



Exploring Opportunities for Sustainable Housing: The Case of East Africa

Max Rosvall¹ · Klas Palm¹ · Swaminathan Ramanathan¹ · Raine Isaksson^{1,2}

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Abstract

This paper contributes to the development of a problem-structuring method for exploring sustainability opportunities in systems. It presents a case of designing the plane while flying it, using an action research methodology to develop the Sustainability Opportunity Study over a period of 2 years. The problem-structuring method was applied and developed in the context of a research and development network for improving sustainability of housing in East Africa through alternative binders in block-based building. The resulting method consists of the three main stages Diagnosing, Analysing, Solving, where activities are informed by critical systems thinking and insights derived from experience and reflections from the case. The method uses different types of workshops to derive specific project proposals for further implementation and realisation of the identified sustainability opportunities. Results also suggest four types of evaluation of the Sustainability Opportunity Study based on the main focus of the intervention: Focus on effectiveness (number of relevant project proposals), focus on creating shared understanding (perceived learning among participants), focus on ensuring fairness (level of engagement among marginalized stakeholders), or focus on commitment to Critical Systems Thinking (breadth and depth in Diagnosing, Analysing and Solving).

Keywords Sustainability opportunities · Problem structuring method · Critical systems thinking · Sustainable housing · Workshop · Sustainability opportunity study

Introduction

The global system for providing housing accounts for 30–40% of global carbon emission making it a major contributor to global warming (Architecture 2030, 2024; Berardi 2017). Access to affordable housing is one of the declared human rights (United and Nations 2017). To provide all people with access to affordable housing by 2030, housing for some 3 billion people is yet to be produced (World Bank 2023). In light of this, the need for a

✉ Max Rosvall
max.rosvall@angstrom.uu.se

¹ Civil Engineering and Industrial Technology, Uppsala University, Uppsala, Sweden

² Business Administration and Industrial Engineering, Luleå University of Technology, Social Sciences, Technology and Arts, Luleå, Sweden

transition towards a sustainable supply of housing is emphasised. Organisations associated with the value chain for providing housing will be affected and affect the needed transition towards a sustainable supply of housing. While the need for sustainable housing seems clear, assessment on general levels of understanding of sustainable building indicate low levels of understanding in both industry and research (Isaksson et al. 2022; Isaksson and Rosvall 2020). How organisations, and networks of organisations, in the value chain for providing housing can identify and improve their sustainability impacts seems unknown based on the low understanding among leading industry and research.

The challenge in sustainable building is similar to challenges in other industries in that they all inhibit the VUCA characteristics; high in Volatility, Uncertainty, Complexity and Ambiguity (VUCA). In an organisational context muddled by the VUCA characteristics, identifying the 'right' things to do as an organisation is challenging. Development of an Opportunity Study has suggested three distinct stages for identifying opportunities in systems, namely Diagnosing, Analysing and Solving (Isaksson 2015). Opportunities are defined as potential to realise measurable improvements. A sustainability opportunity is defined as a potential to realise a measurable improvement that is aligned with a larger transition of progress and development inside the boundaries of an agreed framework for sustainable development. Later development introduces a Sustainability Opportunity Study (Isaksson et al. 2023a) focused on identifying stakeholder needs as a way to complement the Diagnosing in the Opportunity Study. This previous research has made conceptual contributions to the development of a systematic method to identifying and evaluating opportunities for improved sustainability performance in systems. Empirical exploration could contribute to the development through testing the methods and experiencing the strengths and weaknesses based on implementations in cases.

Being able to identify opportunities for improved performance in value chains is a necessary dynamic capability of organisations for achieving sustainable development (Linde et al. 2021; Mousavi and Bossink 2017). The framework for dynamic capabilities in systems has identified Opportunity screening and Partnership scouting as key system capabilities (Linde et al. 2021). However, they do not present any systematic method that could be used to guide efforts aiming to identifying opportunities and scout for partnerships.

This paper seeks to continue the development of the Sustainability Opportunity Study as a response to the identified need among 'purposeful systems' to develop their dynamic capability Identifying opportunities. Ackoff and Emery (1972) state that a purposeful system is a group of actors working together to achieve a common goal, i.e. their purpose. This can be an organisation, but in this study it is used to describe temporary groups of participants who come together seeking to explore opportunities and screen for future partnerships. When looking for a method to derive opportunities, there is an assumption that if a systematic method is used, it will be possible to achieve effective use of resources in that exploration. In this paper, systematic means that there is a structure to follow that is repeatable in multiple contexts. Identifying, in relation to opportunities, refers to finding some information that was not known beforehand. Exploring refers to the process of connecting new and known information about the identified opportunity that is explanatory to why the opportunity exists.

The purpose of this paper is to explore how purposeful systems can identify and explore opportunities for sustainability in a systematic way. To be able to compare the derived systematic method to other methods, indicators for evaluating the method is also explored. This is done in the context of pursuing sustainable housing in East Africa through alternative binders in block-based construction. The paper is guided by the following research questions:

RQ1: How could purposeful systems identify and assess opportunities for sustainability in a systematic way?

RQ2: How could such a systemic method be evaluated?

Background

According to the UN-Habitat and the World Bank, the need for affordable housing is estimated to be 3 billion people by the end of 2030 (World Bank 2023). Examples from East Africa region highlight the growing deficit of housing units as Kenya is estimated to have a deficit of 2 million units growing by 200 000 per year, Uganda's deficit is estimated to 1.7 million in 2019 growing to 3 million by 2030 (Mwesigye 2019). Access to affordable housing is a human right (United and Nations 2017), but far from a reality for habitants in the East African region. Two key factors are highlighted as causes for the major challenges in access to affordable housing in the region; cost of construction and cost of borrowing for financing housing (Mwesigye 2019). Cement as the binder in concrete blocks have been described as a key driver for cost of the block-based housing constructions used in sub-Saharan (Isaksson and Babatunde 2019). Cement is also recognised as one of the key sources for carbon emissions in the construction section. Global construction activities are estimated to account for 30–40% of carbon emissions (Architecture 2030, 2024; Berardi 2017) and cement production alone accounts for 8% of global carbon emissions (Andrew 2019).

In block-based housing constructions in East Africa, substituting the amount of ordinary Portland cement has been suggested as a way to improve sustainability performance in terms of cost and carbon emissions (Isaksson and Buregyeya 2020). Research on alternative binders that could complement or fully replace the use of ordinary Portland cement has yielded a plethora of potential alternatives, often referred to as pozzolanic materials. The pozzolanic property describes how certain materials can create strong and cement-like substances when they react with a specific type of lime (Lothenbach et al. 2011). Pozzolans are often divided into two types, natural and artificial where examples of natural pozzolans are volcanic ash and calcined clays while artificial pozzolans are often by-products from human production processes like rice-husk-ash, cassava-peel-ash, and saw-dust-ash (Sabir et al. 2001). Exploring how research findings about the properties of these pozzolanic materials can support the system of actors in the value chain for providing block-based housing construction in East Africa, offers an example of a complex sustainability challenge with overwhelming opportunities (Isaksson et al. 2023b).

Theoretical Background

The sustainability opportunity study is an emerging problem-structuring method seeking to support system actors in deriving relevant sustainability opportunities to invest in. The concept of a sustainability opportunity study draws its inspiration from a seminal document titled “Manual for the Preparation of Industrial Feasibility Studies,” which was issued by the United Nations Industrial Development Organization (UNIDO) in 1991 (Behrens and Hawranek, 1991). Within this manual, the notion of an opportunity study is delineated as an initial and rudimentary evaluation, conducted with the purpose of assessing the potential viability of an industrial project Conducted prior to embarking on a more comprehensive pre-feasibility study, and subsequently, a full-fledged feasibility study.

The fundamental premise underlying this approach is to ensure that the initial investigative phase of a novel undertaking is conducted with reasonable resource allocation. This premise is aptly reflected in the cost estimations associated with each category of study, as outlined in Behrens and Hawranek (1991, p. 39):

- An opportunity study is estimated to require approximately 0.2-1.0% of the total investment.
- A pre-feasibility study typically demands an allocation of approximately 0.25-1.0% of the total investment.
- In the case of small to medium-sized industrial projects, a full feasibility study is projected to consume approximately 1.0–3.0% of the total investment (Behrens and Hawranek, 1991).

The idea of an opportunity study is developed further in the work of Isaksson (2015). Isaksson's method involves three key steps: Diagnosing, Analysing, and Solving problems with the goal of creating a sense of urgency for making positive changes. Here an opportunity exists if there is sufficient improvement potential and causes can be explained and solved. Later development of the opportunity study introduces its purpose to identify sustainability opportunities (Isaksson et al. 2023a). Changing the focus from opportunity studies traditionally used for industrial projects to those for organizational sustainability projects involves a change in how the study is done. The key steps of the sustainability opportunity study is described using a matrix combining Diagnosing, Analysing, Solving (DAS) from Isaksson (2015), with the three first stages of a common sense logic from understanding to leading namely Understanding, Defining, Measuring (Isaksson et al. 2023a). The major shift between the opportunity- and the sustainability opportunity study is in how we understand, define, and measure sustainability improvements, as opposed to mainly evaluating the economic aspects of industrial projects. The starting point of the Sustainability Opportunity Study is that there is a notion of improvement options, but that there is no agreed key performance indicators and no definition of sustainability. Often there is only urgency, but not a common understanding of neither the problem nor the solution. This makes it necessary to first establish a working definition and propose KPIs to be able to carry out Diagnosing. However, the overall goal of identifying opportunities for further exploration without using excessive resources remains the same. Focus in Isaksson et al. (2023a) is mainly on Understanding, Defining and Measuring in the stage of Diagnosing. The suggested process-steps of the Sustainability Opportunity Study (SOS) is described in Table 1, where Diagnosing is based on Isaksson et al. (2023a) and the Analysing and Solving is based on development done in Isaksson (2015) and applied in Isaksson (2016).

