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The Context Relevance of ICT, Freshwater Management Activity and Sustainability Goal: A Proposed Encapsulated Conceptual Framework

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Abstract

This study proposes an Encapsulated Conceptual Framework (ECF) for understanding the links between Information and Communication Technologies (ICTs), water resource management activities, and Sustainable Development Goals (SDGs). The study aims to contribute to national, regional, and global debates on the potential of ICTs in achieving sustainability goals. A combination of two socio-technical theories - Relevance Theory (RT) and Technology Acceptance Model (TAM) was adopted to inform the study. The literature review further informed the construction of the ECF. The framework testing involved sampling participants and collecting and analyzing the data. A sample of 251 (n = 251) individuals from formal and informal water user groups on the Tanzanian side of the Lake Victoria Basin participated in testing the framework. The study adopted the cross-sectional design to a mixed research approach. Furthermore, it used three quantitative and qualitative data collection techniques: Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and Questionnaire Administration (QA). Each FGDs session accommodated a group of participants with 9 – 12 members across the selected sites. KIIs targeted groups network leaders, water resource managers at various levels, and other individuals with potential information. Gathered dataset was cleaned, summarized, and analyzed using descriptive, correlation, and content analytical methods. The study capitalized on the strength of Tableau and R statistics to produce the visualizations that support the descriptive analysis of the data. Furthermore, the study used R and MS Excel software to establish the relationships among the variables. Results indicated the prominent use of mobile as ICTs for freshwater management activities. Furthermore, mobile-based tools such as SMS, voice call, image and video supported these activities to attain some indicators of SDGs related to water resource management. The study concludes that the framework contributes to understanding the contextual issues on ICT, freshwater management and SDGs.

Keywords

Sustainability goals, conceptual framework, freshwater resource, encapsulation.

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Introduction

General introduction

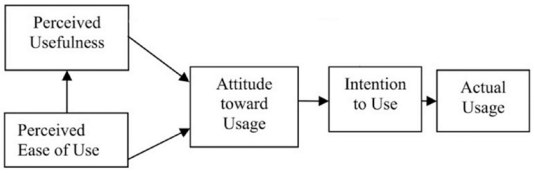
Water resources were among the priority areas for the Millennium Development Goals (MDGs) and now are for the Sustainable Development Goals (SDGs). SDG number 6 addresses the sustainability of freshwater resources. It calls for urgent action to combat climate change and its impacts (United Nations, 2021). Among sectors impacted by climate change is agriculture, which utilizes vast freshwater resources. The Bank Group (2014) indicates that, of the 6,122m^3 of international freshwater per capita worldwide, agricultural production consumes 70%. Therefore, freshwater is among the most wanted resources, especially in developing countries where the economies depend heavily on agriculture. Despite the importance, both traditional and contemporary factors challenge water resources. The evidence of the declining trends of freshwater amid increasing demand, not only for irrigated agriculture but also for industry and households, fuels present-day debates (UN, 2009; UN, 2013; UNEP, 2010; UN-FAO, 2005; WHO/UNICEF, 2010). This evidence calls for adaptation and mitigation

measures leading to the sustainable governance and management of freshwater resources. Information and Communication Technologies (ICTs) are considered valuable inputs for the sustainability of irrigation water resources. They are a "diverse set of technological tools and resources used to communicate and create, disseminate, store, and manage information" (Blurton, 1999). Modern ICTs contribute to the management and development aspects of irrigation in a variety of ways. Glória et al. (2020) show how the Internet of Things (IoT) can improve the sustainable management of irrigation water systems. Theimplementation context of a developed nation, showed that the system significantly reduced over 30% of the wastage of critical freshwater resources." A similar management scenario by Yasin et al. (2021) indicates an increasing trend toward integrating IoT with ICT-based intelligent water monitoring systems for a more efficient, resilient, and sustainable availability and use.

