying the worldview. These two elements are complementary to each other in understanding the problem situation. The four case studies reflected that there was an agreed shared purpose between the learning centers and the technology partners. The shared purpose taps into role players' commitment to improving the socio-economic situation of the youth of that visit the learning centers. The CATWOE analysis assisted the researchers to understand the social systems including multiple role players and their transformation processes.

5.2 | System analysis using Ubuntu

The Ubuntu philosophy professes that where it is practiced in a community, the individual does not simply look out for self-interest, but for that of the greater good of the community; this demonstrates wholeness. In addition, a community as a social system is an organized network of meaningful interconnections and a spirit of collectiveness.

Interconnectedness considers instances where like-minded partners forge strong partnerships in order to uplift communities. The study provided evidence suggesting that partnerships, which include community buy-in, mutual trust, and alignment, played a significant role in the sustainably of the learning centers. The learning centers in this study were all partnered with like-minded companies that shared their vision and were able to assist with providing resources to help realize their vision. Other partners included schools, parents, government departments, and other companies. One of the CSI Managers mentioned that "we have got international software partners we've partnered with, they give us the software, so we put in the hardware they put in the software" (CSIM1). This demonstrates evidence of interconnectedness between the learning center and its serving social systems.

Collectiveness the learning centers all recruited volunteers to help them attain their goals and objectives. Some of the learning centers had a structured volunteer program and they paid the volunteers a stipend for their time, skills and knowledge. This was corroborated by one of the volunteers: "when I was doing Grade 9 I started doing volunteering to helping the children who came after me with the work that I did the last year and since then I have been a volunteer" (OPLC User 1). This showed that collectiveness in the form of volunteering contributed to the upliftment and well-being of the community and that, through the support of others, the children within the communities could be assisted to realize their potential.

5.3 | System analysis using Autopoiesis

This part of the data analysis was concerned with understanding how the social systems in the study maintained and recreated themselves in collaboration with other social systems (structural coupling), in order to remain sustainable.

TABLE 3 CATWOE analysis for each serving system.

Component	OPLC	SAAYC	Nanga Vhutshilo	Boys and girls
Transfor-mation	Providing an education-based curriculum to school learners, and ICT training to unemployed youth using state-of-the-art computer equipment.	Seeks to provide young people the opportunity to work in a collaborative, supportive environment and to use technological tools to express their own ideas and perspectives.	Provision of a high-quality early development curriculum and accompanying programs to children in one of Soweto's most vulnerable communities.	Providing curriculum-based education, safe space, and access to state-of-the-art computer equipment.
Customers	Community of Orlando East School-going children and unemployed youth	Community of Orlando West Youth between aged 8 and 24 years SAAYC Learning center.	Community of Dhlamini Nanga Vhutshilo	The community of Protea Glen schools children from Grade 0 to 12.
Actors	Parents, schools, Acer, and Orlando Pirates Soccer Team	Parents, schools, Intel, and SAAYC.	Government Liquid Capital	Blue Label Telecom, Boys and Girls Learning center, volunteers
Owners	Funders (Acer Africa), Orlando Pirates Soccer Team	SAAYC Intel	Community Nanga Vhutshilo (Founder)	Boys and Girls Club SA, Blue label Telecom
Worldview	Bridging the digital gap through education, and helping young people living in the area to achieve their potential and become confident, contributing members of society.	To provide education and training in IT for disadvantaged people, predominantly the youth.	To provide a high-quality early development curriculum and accompanying programs to children in one of Soweto's most vulnerable communities.	Bridging the digital gap by promoting academic success through access to technology, career guidance, and a safe environment.
Environ-mental constraints	Funding to sustain the OPLC	Funding to sustain the learning center. Lack of marketing; as a result, the center is unable to attract users and funding.	Funding to sustain the learning center; Crime.	Availability of teachers and funding to sustain the learning center.

5.3.1 | Organization and structure

Under this heading, the social systems of interest were described in terms of their identity. The learning centers were identified and characterized as registered non-profit organizations that offer ICT training in poor urban communities. With each learning center, the interactions between the center's management and users shaped its identity. The four learning centers were operationally closed, whereby the external environments or their partners did not determine their identity or structure. The learning centers were governed by board members and management teams who jointly oversaw the activities of the center. Furthermore, the learning centers had clear boundaries between internal and external interactions, and their partners knew their respective roles with regard to the CSI ICT projects or the operations of the learning center. OPLC and Nanga Vhutshilo had established their own operating model, unlike the other two learning centers that were based on international models.