As the SOS specifically aims for identifying sustainability opportunities within certain systems, the concept of sustainability in systems is foundational for further progress and development.

Sustainability in Systems

The term 'sustainability' has one of its first appearances in Hans Carl von Carlowitz's 1713 book *Sylvicultura Oeconomica*, where he described a sustainable use of forest resources to maintain a balance between old and young trees (read in Du Pisani 2006). A dictionary definition of the term is "*the quality of being able to continue over a [long] period*

Table 1 Overview of process-steps of sustainability opportunity study

	Understanding	Defining	Measuring
Diagnosing	<p>Scope, using value chain from cradle to grave by defining input, output and business idea of the studied business.</p> <p>Identifying main sustainability stakeholders, their value needs and the harms they are subjected to by the value chain with focus on climate, biodiversity and poverty as well as any other significant harm as identified with the four sustainability principles.</p> <p>Defining the qualitative improvement potential as the difference between possible and/or required performance and current performance.</p>	<p>Based on the Pareto principle define the vital few stakeholders, value needs and harms caused.</p> <p>Focus on people and planet needs and convert this to a proposed definition that can be operationalised.</p>	<p>Measure sustainability as a state and sustainable development as change.</p> <p>Identify value and harm indicators – the KPIs (y-values) that can be used to describe current sustainability and the sustainability performance over time.</p> <p>Value and harm are expressed in terms of impacts on people, the planet and profit.</p> <p>KPIs should be expressed in absolute and relative terms.</p> <p>Assess the quantitative improvement potential for chosen y-values in terms of level and the rate of change.</p>
Analysing	<p>A quantitative analysis comparing x-values to chosen y-values describing the detected improvement potential.</p> <p>A qualitative analysis based on 10 M checklist.</p>		
Solving	<p>Describing a visionary new steady state – using a process-based system model.</p> <p>Describe main steps in the change process.</p> <p>Assessing if change is feasible.</p>		

of time” (Cambridge Dictionary 2023). Research has grappled with trying to reach a unified universal definition of the concept for a long time, see examples in (Hopwood et al. 2005; Pawłowski 2008). For a historic account of the roots of sustainable development see Du Pisani (2006) and for an overview of common conceptualisations of sustainability in organisations see Lozano (2008). Systems thinking was early in exploring sustainable development on a planetary level, with the account in the club of Rome’s report “Limits to growth” (Meadows 1972).

Sustainability and sustainable development are sometimes used interchangeably but here they are defined separately to make a distinction between the goal and the process. Sustainability is understood as an ideal state with a two-tiered equilibrium (Lozano 2008). The first equilibrium being among the three dimensions Economic, Environmental, and Social. The second equilibrium is among the time perspectives ranging between current and future generations, short-, long-, and longer-term. Sustainability is therefore the ideal state where an equilibrium between the current and future stakeholder needs are met and have the opportunity to continue do so for a long period of time. Sustainable development is understood as the process of progress approaching the ideal state of equilibrium with a required rate of change.

Drawing from the notion of tipping points, introduced in the limits to growth report, which are thresholds that ignite irreversible system changes if trespassed, the understanding of sustainable development entails progress that are within these boundaries of known tipping points. The planetary boundaries (Persson et al. 2022; Rockström et al. 2009) are an example of a framework that has operationalised this idea for the environmental dimension of sustainability and their framework indicates the thresholds for which development should stay within. Here development is understood on a global system level as accumulated progress from various sub-system levels. Progress in turn is understood as accumulated improvements from further sub-system levels. Identifying these sub-sub-level improvements that contribute to overall development within our boundaries striving towards an ideal state is the purpose of the sustainability opportunity study.

Critical Systems Thinking

Parallel to the development of the Opportunity study is the work on various problem-structuring methods. Systems thinkers have for long been engaged in the development of problem-structuring methods for supporting the identification and realisation of opportunities in various systems (Gomes Júnior and Schramm 2022; Jackson 2006). Critical Systems Thinking (CST) is a second-order thinking approach which is the combination of critical systems theory and the applied multimethodology Critical Systems Practice (CSP) (Jackson 2019). CST is a resulting approach from decades of implementations, developments and critiques of system methodologies. CST provides the bigger picture that has allowed systems thinking to mature and progress as a transdiscipline (Jackson 2019). The theoretical foundations of CST are critical systems theory and its cornerstones are captured as commitments to: critical awareness, pluralism, and improvement.

Critical awareness includes a commitment to theoretical awareness and social awareness. Theoretical awareness emphasizes understanding and challenging the philosophical and theoretical underpinnings of applied systems approaches for more effective interventions (Jackson 2019). Social awareness emphasizes understanding the societal and organizational influences that shape the popularity of specific systems methodologies at

different times. Further, it involves considering the consequences of using particular systems approaches, as choices may privilege certain goals over others (Jackson 2019).

The emergence of critical systems theory is closely tied to the adoption of pluralism in systems thinking. Jackson and Keys (1984) initiated a research program, utilizing the System of Systems Methodology (SOSM), to explore the relationships between various systems methodologies. Contrary to the paradigm crisis in hard systems thinking, the SOSM revealed that different approaches could be complementary rather than competitive. Pluralism, as a central tenet of critical systems theory, encourages mutual respect among diverse approaches. In contrast to isolationism, imperialism, and pragmatism, pluralism is identified as the strategy offering optimal opportunities for successful development in management science (Jackson 1987). It acknowledges and leverages the strengths of various systems thinking trends, providing a meta-methodology to guide theoretical endeavours and practical interventions. The theoretical basis for pluralism is rooted in Habermas' (1972) theory of human interests, linking technical, practical, and emancipatory interests to different dimensions of the SOSM (Flood and Jackson 1991). Overcoming debates about paradigm incommensurability, pluralism at the theoretical level justifies and supports methodological pluralism, allowing different systems methodologies to work together in a complementary manner for the benefit of diverse human interests (Jackson 2019).

The commitment to improvement within critical systems theory embraces a broader dedication to enhancing human well-being and potential. Informed by Habermas' (1972) theory of three human interests—technical, practical, and emancipatory—CST seeks to address each interest with appropriate methodologies. The goal is to foster comprehensive improvement by utilizing the strengths of different methodologies based on their relevance to specific human interests, ultimately contributing to a more effective and inclusive approach to problem-solving and societal well-being (Jackson 2019).

Critical Systems Practice is a multimethodological approach with four distinct stages – Explore, Produce, Intervene, Check (Jackson 2020). The commitments of critical systems theory are operationalised in CSP and complemented with a commitment to systems thinking (Jackson 2020). Throughout the four stages of CSP, but emphasised in Explore, five system perspective are continuously considered: machine, organism, cultural/political, societal/environmental, and interrelationships. Their main function in CSP is to ensure the breadth and depth of the system intervention and by that avoiding false starts (Jackson 2020). The lack of in-depth exploration will lead to a lack of insight hindering the subsequent Produce and Intervene. A lack of breadth will lead to a narrow purview restricting the scope of the subsequent Produce and Intervene.

The theoretical foundations of critical systems theory and the applied CSP, as briefly described above, will be used to draw from CST in the continued exploration into the opportunities for sustainable housing through block-based construction in East Africa.

Framework for Exploring Opportunities with SOS

The relations between the context of (1) sustainable housing through block-based construction in East Africa, (2) the sustainability opportunity study as method for exploring opportunities for improvements in systems, and (3) critical systems thinking can now be elaborated. This paper uses the SOS as a problem-structuring method for identifying opportunities for improving sustainability performance. This is applied in the context of sustainable housing through block-based building in east Africa. Critical systems thinking is used to formulate improvements and suggested developments of the SOS as

a problem-structuring method based on the experiences from the implementations in the context. These relations are visualised in Fig. 1.

Action Research Methodology

In seeking the dual purpose of contributing to the local improvements in sustainable housing in East Africa, and exploring how a systematic method for identifying sustainability opportunities in social systems, action research (AR) is identified as a suitable methodology (Bradbury 2015). Susman and Evered (1978) describes a generic action research cycle as involving five main activities; reconnaissance, action research planning, action implementation, evaluating, specifying learnings. A core idea of the action research method is that reflection is used throughout any intervention and resulting ideas for improvement, based on participants reflexivity are fed back into the intervention initiating a new cycle of intervention (Coghlan and Brydon-Miller 2014, p. 675). Checkland and Holwell (1998, p. 17) suggests that the number of cycles of an AR initiative is decided based on researchers judgement that the chosen methodology has yielded significant learnings in interaction