The International Telecommunication Union (ITU), contends that ICT is a potential tool for enhancing the management of freshwater resources (ITU, 2016). It further contributes to various functions of the water sector at multiple scales (Jéquier and Constant, 2010; Ellert et al., 2013; Garriga and Foguet, 2013; Kalitsi, 2003; Baron et al., 2002; World Bank, 2014; UNESCO, 2016). The water resources sector considers ICT a critical asset for promoting, coordinating, enhancing, and enabling participation and control (Georgakakos, 2004). These activities are vital to strengthening water resources institutions and organizations. ICT tools support stakeholders' participation by reducing the power distance that results from several disparities related to demographical characteristics. They also provide crucial infrastructure and tools for knowledge creation, sharing and diffusion; and boost the innovation capacity (Mas et al., 2012). Against this background, the links between ICT tools, water resource management activities they support, and development goals have remained a debatable subject at national, regional, and global levels from the era of MDGs and now SDGs (Kaino, 2012; Siriginidi, 2009; Ono et al., 2017; Odongtoo et al., 2019; Wu et al., 2018). Optimists and pessimists have emerged, taking the roles of proposers and opposers of the motion 'ICTs contributes to sustainability". As a result, findings from some of the studies above have identified linkage as the potential area for further exploration. This paper suggests an encapsulated conceptual framework as an option to study the contextual relevance of activity, and water resources sustainability.

Theoretical framework and literature review

A theoretical framework is the composition of inter-related concepts derived from a theory or a combination of theories (Imenda, 2014). Studies often use theoretical frameworks to explain a particular phenomenon or phenomena. The theoretical framework justifies carrying out the research. It is usually presented early enough before the methodology section of the proposal. Theoretical frameworks provide the lens and scope for studying a particular phenomenon. Two theoretical models have guided this work: Technology Acceptance Model (TAM) and Relevance Theory (RT). TAM which came in the late 1980s, has provided a framework for understanding the technology adoption among users (Davis, 1989). Figure 1 shows a schematic representation of the final version of TAM.



Source: Davis (1989)

Figure 1: The original version of the Technology Acceptance Model (TAM).

The goal of TAM was "to explain the determinants of technology acceptance that in general is capable of explaining user behavior across a broad range of end-user computing technologies and user populations" (Davis et al., 1989). These authors suggest that technology acceptance depends on two fundamental constructs: perceived usefulness (PU) and perceived ease of use (PeoU). Despite the fact that TAM has been revised several times since its formulation, its two constructs - PU and PeoU - have remained the same. PU means "the degree to which a person believes that using a particular system would enhance his or her job performance." In contrast, PeoU means "the degree to which a person believes that using a particular system would be free from effort" (Davis, et al, 1989). In this study, RT complements TAM.

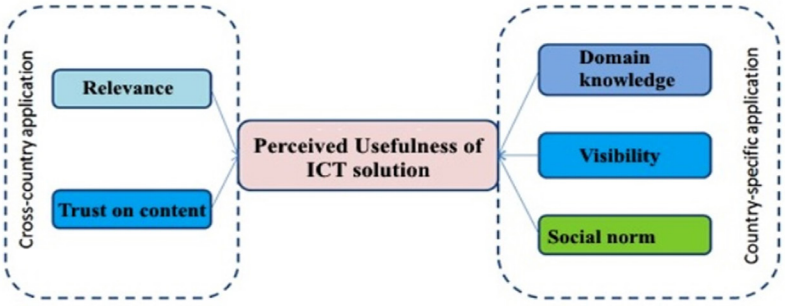
Relevance Theory (RT) authored by Sperber and Wilson came between 1986 and 1995 (Wilson and Sperber, 1986). It is a cognitive theory of human communication that has been used within the discipline of information science. The

theory builds upon the definition of relevance and two principles. According to Wilson and Sperber (1986), the two principles are the cognitive and communicative principles of relevance. The former states that "human cognition tends to be geared towards maximization of relevance". In so doing, human cognition allocates attention and processing resources to the most relevant information; in other words, information that guarantees an optimal balance between cognitive effects and processing effort. The latter principle states that "every ostensive stimulus conveys a presumption of its optimal relevance". In simplifying the meaning of the words in this principle, the authors argue that the term optimal relevance is a key to relevance theory in pragmatism. Furthermore, for the ostensive stimulus to be optimally relevant to an audience, it must have the following characteristics: be relevant enough to be worth the audience's processing effort and be the most relevant one compatible with the communicator's abilities and preferences.

Miller and Khera (2010) introduced relevance into TAM. They confirmed a cross-country application of TAM and identified factors that determined PU within and across countries. Five PU factors likely to influence a technology's intent to use were relevance, trust on content, visibility, social norm, and knowledge domain (Figure 2).