5.3.2 | Structural coupling

Since their inception, all four learning centers as serving systems had established numerous partnerships. From the researchers' interviews and observations, it was apparent that each player knew their role, and therefore it was evident that structural coupling existed between the centers and their partners, to the mutual benefit of the various role-players.

5.3.3 | Sustainability

The sustainability of the learning centers was analyzed in terms of three aspects namely, financial, technological and institutional (Proenza, 2001). In terms of financial sustainability, some of the centers depended on ongoing fund-raising initiatives, partnerships, once-off donations, in-kind investments, investing in equities, or charging a minimal membership fee. The OPLC had a long-term partnership with their technology partner where the partner updated their computer technology as required. As a result, the center was not concerned about its financial sustainability.

Nanga Vhutshilo received government funding from the Department of Social Development. While this center was sustainable, the board needed to work on solid financial sustainability plans.

In terms of technological sustainability, Nanga Vhutshilo's CSI ICT project was discontinued after its Internet café equipment was stolen and the board members agreed not to replace the equipment. The three other learning centers' CSI ICT projects continued to be operational since their inception, which demonstrated that their CSI ICT projects were sustainable and able to impact the community positively. Two of the centers indicated that, when ICT equipment required repairs, the IT learners at the center repaired the equipment as part of their ICT training.

In terms of institutional sustainability, evidence from the data collected suggested that all the learning centers' non-technology operations were operational and ongoing. One of the learning centers replicated their model and opened a second center based on the success of the first. In all four cases, continued structural coupling with partners facilitated the sustainability of the learning centers.

5.4 | Community benefits

The communities served by the CSI ICT projects were found to benefit in several ways, for instance, the learning centers offered school children and the unemployed youth a safe environment which kept them out of trouble while offering them ICT training or access to ICT services. At two of the learning centers, multiple users benefitted from going on international student exchange programs or attending an international teen conference. This was attested by the center managers: "the centre afforded 19 young learners and 14 teachers an opportunity to go on International Exchange programmes to London and Germany" (CM1); the second center manager mentioned that "every second year, within the clubhouse programme, there's what we call the Teen Conference bi-annually it's in Boston MIT Lab. So, even this year in July, we are taking two kids that we've chosen on the programme" (CM2).

Another benefit that was observed was that the unemployed youth that participated in the ICT training at two learning centers, became more employable as a result of the training and received accredited certificates to assist them in seeking employment. This assertion was mentioned by the center managers: "young people who come and do certificates with us in IT and become employed because of those certificates... They've gone out and got work because of the certificates that they've gained while they're here at the learning centre" (CM1); the other center manager mentioned that "the staff that is here is people who came with passion who started like me as a beneficiary, then as a volunteer, then eventually being a manager" (CM2).

School children were found to have significantly improved their English and Mathematics marks, including improved reading and writing, since they started visiting the learning centers. One of the parents stated that "since grade R, I was always called at school and they complained that my child was slow, and he cannot read and write. Since the establishment of the centre, he is able to read and write" (P2). This shows how parents and well as learners have benefitted from these CSI ICT projects. The worldview that the CSI ICT projects in the study subscribed to, are reflected in the African proverb that says: "It takes a village to raise a child", which means that it takes an entire community to educate children. This was demonstrated by the partnerships between the learning centers, schools and the parents support and participation.

5.5 | Company benefits

This research highlighted that the technology partners also benefited from spending their B-BBEE budgets on the CSI ICT projects. This was confirmed by one of the CSI managers: "Yeah, so we do subscribe to BEE, and we are currently a BEE Level 4 contributor" (CSIM3). The types of benefits included B-BBEE points that allowed these companies to do business with government. Two of the technology partners (Acer and Intel) were international companies and they indicated that they did not subscribe to B-BBEE; however, they contributed to CSI ICT projects to fulfill their social and ethical economic development goals and "that their intervention indirectly benefitted the company by giving their brand a competitive advantage and a local profile" (CSIM1).