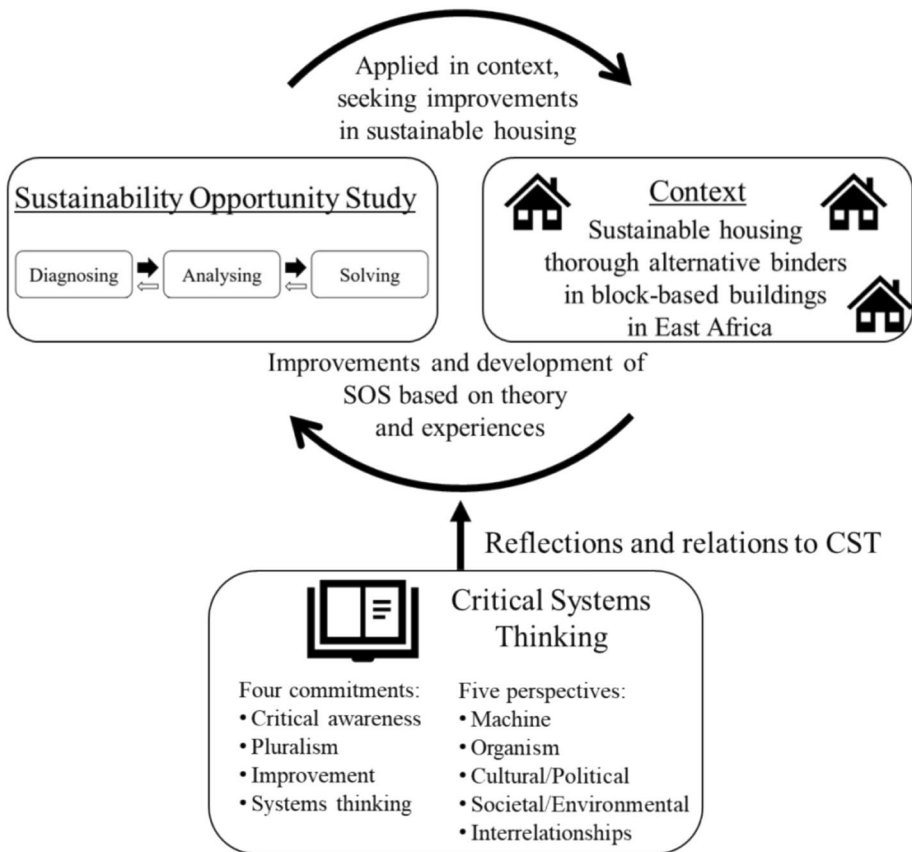


Fig. 1 Relations between the context, problem-structuring method and critical systems thinking as applied in this paper

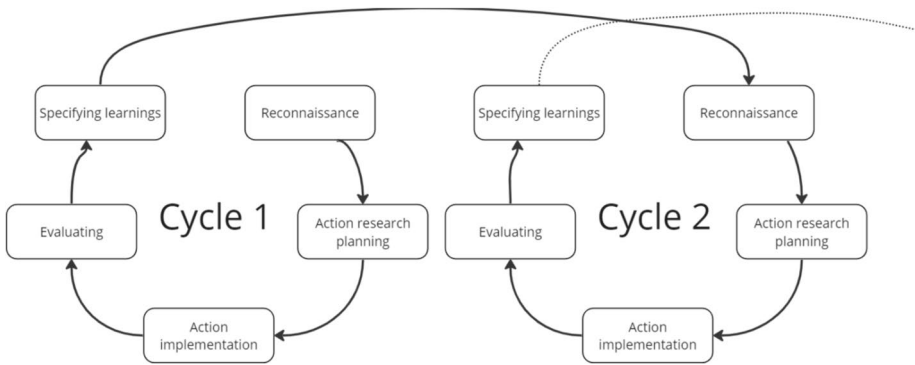


Fig. 2 Generic action research cycles interlocking with each other. Based on Susman and Evered (1978)

with the area of application. In this study two cycles were conducted with the five main activities in each cycle, where the learnings from cycle 1 were fed into cycle 2 as visualised in Fig. 2.

The Context of the Study

The AR initiative was conducted in the context of an initiative to create a network of actors for increased sustainability in housing solutions in sub-Saharan Africa. The initiative was funded by two Swedish agencies funding development research, Swedish Research Council and FORMAS¹. Participants were invited to the network and the planned activities (workshops and conferences) based on the principal investigators' (4th author of this paper) existing network in the region. The purpose of the networking initiative was to identify opportunities for further development in the area of alternative binders for block-based housing constructions. A shared interest for the general aim of the initiative was the initial criteria for the inclusion of any new participants invited or requesting invitation.

Deployment of Action Research Initiative

When conducting action research, it is common that dual purposes are pursued simultaneously, as here with the development of the SOS, i.e. research, and identifying and pursuing opportunities for sustainable housing through block-based construction, i.e. real problem. In doing this, researchers could benefit from distinguishing between the scientific problem statement and the real-world problem statement, and the processes for exploring each of them (McKay and Marshall 2001).

The two action research cycles conducted in order to identify and pursue opportunities for sustainable housing through block-based construction are hereafter described and visualized in Fig. 3. Through these cycles, empirical data has also been generated in order to answer the two research questions posed in Sect. 1 of this paper. A more explicit

¹ The Research Council for the Environment, Areal Industries and Community Building.

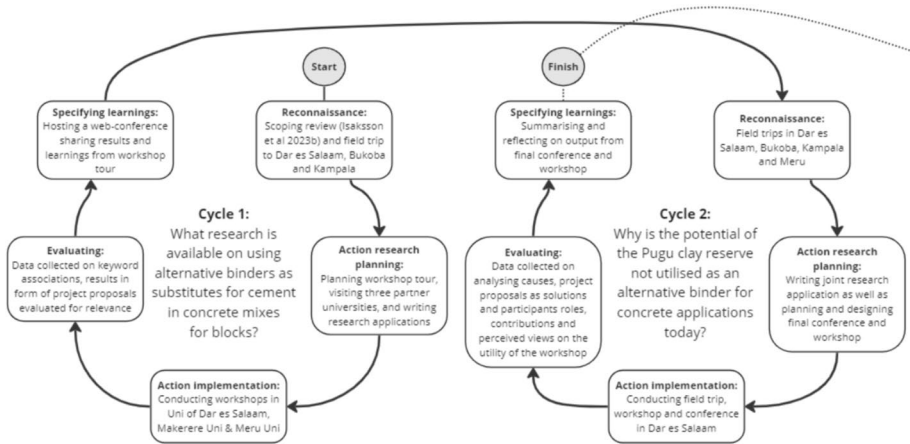


Fig. 3 Action research cycle 1 and 2 with key activities for different stages of the project

description of how the research questions were answered is described in the later sub-section: Data, experiences and reflection.

First Cycle

The initial guiding real world problem statement of the first action research cycle was: What is the potential for alternative binders as substitutes for cement in concrete mixes for blocks? In reconnaissance of cycle 1 it became clear that the answer was not obvious, which led the investigation towards published research and pursuing a second guiding questions: What research is available on using alternative binders as substitutes for cement in concrete mixes for blocks?

This second question was explored using two attempts with Diagnosing, Analysing, Solving steps of the SOS. This led to a scoping review being written, which was later published as “Supplementary Cementitious Materials in Building Blocks—Diagnosing Opportunities in Sub-Saharan Africa” (Isaksson et al. 2023b), using secondary sources to compile an estimate of the potential on the regional level of sub-Saharan Africa. This review revealed a significant knowledge gap in the identified research on supplementary cementitious materials. Namely the fact that the documented reports from laboratory tests from replacing cement with alternative binders all lack relevance in terms of explaining the total replacement factor for use cases like ordinary building blocks.

Within the same cycle, subsequently a second attempt was carried out with Diagnosing, Analysing, Solving. This was done through three two-day workshops conducted in Dar es Salaam (27 participants), Kampala (23 participants) and Meru (24 participants) in autumn 2022 (referred to as the workshops in cycle 1 in the Result section). The participants in these workshops were a mix of university lectures, researchers, master and bachelor students, entrepreneurs, construction company managers, architects, representatives from bureaus of construction standards, all united in a common interest in alternative binders for concrete construction. Insights based on reflections from experiences related to the first cycle was used to design the second cycle of intervention. These insights were partly shared with the network during a digital conference in January 2023. There were 10–20 participants listening in during this conference, as it was a digital forum participants could

easily join and leave while presentations were given. Presentations were given by nine of the researchers in the network, including author 1, 3 and 4 of this paper.

Second Cycle

Result from the first cycle fed into the second cycle allowing for a deeper understanding of the gap in laboratory research results as well as the lack of local knowledge of the real potential of alternative binders for blocks. The guiding problem statement of the second cycle was: Why is the potential of the Pugu clay reserve not utilised as an alternative binder for concrete applications today? Here the case of Pugu, which is a large clay reserve outside Dar es Salaam, was selected to provide more narrow case boundaries for the SOS workshop. Narrower compared to the previous scope in cycle 1 ranging from sub-Saharan Africa to East Africa and a national scope of Tanzania, Uganda and Kenya. This time only one workshop was conducted. The workshop was carried out in Dar es Salaam in October 2023. The workshop sessions were longer in this cycle and the conference was divided into two parts. The first day was a full-day workshop based on the SOS structure, referred to as the workshop during cycle 2 in the [results](#) section. For this workshop, 22 participants with mixed expertise in research, development and deployment and based in seven different countries² contributed. The second day was a half-day conference with invited speakers from the network, complemented with external presentations from the local industry in Dar es Salaam. An overview of the key events related to the two action research cycles conducted is presented in Fig. 3.

These cycles in Fig. 3 have been carried out according to the timeline described in Table 2.

Data, Experiences and Reflection

The process of conducting the two cycles of the SOS has generated data through the use of surveys and documenting the ideas, cause-effect relations and project proposals produced in the stages Diagnosing, Analysing and Solving. These data have been used as manifests of the content produced while experiences among the participating action researchers, author 1, 3 and 4 of this paper, have been used as data from the process. Reflection is used as the link between the content and process that happened and the generation of insights for future action. The reflective practice is a key component for knowledge generation in action research (Coghlan and Brydon-Miller 2014, p. 675). Kakabadse et al. (2007) emphasise that two types of reflection can be used in action research, reflection in vivo, i.e. reflection directly related to the ongoing practice, and post reflection which is a more structured process taking a step back from experience and inquiring into its meaning. Reflective practice is therefore considered to be a primary link between experience, interpretation and future action (Kakabadse et al. 2007).