Hypotheses for each of these factors predicted the perceived usefulness across countries. The authors also found that relevance was the most vital factor, followed by the trust in the content in influencing the cross-country usefulness of ICT solutions. Social norm and knowledge do-main had a significant relationship at the country level, while visibility was insignificant within and across countries. Further analysis revealed that, among cross-country factors, relevance was the most crucial determinant of PU. The authors conducted this research within the context of information management/information science, comparing two countries: USA and Kenya. Despite this fact, the relevance component of the extension would be appropriate in this study for three reasons: The first reason is that IS, particularly its fields such as green-IS, are still growing, thus borrowing its justified concepts and theories from other disciplines or fields. The second reason is that TAM and its many extensions have been used widely in IS research. Third, water resources, in the context of this study, are largely transboundary. Therefore, adopting tested concepts like relevance from a cross-boundary context is appropriate.

Hjørland and Christensen (2002) proposed a different interpretation of determinants of relevance using logically connected concepts. They proposed that in viewing relevance should consider the logical relationship among thing (T), activity (A), and goal (G). Some Researchers contend that users can own and sustain 'things" (T) that they are involved in designing, focused on their actual needs, and resolve cost and related technical barriers (Millett and Estrin, 2012; Cobb, 2011; Aubert, 2004; Maldonado et al., 2010). Furthermore, the authors argue that regardless of their context, the three parameters should align so someone can track a meaningful contribution to the goal. Such consideration helps most information scientists to use relevance as a basis for system design and evaluation while at the same time dealing with theoretical issues related to it. Despite their potential, their conceptualizations have limited use in information systems and related fields. The systematic review study by Mongi and Meinhardt (2016) in Southern Africa regarding trends of measuring relevance within the water resources sector revealed linkages between tools, activities, or/and goals. This nexus could be tracked from several publications, though by extra effort of the reader. This study used



Source: Created from Miller and Khera (2010)

Figure 2: Factors influencing usefulness at national and international scales.

the three concepts as determinants of the relevance of ICT for public engagement activities in the water sector. The concepts were linked in the two theories which were then combined to build a proposed conceptual framework. Theory combination is common in research whereby they normally complement each other in various fashions to guide the study. The term "integration" has been used in studies employing TAM and other models. Integration means a combination of two or more elements to increase efficiency by optimizing their strengths and minimizing their weaknesses. A distinction be-tween hybridization and integration is that the latter does not necessarily result in a new individual. In the IT/IS theories, integration is combining two or more theories to develop a new superior theory from two different ones. In a set theory, this combination usually takes only features applicable in both and leaves the rest.

A. J. Chen et al. (2009) propose an integrated model developed using three theories, namely, TAM, Theory of Planned Behaviour (TPB), and Technological Readiness (TR). The new architecture explains the users' adoption of self-service technologies. Cheng (2014) proposed an integrated model composing Expectation-Confirmation Model (ECM), TAM, and updated IS Success Model (ISSM) to examine whether the quality factors as the antecedents to user beliefs affected users' continuance intention toward the digital library. The author argues that the proposed model was an excellent explanatory tool for the user's intention to use the digital library. Furthermore, the authors added that information relevance, system accessibility, and technical support played an important role in users' continuance intention of digital library use via their beliefs. Klopping and Mckinney (2004) combined their modified TAM with TFF models to study the consumers' e-commerce behaviour. In modifying the TAM, they argued that PU de-linked from PeoU. Nabavi et al. (2016) enumerate more examples of authors who have used TAM in integrated fashions (Nabavi et al., 2016). The set of information shows that authors who used TAM with other models adopted hybrid models much earlier than integrated ones (Nabavi et al., 2016; Chen et al., 2008; Liu et al., 2012; Cheng, 2014; Klopping and Mckinney, 2004). In contemporary trends, however, both fashions are used probably because of proposed new directions in IS research. Therefore, this paper proposes another combination of two models to inform IS research in the water resource sector.

This study introduces the concept of Theory Encapsulation (TE), hence contributing in both conceptualization and related debates. ET is a proposed form of combined architecture for theories. “Encapsulation” is a common technical term in computer networks and information systems. Collin (2004, p. 88) defines encapsulation in a computer network as “a system of sending a frame of data in one format within a frame of another”. In Information Systems (IS) development, especially with Java programming language, encapsulation refers to “wrapping data and methods within classes in combination with implementation hiding” (Eckel, 2006, p.228). In Chemistry, the term "encapsulation" relates to "technologies which enable to formulate one active compound (or more), inside individualized particles with a specific geometry and properties" (Capsulae.com, 2015). In the social realm, encapsulation applies especially regarding to “the friendship cohesion between internal and external friends” (Stark and Bainbridge, 1980, p.3). In this case, more cohesion tends to develop among friendship groups that share many in the same socio-cultural environment (internal) than among those who share just a few (external). The scholarships indicate wide and contextual use of the term "encapsulation" for tangibles and intangibles as well as materials and non-material things. This study proposes the application of the term "encapsulation” in theories combination.