5.6 | Overall impact

Assessing the impact of CSI ICT project is paramount because it indicates whether developmental projects have made a positive impact in the lives of those that stood to benefit. Positive impact of CSI ICT projects focuses on access, meaningful use, and social appropriation of ICT resources. Overall, it was found that the four CSI ICT projects strengthened the learning center's ability to make a positive impact in the socio-economic development of the communities and individuals. The projects provided the communities with access to state-of-the-art ICT equipment for use by unemployed youth and school children. Moreover, the projects provided meaningful use of the center including practical training. The unemployed youth were more employable after completing ICT training and received accredited certificates and the school children improved their English and Mathematics marks. The centers further provided employment for the volunteers and they are paid monthly stipend.

Two learning centers, namely the OPLC and SAAYC established a set of indicators to assess the impact of their CSI ICT project, and these include, assessment of their programs, technology use, academic credentials, and social emotional development activities. The other two learning centers (Nanga Vhutshilo and Boys and Girls Club) did not define indicators for the impact of the technology center; however, they had indicators that they tracked such as academic success, healthy lifestyle, and character and leadership.

According to autopoiesis theory, the sustainability of the learning centers depended on the survival and preservation of the organization, viability, identity, and management of the learning centers for future generations to benefit from. Developing capacity was crucial for the sustainability of learning centers and for technology partners, as it assisted them to fulfill the needs of the community. Following Proenza's (2001) classification of sustainability, this research considered financial, technological and institutional sustainability. With the aim to be sustainable, the four learning centers employed various strategies to enable them to stay afloat and to diversify their revenue streams.

The overall observation was that all four learning centers' non-technological operations were sustainable at the time of data collection (even if the ICT project at one center closed down). The learning centers were financially viable and well managed. One of the centers expanded their model and opened a second learning center in another community. This indicated that the particular learning center was self-maintaining and self-producing.

6 | DISCUSSION

6.1 | Characteristics of sustainable and impactful CSI ICT Projects.

The findings derived from the four case studies suggested common principles of impact and sustainability of CSI ICT projects.

6.2 | Principle 1: Transformation

A successful CSI ICT project should plan for the expected transformation required. This was evident from the root definitions of each case study, which articulated significant activities required for learning centers to transform. Moreover, transformation processes need to be identified. In addition, Schwalbe (2006) asserted that if any socio-economic development project, including ICT, wants to meet the needs of the community, they should be viewed holistically and within the context of the community, which is what Ubuntu advocates for. Prior to the introduction of CSI ICT projects in the communities, the learning centers, and the technology partners should engage the communities, to arrive at a shared vision of the social system's intended transformation.

6.3 | Principle 2: Interconnectedness—the partnership

Interconnectedness is one of the significant values of Ubuntu, where a community works together and take a collective stand to seek for solutions to address their common problem. Moreover, it is vital for learning centers to forge strong partnerships with other organizations that can support them (Batchelor et al., 2003). Therefore, it is prudent for learning centers to seek partners that can complement their strengths and provide the resources that the learning center requires. For an effective partnership, all parties should consider mutual benefits from projects and trust, alignment, and community buy-in. Evidence from the four case studies suggests that impact and sustainability are characteristics that are achieved through strong and long-term partnerships.

6.4 | Principle 3: Collectiveness

For developments to be sustainable and impactful, drawing on the shared value of reciprocity, Ubuntu suggests collective volunteerism. Ubuntu represents a collective viewpoint, shared vision, collective responsibility and collective empowerment (Ntseane, 2011). A contribution of each volunteer to the learning center social system incrementally increases the value of the collective. All learning centers in the study instituted a formal and structured volunteer program where they paid their volunteers a stipend and followed a suitable process to recruit their volunteers.

6.5 | Principle 4: Organizational identity and structure of learning centers used by ICT companies to implement CSI ICT project

A social system's organization is established through its structure; however, it is the structure that interacts and change, but it is prudent that the structural changes maintain the organization and that the system retains its identity (Maturana, 1970). Organizational identity defines a social

TABLE 4 Learning center and CSI ICT project sustainability.

Case	Learning center	Learning Center sustainability	CSI ICT project sustainability
1.	Orlando Pirates Learning Centre (OPLC)	Yes	Yes
2.	Southern African Association of Youth Clubs (SAAYC)	Yes	Yes
3.	Nanga Vhutshilo	Yes	No
4.	Boys and Girls Club	Yes	Yes

system. Social systems may share the same identity; however, they are distinguished by their structures and they differentiate themselves and the environment to create their identity and boundary. They are operationally closed and governed by board members. The Learning centers in the study had clearly defined their boundaries between internal and external interactions so that all partners knew their roles.