The three action researchers have engaged in spontaneous reflection throughout the initiative and a specific post reflection session was conducted among the three. For this, a set of reflective questions were prepared and answered in a group reflection which was recorded and later transcribed. Figure 4 illustrate how action researcher 1, 2 and 3 (hereafter referred to as AR1, AR2, AR3) are embedded among the other participants ‘wearing two hats’ of both

² Tanzania, Uganda, Kenya, South Africa, Nepal, India, Switzerland and Sweden.

Table 2 Activities within in the action research initiative following a time line and indicated phase of action research cycle

Time	Activity	AR phase	Comment
April 2021	Researching for VR applications	Reconnaissance & action research planning	Start of first cycle
September 2021	Researching for FORMAS applications	Reconnaissance & action research planning	
November 2021	Writing first draft of 'diagnosing opportunities' – later published as Isaksson et al. (2023b)	Reconnaissance	Scoping review of top-cited review articles on alternative binders
January 2022	Web-meeting with research group	Reconnaissance & action planning	
April 2022	Researching for VR applications	Reconnaissance & action research planning	
March – April 2022	Field trip to Dar es Salaam, Bukoba and Kampala	Reconnaissance	Pilot study to understand context and main challenges
September 2022	Planning and designing workshop tour	Action planning	Preparing presentations, structure and keyword survey
October 2022	Workshop in Dar es Salaam (first of three in tour)	Action implementation	Testing workshop structure following DAS with less structure
October 2022	Workshop in Makerere (second of tour)	Action implementation	Testing workshop structure following DAS with more structure
October 2022	Workshop in Meru (third of tour)	Action implementation	Testing workshop structure following DAS with more structure
October 2022	Field trips in Dar es Salaam, Bukoba, Kampala and Meru	Reconnaissance	Start of cycle 2
January 2023	Web-conference with research group	Evaluation and specifying learnings	End of first cycle
April 2023	Writing and submitting joint research project for Swedish Science Council	Action planning	The call was cancelled by a government decision and the proposal was never assessed
August – October 2023	Planning and designing final conference and workshop	Action planning	Stakeholder mapping, defining scope and goal for conference, selecting methods and tools to be used for support
October 2023	Final conference and workshop	Action taking	
October 2023	Summarising and reflecting on output from final conference and workshop	Evaluating and specifying learnings	End of second cycle

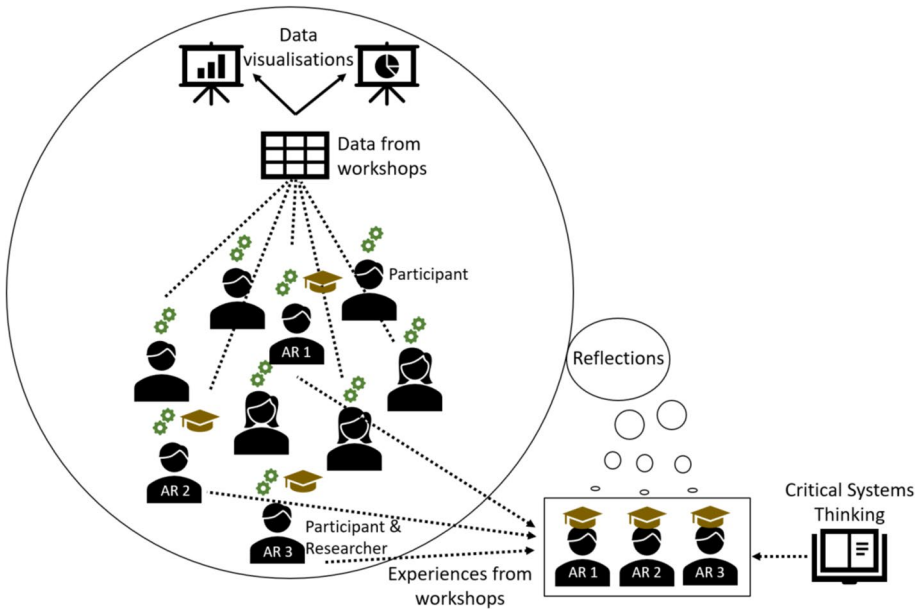


Fig. 4 Schematic overview of data collection and analysis from the interactions with participants and the dual role of the participating action researchers. Coggs represent a role as a participant and the Tudor bonnet represent the role as researcher

participant in workshops and action researcher. The workshops, and all interaction that occurs, produces some data which can be analysed and visualised. At the same time, the action researchers gain experiences of the perceived support from the structure introduced via the SOS. The three action researchers later use reflection based on the data, experiences and theory from critical systems thinking to derive results in the form of suggested activities for the Diagnosing, Analysing and Solving stages of the SOS and measures to evaluate the method by.

Quality and Validity in Action Research

Herr and Anderson (2014) conclude that we should not judge action research by the same criteria which we judge positivistic or naturalistic research. For elaboration on this see e.g. Checkland and Holwell (1998) and Susman and Evered (1978). Instead Herr and Anderson (2014) suggest that the quality and validity criteria of action research should be linked to the intended goals of the action research. They list five criteria: Dialogic and process validity, Outcome validity, Catalytic validity, Democratic validity and Process validity. The related goals of these criteria and the interpretation of the criteria to this paper is outlined in Table 3.

Table 3 Five quality/validity criteria of AR with respective related goal of AR and interpretation in this paper

Quality/ validity criteria	Goal of action research	Interpreted to the context of this study
Dialogic and Process validity	The generation of new knowledge.	Explicit description of the use of reflection as key component for generation of new knowledge in Sect. 3.3. Explicit references to what sources substantiate what results (column 2 in Tables 4, 5 and 6). Peer review process prior to publishing results.
Outcome validity	The achievement of action-oriented outcomes.	Cycle 2 produced 9 concrete project proposals which could be taken forward by participants of the network, however the measurement of any achieved effects as results of the intervention is beyond the scope of this study.
Catalytic validity	The education of both researchers and participants.	Perceived learnings among researchers and participants are presented in Fig. 11. Average 4.5 out of 5 on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) based on the statement 'I learnt new things during this workshop'.
Democratic validity	Results that are relevant to the local setting.	Participants of the network were continuously invited to group discussions to validate, scrutinize and critique suggested solutions and suggestions.
Process validity	A sound and appropriate research methodology.	Results generated through cycles of action and reflection.

³ As per Herr and Anderson (2014, p. 55)⁴Based on Herr and Anderson (2014, pp. 55–57)

Results

Based on the experiences acquired from the two cycles of exploring opportunities for sustainable block-based housing in East Africa, this section focuses on the development of the problem-structuring method SOS.

RQ1: How could Purposeful Systems Identify and Explore Opportunities in a Systematic way?

The working hypothesis during the intervention has been that a sequence of Diagnosing-Analysing-Solving could be used to derive relevant projects with a potential to realise improvements of sustainability performance in the systems in focus. After defining the key concepts used in the Sustainability Opportunity Study, this section continues to describe the processes of Diagnosing, Analysing and Solving with examples of experiences, reflections and insights from CST. Each stages' activities are listed in Tables 4 and 5, and 6 respectively where the comments guide the reader in providing the examples which led to the suggested activity.

Diagnosing

The Diagnosing process was prepared before conducting the workshops in both cycle 1 and 2. Previous research by one of the action researchers led the project to focus on cost and carbon emissions as key indicators for performance in production of concrete block-based housing constructions in east Africa (Isaksson 2015; Isaksson and Babatunde 2019; Isaksson and Buregyeya 2020). To explore the associations of sustainable building among the participants in the workshops during cycle 1, a keyword survey was conducted asking the participants to provide three to five keywords they associated with sustainable building. From a thematic analysis, the themes 'Areas and objects', 'Properties' and 'Sustainability impacts' emerged. Figure 5 shows all eight clusters and examples of keywords associated to each of them. The keyword association was also conducted after the workshop and the frequency of each theme at each of the workshop sessions during cycle 1 is visualised in Fig. 6.

The key takeaway from the keyword association of the participants is that it does not exist any shared understanding of what constitutes sustainable building in the context of East Africa. This insight was further reinforced when an analysis of the submitted project proposals from the workshops in cycle 1 was conducted. Here the project proposals were again clustered into four themes. First theme is 'Technology' which includes projects directly focused on new knowledge about cement-based blocks with regards to minimizing ordinary cement or new knowledge about block-based construction materials. Second, 'Alternative solutions/technology' includes suggestions that involves other construction techniques beyond the block-based using a binder and water to achieve compressive strength. The third theme 'System development and demonstration' includes project proposals like 'Raise customer awareness', i.e. targeting challenges beyond the technical scope of identifying alternative mixes of binders that can form blocks that construct walls at low cost and low carbon footprints. The final theme was every other proposal named 'Out of scope'.