Materials and methods

Overview of research design and approach

The study adopted a mixed research approach that combines qualitative and quantitative socio-technical methods. This combination allows for collecting qualitative and quantitative data and dynamics in analysis. On time-based design, the research adopted a longitudinal approach to data collection. This approach allows sequential implementation of the mixed methods. In this approach, the quantitative (QUAN) is followed by the qualitative (QUAL) paradigm, whereby the sequence does not necessarily attach equal weight to methods from each of the QUAL and QUAN paradigms. The literature review informed the construction of Encapsulated Conceptual Framework (ECF). The construction involved the review of constructs from the two guiding theories, and mapping them to augment the ECF in an encapsulated way. The literature review further informed the potential elements

of ICT as a tool, management activities for water resources, and sustainability goals.

The study area was the Mwanza region which is part of the Lake Victoria Basin (LVB). Mwanza region lies in the extreme northern part of Tanzania Mainland, bordering the Southern shore of Lake Victoria. Geographically, it lies between latitudes 1° 30' and 3° 0' South of the Equator and the longitudes 31° 45' and 34° 10' East of Greenwich (United Republic of Tanzania (URT), 1998). Currently, the region has seven administrative districts: Nyamagana, Ile-mela, Magu, Kwimba, Sengerema, Ukerewe, and Misungwi. Mwanza is among the fast-growing cities along Lake Victoria. As for other parts of LVB, the water resources in Mwanza have been facing severe pollution challenges and declining levels due to the increasing demand, population growth, and climate change. The study selected three administrative districts: Ilemela, Nyamagana, and Kwimba, representing urban, metropolitan, and rural areas, respectively (Figure 3).

The criteria for selection of the districts were the presence of water resources of significant size, formal institutions for water utilization for agriculture at small and medium scales, and challenges amounting to classifying such sites as "hotspots." The institutions, their members, and the associated technical and managerial support at meso and macro levels became the core target group in the study. One ward from each district was selected purposively based on the same criteria. In addition, the readiness of communities to collaborate with the researcher informed the selection process. The selected wards from Ilemela, Nyamagana, and Kwimba districts with formal irrigation organizations were Buswelu, Lwanhima, and Mwanghalanga, respectively.

Selecting participants for testing the framework

The sample was produced from the study area's three geographic contexts: urban, peri-urban, and rural areas. The sampling frame was small-scale irrigators of the selected wards in the three districts, with the population estimated at 720. The population size was used to estimate the sample size. Israel (2013) argues when estimating the sample size have to consider five factors: the purpose of study, the population size, the level of precision, the level of confidence or risk, and the degree of variability in the measured attributes. Estimation of the sample size adopted the formula suggested by Chen and Popovich (2002), Krzanowski (2007), Kothari (2010), and Ryan (2013) (Equation 1):

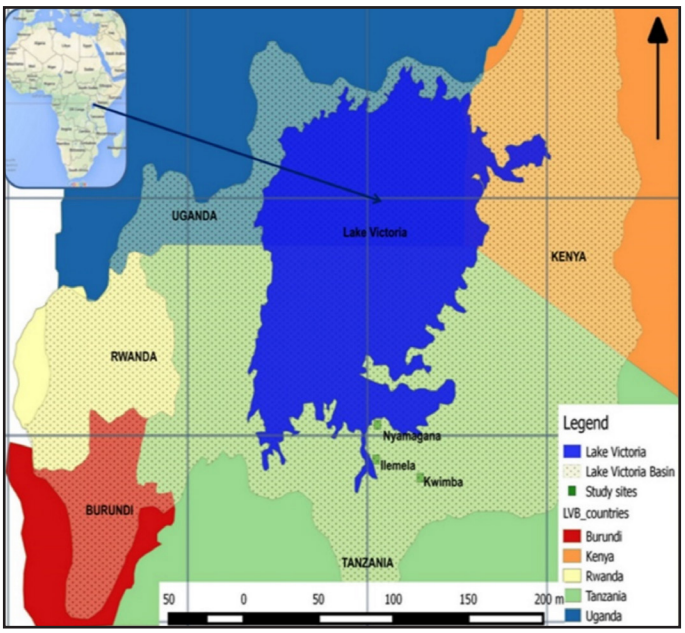
$$n = \frac{pZ^2}{Z^2 - 4e^2(1-p)} \quad (1)$$

Whereby:

n = estimated sample size.

z = a number relating to the confidence wished to be envisaged in the result.

e = the desired level of precision (standard error).