6.6 | Principle 5: Sustainability of the learning center associated with the CSI ICT project

The sustainability of the learning center that hosts the CIST ICT project is a necessary condition for the ICT project's sustainability. For learning centers to be sustainable, they have to be viable and adequately managed, according to Corporation for National and Community Service (n.d.). Developing capacity is crucial for the sustainability of learning centers as well as for associated partners as it enables them to fulfill the needs of the community. With the quest to be sustainable, the four learning centers employed various strategies to enable them to stay afloat and to diversify their revenue streams such as fundraising, once-off donations, in-kind investments, and membership fees. The overall observation was that all four learning centers' institutions (non-technological operations) were sustainable however some of them have raised concerns regarding their financial sustainability, as illustrated in Table 4. As a way of self-producing, one of the learning centers replicated its model and opened a second learning center based on the success of the first center.

All the centers demonstrated characteristics of autopoiesis whereby they were self-producing and self-maintaining, though some of the centers needed to put in extra effort to ensure their continued financial sustainability.

6.7 | Principle 6: Assessing the impact

This study demonstrated the importance of having impact indicators to assess the impact of the CSI ICT project for all the partners who are directly or indirectly involved including the intended beneficiaries. Additionally, on-going data gathering is required to frequently evaluate the impact of the intervention on the communities involved. The partnership on measuring ICT for development developed impact indicators and they categorized them as follows: (1) ICT infrastructure and access, (2) access to, and the use of, ICT by households and individuals, (3) use of ICT by companies, and (4) ICT sector and trade in ICT goods (The United Nations Conference on Trade and Development, 2011). There was clear evidence that the existing CSI ICT projects contributed impactfully to poor urban communities in Soweto and businesses have also benefitted from these projects.

The presented case studies afforded an opportunity to do critical learning and provide recommendations for decision-makers in the similar CSI ICT projects in the South African context. The combination of SSM, ubuntu and autopoiesis in the systems framework has led to the development of guiding principles of assessing sustainability and impact of CSI ICT projects to meet the needs of the communities as social systems responsively.

7 | CONCLUSION

The objective of this research was to investigate the impact of South African CSI projects with an ICT focus, with the aim to see whether there were systemic and longer-term benefits to the communities. The article sought to address the following research question: *How can systems thinking be used to analyze the impact of CSI ICT projects in poor urban communities in South Africa?*

A qualitative case study was conducted that included four CSI ICT learning centers in poor urban communities in Soweto, South Africa. A systems framework combining SSM, ubuntu and autopoiesis was used to provide a theoretical lens to analyze sustainability and the impact of CSI ICT projects in poor urban communities using a systems approach. SSM was used to identify and describe the social systems of interest. Ubuntu's contribution was to accentuate the value of mutuality and partnerships, which are consistent with the premise that an individual is part of a community, and individuals therefore strive to assist others while putting the interests of the community above self-interest. The autopoiesis concepts contributed by accentuating the importance of learning centers' ability to self-reproduce and self-maintain, to be sustainable.

Analyzing the impact of CSI ICT projects requires a systems approach to understand the relationships and interactions among the elements that form the entire system to implement initiatives that are impactful. This refers to understanding the community needs, learning centers, and companies' objectives as a whole prior to implementing any CSI ICT project. Based on the findings of the systems analysis, a conclusion can be drawn that the CSI ICT projects strengthened the learning centers' ability to make a positive impact to the socio-economic development of the communities. In addition, the learning centers proved to be self-producing and self-maintaining which indicated that they were sustainable.

The contributions of the study include a systems framework combining SSM, ubuntu and autopoiesis to systematically understand the impact of CSI ICT projects. The framework makes a contribution by extending Turpin's (2012, 2017) systems framework for impact assessment, specifically by adding the notion of ubuntu. The study further contributes a set of guiding principles that companies, systems thinkers, government departments, and ICT4D practitioners could use to assess the sustainability and the impact of similar projects identified to improve socio-economic development in poor urban communities.

The limitations included that the systems framework was applied to four case studies in the same geographical area. It is recommended that it be tested in other CSI ICT projects and refined during further research.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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