Table 4 Suggested activities in diagnosing with the key source used to derive the suggested activity and comments on each specific activity

Suggested activity step in diagnosing	Key source for suggestion	Comment
<i>Identify the value chain</i> , its main processes, their main input & outputs, the key stakeholders of the value chain and derive key outcomes of the value chain based on the stakeholder needs.	Previous research paper (Isaksson et al. 2023a)	Using previous publication as starting point.
<i>Create a definition</i> for what sustainability is in the given context using a formulation like 'sustainable xx is at least yy'.	Experiences from the workshops in cycle 1.	With more than 1 participant it is likely that there will be more than 1 opinion about what constitutes sustainability in the given area of focus. Using the 'at least phrasing' allows for moving beyond definitive discussions and agree on key stakeholder needs that are deemed most relevant in the given moment.
<i>Derive sustainability key performance indicators</i> based on the definition for sustainability using both relative and absolute indicators.	Experiences from the workshops in cycle 1.	The suggested indicators during the workshops in cycle 1 were cost and carbon footprint per square meter of wall. Throughout the discussions about alternatives to conventional concrete blocks there were never any data available for comparing any type of performance between the alternatives being championed by various participants.
<i>Prepare a one-pager</i> with the information from the three previous steps and send out to invited participants of the Analysing & Solving workshops.	Experiences from the Diagnosing workshop in cycle 2.	Here the received feedback on the one-pager in the group discussions was that receiving the one-pager prior to the workshop was good as an initial preparation.
<i>Prepare a survey</i> for the participants to complete after reading the one-pager.	Experiences from the Diagnosing workshop in cycle 2.	The survey results helped prepare the initial Diagnosing workshop.
<i>Initiate the Diagnosing workshop</i> by presenting the key points from the one-pager and then engage in group discussions questioning and potentially surfacing revisions for the boundaries and choices made in the Diagnosing.	Experiences from the workshops in cycle 1 and the Diagnosing workshop in cycle 2.	Here the presented Diagnosing was anchored with the participants as they were given a chance to voice their opinions about any possible disagreements in drawing the boundaries or selecting the sustainability KPIs in group discussions. This was not done successfully in the three workshops during cycle 1 which led to a great disparity in the resulting project proposals.

Table 4 (continued)

Suggested activity step in diagnosing	Key source for suggestion	Comment
<p><i>Let participants vote on whether or not the diagnosing should be revised based on the new suggestions surfaced during group discussions.</i></p>	<p>Experiences from the Diagnosing workshop in cycle 2.</p>	<p>As the continued work in the Analysing and Solving workshops are guided by the resulting Diagnosing, the responsibility for selecting the boundaries in terms of the value chain, identified main processes, inputs and outputs, main stakeholder needs is placed with the participants to vote on any suggested revision to the initial Diagnosing.</p>

Table 5 Suggested activities in analysing with the key source used to derive the suggested activity and comments on each specific activity

Suggested activity steps in analysing workshop	Key source for suggestion	Comment
<i>Brainstorm challenges</i> , first individually then group wise.	Experience from analysing workshop in cycle 2.	AR reflection suggests it was successful.
<i>Check 3 system perspectives</i> Mechanic, Organismic, Cultural/Political.	Critical Systems Thinking, commitment to systems thinking.	This could potentially help the group to break any group-thinking and hopefully surface any challenge previously overseen.
<i>Relate challenges</i> to each other through relation mapping group wise.	Reflections from experiences from analysing workshop in cycle 2. Operationalising the 'interrelations' systems perspective from CST.	Experiences suggest the relating of challenges was messy and difficult during the workshop in cycle 2 but provided essential understanding for where the core challenges were located and thereby informed the subsequent process of prioritising the challenges.
<i>Prioritise challenges</i> using complexity/impact matrix to map the identified challenges against each other.	Experiences from analysing workshop in cycle 2.	AR reflections suggest the matrix helped sort out the key challenges that has the potentially high impact of realising the identified improvement potential while also being able to distinguish differences in complexity in the challenges.
<i>Explore group agency</i> and declare initial boundaries for what challenges the group/organisation could engage with in a forthcoming intervention.	Reflections on results from workshops in both cycle 1 and 2.	AR reflections on the challenges being discussed suggests that a check among the potential partners within and beyond the organisation should guide the selection of challenges for which solutions are explored if action is to be enabled and an intervention have any chance for success.
<i>Select top 3 challenges</i> to be documented with descriptions, relations and assumptions.	Experiences from analysing workshop in cycle 2.	AR reflections suggest that selecting and prioritising core challenges is needed to make the next stage of Solving possible with a limited set of challenges to explore solutions for.
<i>Present top 3 challenges</i> for other groups and expose assumptions and reasoning for a group discussion scrutinising and further informing the descriptions, relations and assumptions.	Experiences from analysing workshop in cycle 2.	Sharing the derived key challenges and explaining the groups' identified relations and used assumptions support learning across the groups and the exercise can work as an initial reality check on the identified challenges.

Table 6 Suggested activities in solving with the key source used to derive the suggested activity and comments on each specific activity

Suggested activity step in solving workshop	Key source for suggestion	Comment
<p><i>Summarise and curate</i> (for overlap) the list of key challenges presented by all groups in the last stage of Analysing workshop.</p>	<p>Experience from Solving workshop in cycle 2.</p>	<p>As several groups may identify similar or same challenges in the parallel group work in Analysing a curation into a resulting list supports the initial steps of Solving.</p>
<p><i>Re-group</i> in new groups based on ambitions and agency around a few selected key challenges from the resulting list.</p>	<p>Reflections from Solving workshops in both cycle 1 and 2.</p>	<p>To increase the chances of deriving a feasible and desirable project proposal AR reflections from cycle 2 suggest that workshop participants are re-grouped to form groups based on interest and agency for certain key challenges among those in the curated list.</p>
<p><i>Review the key challenges</i> and try to identify which system perspective is dominant and draw from any previous experiences and knowledge about suitable system methodologies among the group members.</p>	<p>Critical Systems Thinking, commitment to systems thinking.</p>	<p>This could potentially help the group to draw from previous experiences and better align their strategy for intervention with the character of the challenge they seek to engage with.</p>
<p><i>Brainstorm</i> group wise trying to create solutions to the challenge.</p>	<p>Experiences from Solving workshops in both cycle 1 and 2.</p>	<p>Here a free format seems to release creative thinking and allowing the type of 'natural-state' of problem-solving many participants showed during the conducted Solving workshops.</p>
<p><i>Document</i> three project proposals per group with information about: -The need motivating the project -Team members of the project -The goal of the project -Potential sponsors of the project -Timeline with main activities -Assumptions used in designing the project proposal</p>	<p>Experiences from Solving workshop in cycle 2.</p>	<p>The content of the project proposal is derived from discussions on what could be reasonable to include but should be tailored to the intended group of decision makers who have the agency to support the progression from project proposal to real intervention.</p>
<p><i>Present</i> the three project proposals for the other groups.</p>	<p>Experiences from Solving workshop in cycle 2.</p>	<p>Sharing the derived project proposals and explaining the groups' identified content for each proposal supports learning across the groups and the exercise can work as an initial reality check on the identified projects.</p>

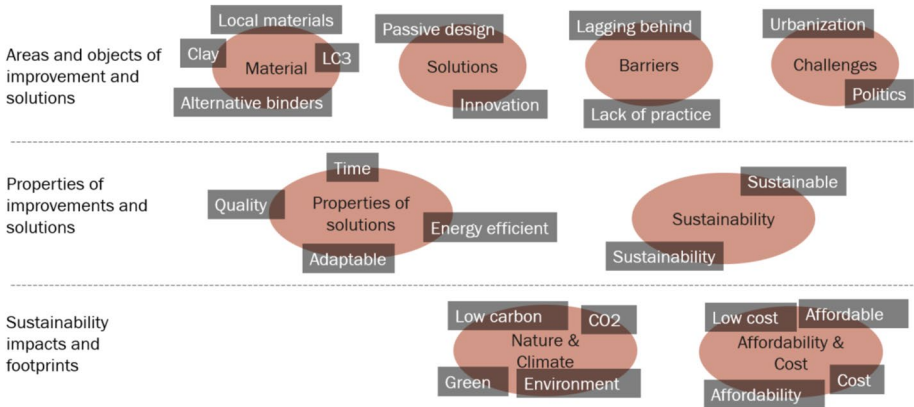


Fig. 5 Illustration of the relations between the themes ‘Areas and objects’, ‘Properties’, and ‘Sustainability impacts’, and their clusters where examples of keywords associated to each cluster is provided in the grey boxes

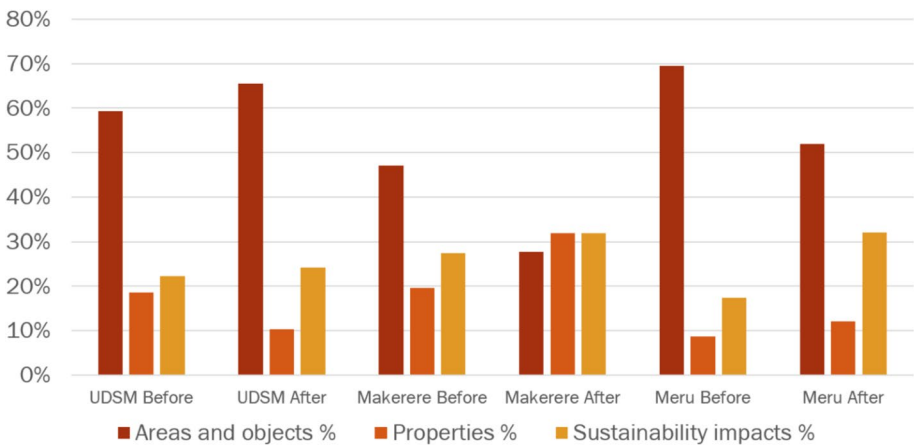


Fig. 6 Distribution of keyword frequency over the three themes, before and after each workshop in cycle 1

The distribution among the project proposals is illustrated in Fig. 7. From this illustration we learn that about 35%, i.e. more than a third, of all project proposals aims either on alternative solutions or out of scope. This is suggested to result from a failed anchoring of the diagnosing in the beginning of the workshop, which should provide the boundaries for the opportunity study and assure that the aim of the produced project proposals remains within the scope.