Source: Authors' creation with Google Maps

Figure 3: Map of LVB showing the location of study sites in Tanzania.

p = population that produced the sample.

Normally, 95% is considered a safe confidence interval associated with a Z-value of 1.96. The desired level of precision is therefore 5% (e = 0.05). The results of substituting these two values into Equation 1, is shown in Equation 2:

$$n = \frac{3.8416p}{3.8416 - 0.01(1-p)} \quad (2)$$

Substitution of the value of the estimated population size (p = 720) of members in the formal irrigation institutions and technical supporting individuals at micro and meso levels into into Equation 2 gives the sample size (n) = 251 respondents.

The study adopted purposive sampling, a non-probabilistic sampling procedure suggested by Trochim and Donnelly (2006) and Kothari (2010). In this study, purposive sampling served as the only appropriate method available, bearing in mind that formal irrigation associations and their members were limited in number. Dudovskiy (2013) indicates that this technique suits exploratory studies where the discovery of meaning can benefit from an intuitive approach. Since the researcher was aware of its disadvantages, he undertook necessary measures to minimize their effects. Purposive sampling targeted respondents who used smartphones to send and receive water resources information. The study, therefore, involved 251 participants drawn purposely and randomly from urban, peri-urban, and rural areas. Among them, 36.21% were females, and 63.79% were males.

Testing data collection and analysis

The collection of primary quantitative data used a closed-ended survey questionnaire. In contrast, primary qualitative data collection used open-ended survey questionnaires, focus-group discussions, key informant interviews, and observations. Secondary data collection used a systematic literature review of documents, reports, and other sources. Descriptive qualitative data analysis was coded and analyzed using descriptive statistics. Among the descriptive statistics employed were frequencies, means, and percentages. The study adopted correlation analysis to compare the system-oriented and user-oriented views to establish a significant relationship between the two.

Furthermore, it employed correlation analysis in testing the significance of relationships among the components of the system, public engagement, and sustainability indicators of water resources. The Spearman rank-order correlation or simply Spearman's correlation as denoted by ρ or "rho" was used to calculate the coefficients of association of pairs of ordinal variables. The requirements for Spearman's correlation test were observed, including that it does not make any assumptions about the distribution and that at least ordinal data and scores on one variable must be monotonically related to the other variable. The contextualization and usage of effect sizes were done. Several authors have suggested the effect sizes for interpreting the practical significance of correlation coefficients in statistics and behavioural studies. Among them are Hinkle et al. (2003) and Kotrlik et al. (2011). They suggested effect sizes' rule of thumb with intervals and five levels from negligible (±0.00 to ±30), low (±30 to ±50), medium (±0.50 to ±0.70), high (±0.70 to ±0.90) to very high (±0.90 to ±1.00). However, the most common is Cohen's rule of thumb (Cohen, 1988; 1990). It suggests three levels of interpretation of Spearman's correlation from small (± 0.10), medium (±0.30), to large (±0.50). Based on the three levels of relevance (low, medium, and high) adopted in this study, Cohen's rule is used with slight modification, as shown in Table 1.

High and very high levels are merged into high levels to confirm the context requirements. In this case, associations with Spearman's correlation below |0.30| were considered negligible.

Positive correlation		Negative correlation	
Size	Interpretation	Size	Interpretation
0.70 to 1.00	High (Strong)	-0.70 to -1.00	High (Strong)
0.50 to 0.70	Moderate (Medium)	-0.50 to -0.70	Moderate (Medium)
0.30 to 0.50	Low	-0.30 to -0.50	Low
0.00 to 0.30	Negligible	-0.00 to -0.30	Negligible

Source: Adopted with slight modification from Cohen (1988)

Table 1: Rule of thumb for interpretation of the effect sizes in correlation analyses

Results and discussion

Proposed Encapsulated Conceptual Framework

Encapsulated Conceptual Framework (ECF) is proposed as a gateway to linked ICTs, water resource management activities, and sustainable development goals. ECF is a conceptual stage toward the Encapsulated Theoretical Framework. ECF, in this context, extends the relationships but in the context of two theories, TAM and RT. Since extended TAM incorporated relevance as one of the criteria for PU of technology, it can combine with RT in a way that TAM "encloses" or "contains" the RT. Conceptualization in Miller and Khera (2010) for TAM and Hjørland and Christensen (2002) for RT formed a basis for the suggested conceptual encapsulation (Figure 4). Further, it operationalized each of the three encapsulated components of relevance (i.e., thing, activity, and goal) into variables in the context of water resource sustainability.

The Digital "Thing"

This study views the digital "Thing" or ICT solutions as having two interrelated and self-supporting parts: the social and technology sub-systems. The social sub-systems comprise the users, their activities in supporting the water resources, and their goals to ensure that the sustainability of the resources is enhanced. The technology sub-systems comprise ICT solutions for supporting various public engaging activities in water resource management. The ICT tools (T) can be operationalized into one or more variables as shown in Equation3:

$$T = \{T1, T2 \dots Tn\} \quad (3)$$

Where n = number of elements making a set of ICT tools

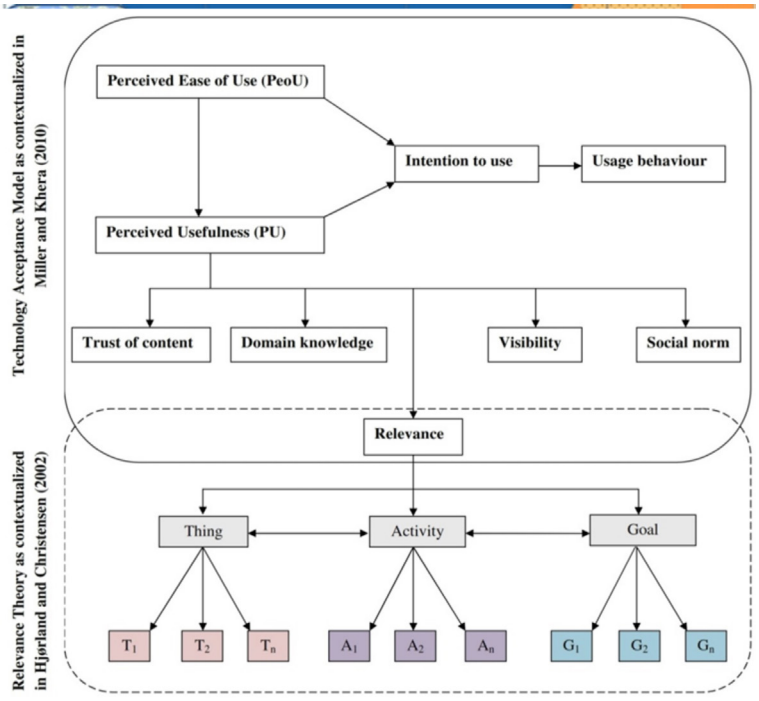
Some studies have indicated that ICT tools may vary with main and sub-tools. Using a case of a Water Resource Governance System (WaGoSy) that was developed in the study area (Faustine et al., 2014) exemplified and tested four (n = 4) ICT tools that were perceived to be basic applications at the community level. For mobile phones, for example, there were tools like SMS, voice, image, and video, while for web-based tools, the focus could be on social media.

The Digital-based Activity

The digital activities (A) identified within the context of the application of the framework can be operationalized into one or more variables as shown in Equation 4:

$$A = \{A1, A2 \dots An\} . \quad (4)$$

Where n = number of elements making a set of digital activities.



Source: Authors' processing

Figure 4: Encapsulated Conceptual Framework showing at the bottom the set of essential variables explored.

Each of these variables can represent a specific digital activity. For example, Mongi (2016) identified public engagement activities by members of small-scale irrigation organizations were from policy, strategies, and action plans. Public engaging activities from literature and confirmation during the first field visits. The author included eight (n = 8) categories of activities in his study.

The Goal

The Goal (G) can also be operationalized into one or more variables as shown in Equation 5:

$$G = \{G1, G2 \ldots Gn\} \quad (5)$$

Where n = number of elements contributing to an overall goal.

Different goals can be factored in depending on the context of the framework. To exemplify the applications of the goal (see Mongi (2016)) adopted the indicators of sustainable development goals entrenched in goal number 6. The United Nations (UN) suggests the following global indicators for Goal 6: (i) Ensure availability and sustainable management of water and sanitation for all; (ii) Proportion of population using safely managed drinking water services; (iii) Proportion of population using (a) safely managed sanitation services, and (b) a handwashing facility with soap and water; (iv) Level of water stress: freshwater withdrawal as a proportion of available freshwater resources; (v) Proportion of transboundary basin area with an operational arrangement for water cooperation; (vii) Amount of water and sanitation-related official development assistance that is part of a government-coordinated spending plan; and (viii) Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management. Furthermore, the indicators were domesticated to Tanzania and validated in the context of smallholder FFG through local experiences.