An insight resulting from reflections on the discussions during the workshops in cycle 1, is that the fact that many participants had other perspectives on what aspects should be included when discussing sustainable building. One example from the workshop in Dar es Salaam during cycle 1, is where the issue of sand, the aggregate in the concrete blocks, was highlighted as becoming a scarce resource and sand looting from local beaches were increasingly becoming a problem. A pragmatic approach to evade the discussion about what should be the complete definition of sustainable building was

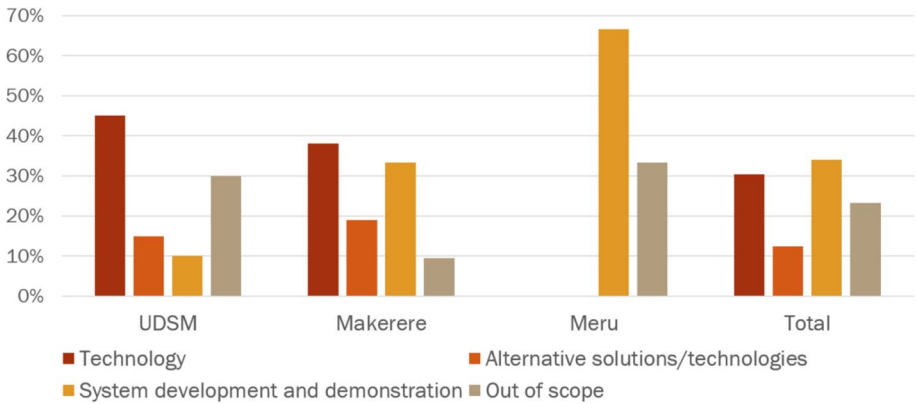


Fig. 7 Distribution of project proposals over the four themes, for each workshop session in cycle 1 and in total

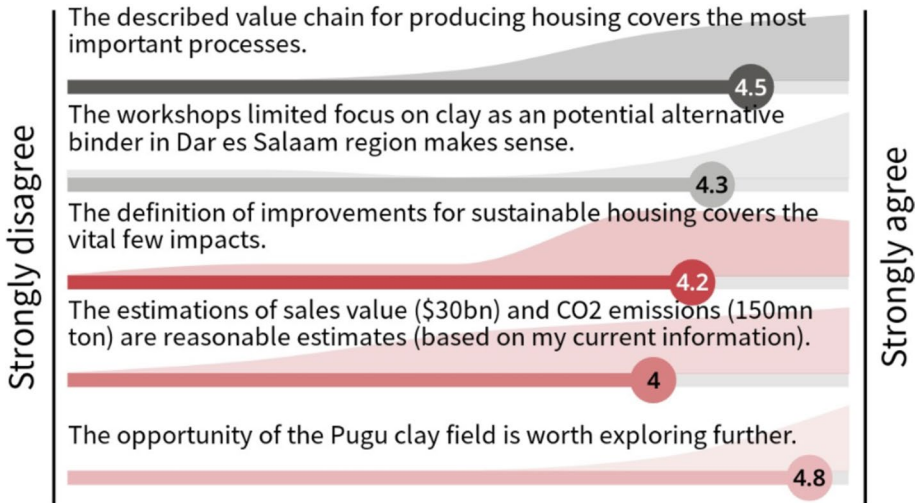


Fig. 8 Five statements regarding the initial Diagnosing shared with the workshop participants of cycle 2 with numerical averages showing and the distribution indicated as waves

used, where the phrase ‘at least’ was used when introducing cost and carbon footprints as the main impacts. This provided space for other participants to include their own views about what indicators should be considered in evaluating sustainable housing, while keeping the focus of the specific workshop within the predetermined scope. Further, discussions about alternative block solutions like burnt clay, stabilized soil or cut sandstone, were all limited by the conclusion that there were no available data for comparison based on the functional unit square meter wall. The reason for this lack of data is interpreted as a lack of shared understanding of the indicators relevant for sustainable building. This further indicated the need to anchor the diagnosing with the participants before moving on with Analysing and Solving workshops.

In the workshop during cycle 2, the Diagnosing was documented as a one-pager in an attempt to improve the shared understanding of the case prepared for the workshop, and prepare for a larger acceptance of the boundaries and focus on described ‘vital few’ sustainability impacts. Further, the participants were asked to respond to a survey prior to the workshop where they had to take a stance on the content of the diagnosing, see Fig. 8. Both the one-pager and the survey were used as preparations for an initial discussion about the case, boundaries, and focus suggested for the Analysing and Solving workshops. The initial discussion was done in small groups for 15 min before all participants met again and any potential revisions to the case, boundaries, and focus was discussed and a consensus was reached to keep the diagnosing as in the one-pager.

Reflections from the use of the one-pager, the associated survey, and initial groups discussions, were captured in the reflection session among the three action researchers where the following was said about the Diagnosing in cycle 2:

Question: Did the Diagnosing session work out as planned?

AR2: “Nothing I reacted on like: oh we should have done this differently.”

AR2: “I mean it was a huge simplification to go from saying that we look at alternative binders to say that we look at Pugu clay and I thought that would lead to some criticism because people would like to talk about their own pet projects but somehow it passed. And I’m happy it went through because it made so much more sense to creating this common understanding that: yes this is an opportunity. And still it was unclear in the discussions, when we are discussing the causes everybody is already solving the problem. That happens with everybody.”

AR3: “Yeah [agreeing]”.

AR2: “Even if it logically is so simple: Is there an opportunity? Yes – tick. What are the causes? People go schoum: we can do this, we can do that – so it just shows how much pre-work is needed to agree upon the boundaries like this is where we are. So I think if something we would have needed even more clarification on the diagnosing part.”

AR1: “My experience from my group were that we were able to establish a consensus from the group discussion and we didn’t flow out [of scope].”

Based on the experiences and reflections presented, a step-wise set of activities for the Diagnosing of an opportunity is suggested in Table 4. Here activity-specific comments are provided in relation to the key source for the suggested activity and the experiences and reflections presented here above.

Analysing

The reflections on the Analysing session in the workshop during cycle 2 witness of a successful session:

Question: Did the Analysing session work out as planned?

AR3: “I think the causes-part of the group exercise was very nicely structured and I think it flowed beautifully”.

AR1: “In my opinion I was very happy with the analysing session, where we were able to brainstorm out all the possible solutions, and then narrow it down to three key causes and then share that in the big group and kind of have a selection of key causes. I’m very happy with that.”

Some major changes in the Analysing session were done between the first workshop and the other two in cycle 1, as well as a remake of the activities for the workshop in cycle 2. The first workshop in cycle 1 was given a free format for group discussions based on the questions “Why is this improvement potential here?”. This resulted in quite superficial discussions where the summary from the sharing among the groups resulted in a set of 19 “causes” collected as a starting ground for the Solving session. Examples of such causes are “unfair competition due to unofficial market for blocks”, “high cement prices”, “correct sand grading is difficult” and “no big investors”. For the following two Analysing workshops in cycle 1, a 10 M resource analysis was introduced and the participants were asked to rank the importance of each resource, set a ranking number for its level and relevance for the purpose of enabling the system to improve its sustainability performance. These rankings could then be used to derive a weighted score for each group of resources.

Experiences from introducing the 10 M analysis tell that the 10 M tool was difficult to use with a value chain perspective and the discussions remained on a superficial level throughout the discussions. Two out of four group submissions from Makerere workshop named the mission resource highest priority with motivations like “*The climate change policies exists but their interpretations are limited*”, and “*Mission concise explanation of the organisations reason for existence*”. Similar for the workshop in Meru where 2 out of 6 group submissions named ‘Method’ resource as the top priority with motivations like “*the methods in which the production of the binders are not clear. Documentation of these methods need to be developed*” and “*Methods to provide standardization in the production of the binders*”. While the data collected from the participants’ 10 M analysis could be used to create nice graphs, like the one in Fig. 9, it was clear from the workshops that too little time was given for the participants to comprehend the concept of resources mapping using the 10 M tool. The time given for the Analysing session in cycle 1 was about 30–40 min, this was increased to 120 min in cycle 2. The 10 M analysis in cycle 1 did not provide any fruitful insights that could be used as a stepping stone for the next Solving session and were rather considered a barrier

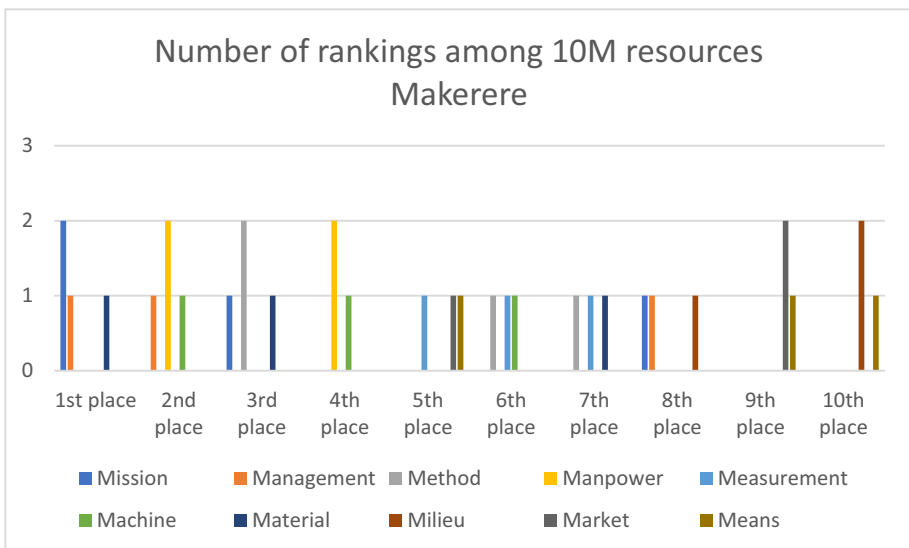


Fig. 9 Example of graph created with results from ranking 10 M resources in Makerere workshop during cycle 1

than enabler for good group discussions. Later reflection on the use of the 10 M tool led to the removal of the tool from the Analysing session. The evaluation of this decision was conducted during the reflection session after the workshop in cycle 2:

AR2: “I think it was good not to confuse people. Maybe now afterwards we can try to fit these into an explanatory structure. Theory can also be a limitation in action. So I think it went well.”