Test Results of Encapsulated Conceptual Framework

Overview of participants' characteristics

Encapsulated Conceptual Framework (ECF) was tested by finding the actual ICT tools, water management activities, and locally perceived sustainability indicators for SDG number 6. The demographic characteristics of the sample selected for testing the framework were 36.21% and 63.79% for females and males, respectively. Except for rural areas where middle-aged persons seemed to dominate by 46.48% (N = 33), the rest of the geographical areas were dominated by youths by 62.64% (N = 57) and by 42.70% (N = 38) for urban and peri-urban areas, respectively. Participation by age categories showed that youth (20-35 years) were the majority with 49%, followed by middle age (36-50 years) with 35.06% and Elder (above 50 years) with 15.94%. Usually, the longer they stay in the same place, the more experience accumulated about the environment, including water and related resources. Participants with such experience (16 and more years) were 75.5% (N = 288) compared with less experience (less than 16 years) who were 24.5% (N = 94).

The Digital "Thing" in context

This study has indicated that ICT tools may vary with main and sub-tools. Using a case of Water Resource Governance System (WaGoSy) (Mongi, 2016) exemplified and tested three (N = 3) ICT tools that were perceived to be basic applications at the community level. In addition to that, some sub-tools were considered for each primary tool. For mobile phones, for example, there were tools like SMS, voice, image, and video, while for web-based tools, the focus was on social media tools. Table 2 shows the existing ownership of ICTs in the study area.

ICTs items owned (Mobile phone, Radio, TV, Computer)	**Study location**			**Average (N=251)**
	Ilemela (N=91)	*Nyamagana (N=89)*	*Kwimba (N=71)*	
Mobile phone	89	76	60	75
Radio	78	69	45	64
Television	29	24	5	19
Computer	19	17	0	12
None	2	5	2	3

Source: Authors' processing

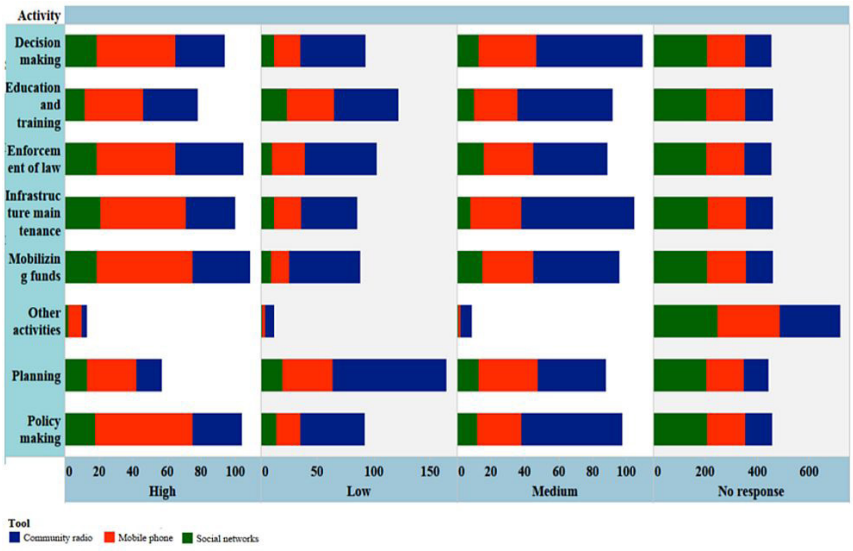
Table 2: Common ICT items (Things) owned in the study area.

The Digital-based Activity in context

There were several activities related to water resources management. These included decision-making, educating and training, enforcing the laws, maintaining the infrastructure, mobilizing the funds, planning, and policy marking. Figure 5 shows the perceived importance of ICTs in supporting various activities. Again, mobile phones became a prominent tool across activities.

The Goal in context

The perceived sustainability indicators for water resource management at the local level were mapped with standard SDG indicators for goal number 6. The purpose was to domesticate the indicators to gain context relevance for Tanzania, particularly for water resources management in LVB. Figure 6 shows the process of identifying the perceived indicators of water resource sustainability.



Source: Authors' processing

Figure 5: Perceived levels of contribution of selected ICTs to public engaging WRM activities.

Source: Authors' processing

Figure 6: Respondents in strategic action research to identify local indicators of water resources sustainability.