A key insight from doing the Analysing in cycle 1 was that much of the group discussions were based on assumptions and high-level reasoning. This led to an inclusion of a documentation of assumptions in the Analysing of cycle 2. Since the opportunity study is not designed to be complete, assumptions are accepted and needed to move forward. Acknowledging and documenting them enables more efficient follow-up work where the underlying assumptions can be scrutinised and the continued intervention can adjust based on new information shifting the viability of the assumption. Further, a clearer set of activities guiding the group-work with the Analysing was introduced. First an individual brainstorm where some 10 min were given to each participant for individual thinking and documenting challenges guided by the problem-statement “Why is the potential of the Pugu clay reserve not utilised as an alternative binder for concrete applications today?”. Following this was a group discussion, continuing to document challenges on post-it notes before the challenges were related to each other and spontaneously clustered. Here a post-reflection based on CST suggests introducing a check against the three system perspectives Mechanic, Organismic, Cultural/Political. The check would be done to challenge the group-thinking conducted by the group as they identify potential challenges, and ensure breadth of the Analysing (Jackson 2020).

The reason for suggesting three out of five system perspectives is that the Interrelationship perspective is considered in the subsequent step when the relations among the identified challenges are mapped. And the Societal/Environmental perspective is dealt with during the Diagnosing. In order to improve the work with prioritising the key challenges that were selected for continuing with in the Solving workshop, a matrix with two dimensions ranging from low to high complexity and impact was introduced. The matrix worked as a tool to help compare the derived challenges and identify those deemed to have low complexity and high impact. An example of one groups’ matrix and the positioned post-it notes with challenges is shown in Fig. 10. This is captured in the suggestion during the reflection session after the workshop in cycle 2:

AR1: “So a suggestion of looking for what comes first of the causes identified in the brainstorm and then go ahead and start looking for relations. I think that gives, even though it was difficult and messy, it gives you insight into like ‘where does the real problem lie’? and then when you have the complexity matrix you can go like, ok this seems to be the real problem and it has x complexity and y impact.”

Once the groups have mapped the challenges based on complexity and impact, before moving on to selecting the top three challenges, one AR witness:

AR3: “We had a stress test to see if we could drop any of the causes after the brainstorming in saying that ‘is this something that we can solve as a network’?”

Introducing such a check, before moving on to select the top three challenges is assumed to improve the chances of finding working groups for the Solving session where there is enough willingness, competence and access to resources to take the project proposal beyond the SOS into an actual intervention. After the selection of the top three challenges,

AR1: “Maybe an alternative could be to synthesize the causes that we found and have some way of describing those causes so that the participants can choose the one that they feel that they have the competence and the willingness to contribute to.”

AR3: “So if we synthesize the causes maybe we can reduce them, so if there are five groups then you put out those five core causes, and then each group can choose which cause they want to work with.”

AR1: “You can have some type of speed dating or a small group exercise that you can do. And then I was also thinking that the competences and access to resources could be highlighted in some way. So it would be kind of a matchmaking around the causes and the start of forming an alliance going forward in looking for solutions and real projects that could be implemented.”

AR2: “So I don’t think we talked about this but maybe we should have said that we take the three main causes and then select the one main cause and look for solutions to that one. So, you narrow it down further. And we might have divided it into different groups.”

AR1: “Group the causes that we did identify into themes, then have an exercise that lets the participants understand their capabilities and access to resources to prepare self-selection of solution groups based on interest for the theme and recognition of actual solving capabilities”.

Comparing with CSP, the second stage Produce seeks to identify already existing system methodologies, methods and models based on the identified system perspective the Primary issues is mainly associated with. In the case that participants of the Solving session have experience or knowledge of systems methodologies and CST/CSP an activity could be added to the Solving session. Where the participants reflect on the Primary issue, i.e. the challenge they have formed a group around, relate it to a system perspective and discuss any potential system methodology that can be used to guide an intervention. An alternative and complement to this would be a brainstorming session. Both approaches would result in three documented project proposals briefly describing the ideated motivation, team members, goal, potential sponsors, timeline with activities of the project, and assumptions used in designing the project. A summary of the activities suggested for Solving is presented in Table 6.

RQ2: How could such a Systemic Method be Evaluated?’

In the development of the Sustainability Opportunity Study the question of how to evaluate the results of the workshops was discussed and elaborated on. Initially in the three workshops during cycle 1, a schema was developed to test the learnings in terms of increased abilities for systems thinking, as a result of the participation in the workshops. The schema planned to use the first workshop in cycle 1 as a control group where no system models and tools were introduced and the structure of D-A-S was the only influence from the SOS to the workshop. As compared to the two following workshops where a process-based system model was introduced and used to describe the Diagnosing and how the following Analysing using the 10 M tool related to the overall system and the stakeholders in focus. The hypothesis was that the project proposals and the keywords collected at the end of the workshops would show higher levels of systems thinking. This was never possible to derive since there was a big discrepancy between the participating persons that completed both the keyword surveys prior and after the workshops. Further, no pattern could be distinguished between the first and the two following workshops’ resulting project proposals, see Fig. 6 for comparison based on the theme.

After the attempt to measure some learning effects in the first cycle, discussions among the action researchers partly shifted the focus towards the quality of the project proposals and the likelihood of moving into actual projects being implemented. In these discussions the concept of agency and ambitions surfaced as key factors among the participants, determining the likelihood of the continuation of the project proposals from idea to implementation. Here agency is defined as the ability among actors to mobilise resources for a certain goal and ambition defined as the willingness of actors to move to action (Avelino 2011). In preparations of the digital networking conference, an analysis of the data collected during cycle 1 was done. Here the project proposals were screened and clustered based on the themes presented in Fig. 7. The analysis was done based on an expert review, assuming that the experience and knowledge of the action researcher granted the privileged position to make judgements about the content and quality of the project proposals.

Going into cycle 2 and preparing for the workshops, it was agreed that while producing relevant project proposals was part of the aim, more important was the learning and relation building opportunities for the participants joining the workshop in Dar es Salaam. This guided the evaluation survey, that was conducted at the end of the workshop, to focus on the participants perceived learning and networking, captured with statements and answers on a Likert scale. See Fig. 11 for results from the workshop during cycle 2. Here a question about exceeding expectations and general success of the workshop was also included as general measurements of the perceived success of the workshop among the participants.

The start of this project was the successful application of two networking grants where the purpose was to build relations with local researchers and developers to create common project proposals. The explicit outcome expected from the networking grants was research applications for funding from various research agencies and development grants. Research applications were submitted, but not assessed (see Table 2). These committees would serve as a type of independent expert panel, which would have the agency to allocate the resources estimated for implementation of the identified research projects. Where the success rate of the applications submitted to such



Fig. 11 Survey results from workshop in cycle 2 showing average scores for participants' perceived level of agreement to four different statements

funding agencies could serve as a proxy for a successful SOS. Time and resources of this project would not allow for this type of evaluation but is suggested as an alternative for future evaluation.

Another aspect of the evaluation that was discussed during the project was the scope of stakeholder needs considered. It was suggested at several instances throughout both cycle 1 and 2, that the introduction of an alternative value chain for producing binders for block-based building would create employment locally. See the argument being presented in Isaksson et al. (2023b). This was included, and again excluded, from the diagnosing as a complementary key sustainability indicator to the focus on cost and carbon emissions. In discussion with one of the project partners it was questioned as a simplified chain of logic. Due to the uncertainty in how the cause-effect of an introduction of an alternative value chain for binders for block-based construction, it was for practical reasons decided that the impacts on local employment would be left out the discussion in the workshop of cycle 2. Where the practicality considered was the likelihood of acceptance of such indicator among the participants, where disagreement would lead to discussions on the scope of stakeholders to include, rather than exploring opportunities.

Using the main system paradigms identified by Jackson (2016), it is apparent that the perspectives and aims of the functionalist, the interpretative and the emancipatory paradigms have been considered in the discussion on how to evaluate the success of the SOS. This leads to a conclusion that the main purpose of the project should guide the selection of which measures for evaluations are considered most important, or if all should be designed for.

A post-reflection from CST contributes to the discussion, where Jackson (2020) in CSP emphasises a focus on breadth and depth of the Explore phase of CSP. The argument is that a lack of breadth and depth will lead to a false start in Explore. This is deemed equally true for the Diagnosing, Analysing and Solving of the SOS. Where a false start would be any derived project proposals based on false assumptions or missed project proposals due to narrow purview. Experiences from the discussions during the first cycle was that their focus was often quite high-level and superficial, indicating a lack of depth. In seeking breadth of Exploration, Jackson (2020) warns that problem solving techniques like brainstorming limits the boundaries of the discussion to the groups existing ideas and quotes Einstein's dictum saying that 'no problem can be solved on the same level of consciousness that created it'. Jackson's (2020, p. 843) suggested solution to ensuring breadth and depth, and avoiding the trap of false starts, is to ensure pluralism and guard against the competing approaches like isolationist, imperialist, and pragmatist. Based on this argumentation by Jackson, another way to evaluate the SOS would be to consider the design elements aimed towards ensuring breadth and depth of any SOS.

Based on these experiences, reflections and insights from CST, Table 7 summarises four types of evaluation of the SOS based on the primary purpose of the study.