The following local indicators were rated for their importance in water resource sustainability: Controlled livestock population, controlled illegal fishing within the resources, Regular training and advisory services, Reduced income poverty, regularly maintained infrastructures, Con-trolled Siltation of water reservoirs, controlled human population, Controlled water pollution, controlled drought and floods, Mapped water resources and surroundings and Enforced rules and regulations. Table 3 summarizes the contextualized indicators for SDG 6 using the perceived sustainable indicators for freshwater management at the study area.

The relevance between T-A-G in context

Testing extended to the contextual relationship between "Thing," "Activity," and "Goal" showed the same trend. None of the selected ICT tools was perceived to have a strong correlation along the ICT tool – Activity – sustainability continuum. Although there were cases where ICT tools had strongly significant correlations, the complete relationship ended with non-significant correlations between activities and sustainability thus dropped. Table 4 shows the relationships along the continuum which have significant correlation as well as their associated effect powers (i.e., Cohon's RoT).

As an exploratory study, these relationships did not mean a waste but a message that there was something wrong with the end link that needed to be addressed. Cases like this one may equally attract the attention of researchers, innovators, decision-makers, and policymakers.

Table 4 further shows that despite the medium

Priority local perceived indicator	Total Scores (n, %)	Remarks	Nearly equivalent Corresponding SDGs 6 indicators
Controlled human population	109 (43.4%)	Medium	Ensure availability and sustainable management of water and sanitation for all.
Controlled water pollution	142 (56.6%)		The proportion of the population using safely managed drinking water services.
Controlled drought and floods	146 (58.2%)		Level of water stress: freshwater withdrawal as a proportion of available freshwater resources.
Mapped water resources and surroundings	149 (59.4%)	Strong	The proportion of transboundary basin area with an operational arrangement for water cooperation.
Enforced rules and regulations	163 (64.9%)		The proportion of local units with policies and procedures for local communities' participation in water and sanitation management
Average	141.8 (56.5%)		

Source: Authors' processing

Table 3: Fitting the top-ranked perceived indicators of water resources sustainability into their SDG equivalents.

ICT tool	Cohon's RoT	Activity	Cohon's RoT	Sustainability Indicator
Mobile SMS	Medium	Planning	Medium	Human population
Mobile Voice	Medium	Planning	Medium	Water sanitation
Mobile Image	Medium	Planning	Medium	Controlled GHG
Mobile Video	Medium	Planning	Medium	Encroachment of water sources
Mobile Voice	Medium	Decision making	Medium	Encroachment of water sources
Mobile SMS	Medium	Decision making	Low	Water sanitation
Mobile Image	Medium	Decision making	Medium	Controlled GHG
Mobile Video	Medium	Decision making	Low	Encroachment of water sources
Mobile SMS	Medium	Law enforcement	Medium	Water sanitation
Mobile Voice	Medium	Law enforcement	Low	Controlled GHG
Mobile Image	Medium	Law enforcement	High	Encroachment of water sources
Mobile SMS	Medium	Capacity building	Low	Encroachment of water sources

Source: Authors' processing

Table 4: Activities as a bridge between ICT tools and sustainability goals.

level that images contribute to enhancing law enforcement, it ended with high contribution in addressing challenges of encroachment into water resources. A few cases where medium linkages corresponded with high or low linkages were also observed. The findings support evidence in developing countries of a potential combination of ICT tools in engaging a wide array of the public in promoting sustainability of water resources. Low relevance, according to Cohen's RoT, was perceived for some cases of ICT tools and public engagement activity. As for the previous case, the contribution of activities that were supported by those ICT tools to sustainability was mainly low. The study adopted a mixed research approach that combines qualitative and quantitative socio-technical methods.

Conclusion

This paper describes the theoretical consideration within IS research, especially when more than one theory has to be used. This paper has described various combinations with which theories have been applied in information systems (IS) research. Problems with traditional combinations, especially with the popular TAM were described with examples of the nature of their use. A unique combination of two theories, TAM and RT, was proposed for future applications in IS research. Given the background of the two theories and the need to advance theoretical contribution to information systems, this study proposes an ECF. The architecture is neither integration nor hybridization. In this framework, the relevance of a cross-country usefulness of technology as one of TAM's constructs is strongly determined. ECF, therefore, zooms at relevance as a contextualized construct of TAM in developing countries as well as three factors that determine relevance: "thing," activity, and goal. Operationalizing these factors into variables with consideration of the context was exemplified based on an actual study that tested them in small-scale irrigation schemes. This study, therefore, proposes the ECF for use in studying the context-specific relevance where information systems mediate between activity and development goals.

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