Discussion

The development of the Sustainability Opportunity Study has further progressed as a result of the 2 year long systemic intervention. Critical Systems Thinking has been used to revise the method to be suitable for multimethodological interventions, ensuring both breadth and depth in the exploration of sustainability opportunities (Jackson 2020). While this development of SOS could be viewed as competing with Jackson's Critical Systems Practice, the SOS is introduced as a method that specifically could be used to support purposeful systems' dynamic capabilities of screening for opportunities. The area identified by Linde et al. (2021) and Mousavi and Bossink (2017) as a key capability for achieving improvements in sustainability performance and progress towards a sustainable development. CSP

Table 7 Four types of evaluation of the sustainability opportunity study differentiated based on the primary purpose of the study

Primary purpose of SOS	Type of measurements	Comments
Derive implementable project proposals	Total number of projects 'approved' for further exploration or implementation.	This could be a straight forward way to measure the effectiveness of the workshop if there is a group of decision makers who have the resources and mandate to fund further project implementation, like a management team in an organisation.
Form partnerships and coalitions with a shared understanding and common goals	Perceived learning and networking opportunities among participants of workshops.	This would be a focus on results in the interpretative or soft paradigm of system methodologies, see Jackson (2016). Objectives focus on the learning and creating a shared understanding .
Ensure fairness for all stakeholders of the issues investigated	Scope of engagement with stakeholders not directly involved but affected by possible system interventions.	This would be a focus on results in the emancipatory paradigm of system methodologies, see Jackson (2016). Objectives focus on ensuring fairness and empowering the marginalised.
A support to CSP, or alternative operationalisation of CST committed critical systems theory	Breadth and depth in Diagnosing, Analysing and Solving	Here a focus on the level of adherence to the commitments of critical awareness, pluralism and improvement operationalised through a focus on breadth , and depth in order to ensure CST in the SOS.

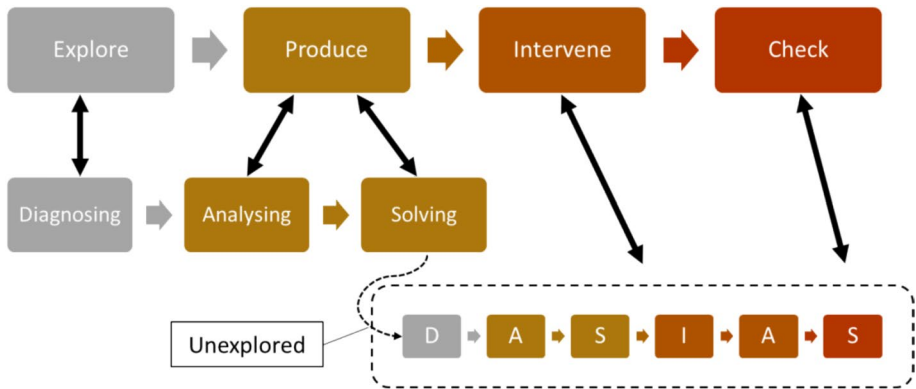


Fig. 12 Illustration of the relation between CSP Explore and Produce and the SOS Diagnosing, Analysing and Solving and the suggested sub-sequent DASIAS improvement process, which yet remains unexplored in relation to the SOS developed in this paper

is also questioned for being too complicated, comprehensive and demanding for some practitioners (Patton 2023). This is acknowledged in the reply from Jackson (2023a) and is to be thought of as an ‘ideal type’ of multimethodological systemic intervention which will require some flexibility and adjustment for each application (Jackson 2022). While practitioners are informed by the paper series on CSP (Jackson 2020, 2021, 2022, 2023b), the summary of guidelines for practitioners in appendix 1 of (Jackson 2023b) is very limited in its tangible advice for practitioners. The suggested activities for conducting a SOS through the steps of Diagnosing, Analysing and Solving could be easier for practitioners who are less familiar with CST and the range of system methodologies available in the literature. In this sense SOS could be a step on the way in the model of learning proposed by Midgely (2001). Due to the challenges of dealing with incommensurable paradigms, psychological resistance to methodological pluralism and cultural norms resisting pluralism, Midgely (2001, p. 253) presents a model of learning which emphasises that “*learning about the existence of different methods, and their possible strengths and weaknesses, need to be an ongoing process: one can start with just a couple of methods and proceed from there*”.

Reviewing the sustainability opportunity study from a CST perspective, it would seem like a method aspiring to be on the same level as critical systems practice doing practically the same thing as the two initial stages explore and produce. Here the initial stage of CSP, Explore, aims to identify primary and secondary issues, which is partly similar to what happens in Diagnosing. Although a focus on deriving measurable indicators for the primary issues is more evident in the SOS. Further, Analysing and Solving of the SOS are similar to the focus on producing and intervention strategy of CSP, i.e. the second stage Produce. See Fig. 12 for comparison. The implementation component of SOS has been suggested to be a reiteration of Diagnosing, Analysing, Solving followed by the stages Implement, Anchor, Study forming a DASIAS improvement process (Isaksson 2015). The match between the SOS and DASIAS study remains unexplored but could be an interesting continuation of this development of the SOS. How DASIAS compares to the EPIC of critical systems thinking could possibly provide new insights contributing to the development of both concepts.

While some suggestions for new activities in the stages of the SOS have been based on the commitments of CST, a full review of how the new SOS relates to the four commitments of CST can indicate further areas of development. See Table 8 for a crosscheck

of the stages Diagnosing, Analysing and Solving against the four commitments of CST, Systems Thinking, Improvement, Pluralism and Critical Awareness. It is apparent that the new SOS aligns with CST in commitments to Systems Thinking and Improvement, but not yet to Pluralism or Critical awareness. Future studies could contribute to the continued development by exploring if and how a problem-structuring method like the new SOS can benefit from operationalising a commitment to pluralism and critical awareness.

There is an interesting point to be made about the relation between the two dynamic capabilities, exploring opportunities and screening for partnerships as described by (Linde et al. 2021), and the main focus of the SOS. The SOS can either be conducted with a pure ‘emancipatory/liberating’ perspective and identify the improvement dimensions in Diagnosing based on the interpretation of what is needed for a sustainable development. The resulting project proposals would then be used to attract potential partners with similar values and willingness to engage for that type of ‘emancipation/liberation’. Or, the Diagnosing in SOS can be conducted after identifying the group of project participants, and let the collective ambitions and agency guide the choices in the opportunity study. This would lead to a set of project proposals that can go directly to the intervention stage since the partnerships are already identified and forged. This analysis of the two ways of conducting the SOS is not yet explored.

The purpose of the network grant was double sided, expecting both an exploration of opportunities and scouting for partnerships, while the espoused purpose of the SOS has remained as focusing on identifying opportunities. The focus of the workshop in the second cycle was mainly evaluated based on perceived learning and relationship building among the participants. The role of, and the interdependence of, the two dynamic sensing capabilities Opportunity Screening and Partnership Scouting, should also be interesting for further investigations.

Preparing for a Successful Workshop

The preparation for workshops on both cycle 1 and 2 were complemented by specific workshop skills and tools beyond the SOS. As a final note on the updated activities suggested for the SOS these workshop planning skills are briefly touched upon. Palm et al. (2024) suggest that the success of any workshop is determined by achieving four key parts:

1. Right mix of participants.
2. Right structure.
3. Right problem-statements.
4. Right facilitation.

The SOS was used to design the right structure in terms of the D-A-S sequence and the activities related to each stage of the SOS. The problem-statements, used as main guidance for the Analysing and Solving workshops during the second cycle, were derived based on the Diagnosing of the case and formulated as:

- Problem-statement for Analysing: “Why is the potential of the Pugu clay reserve not utilised as an alternative binder for concrete applications today?”
- Problem-statement for Solving: “What solutions can you identify as part of realising the potential of Pugu clay as an alternative binder for concrete applications?”

Table 8 Connection between each stage of D-A-S and the four commitments of CST. * indicates a suggested addition to the SOS based on CST in this paper

	Diagnosing (D)	Analysing (A)	Solving (S)
Systems Thinking (ST)	D draws from ST in using processes for making implicit system boundaries.	* A is suggested to draw from ST in checking the challenges that emerges from individual and group brain storming against three systems perspectives, see Table 5.	* S is suggested to draw from ST in reviewing the key challenges that arises and seek for experience and knowledge about any existing system methodology suitable for the type of challenges identified within the group.
Improvement (I)	D has high commitment to I in the sense that it is quantifying (if possible) improvement potential.	A focus on finding causes for I and also quantifying improvement potential if possible.	S focus on finding solutions for I and also quantifying improvement potential if possible.
Pluralism (P)	<i>D does not reflect any commitment to P.</i>	<i>A does not reflect any commitment to P.</i>	<i>S does not reflect any commitment to P.</i>
Critical Awareness (CA)	<i>D does not reflect any commitment to CA.</i>	<i>D does not reflect any commitment to CA.</i>	<i>D does not reflect any commitment to CA.</i>

Further use of the SOS as a method for deriving sustainability opportunities should benefit from considering how to achieve the right mix of participants and right facilitation Palm et al. (2024).

Conclusions

The new SOS constitute a further development from previous publications (Isaksson et al. 2023a), exploring activities beyond the Diagnosing, and suggesting activities for both Analysing and Solving based on experiences from two cycles of implementation. The intervention into the system for providing housing in East Africa with block-based building, has yielded both tangible project proposals and learning and shared understanding among participants. New relations have formed and the network has expanded as results of the conducted workshops and conferences during the intervention. These are all relevant dimensions for evaluating the SOS for potential comparison to alternative support methods for identifying and exploring sustainability opportunities in systems. Further measures of evaluation are suggested to be the level to which marginalised stakeholder needs are considered throughout the stages of the method. Finally, informed by critical systems thinking, the method could be evaluated based on to what extent breadth and depth is ensured in the different stages of the method and throughout the intervention. The summarising overview of the suggested activities for the stages Diagnosing, Analysing and Solving, as well as the suggested measures for evaluating the method is presented in Fig. 13.

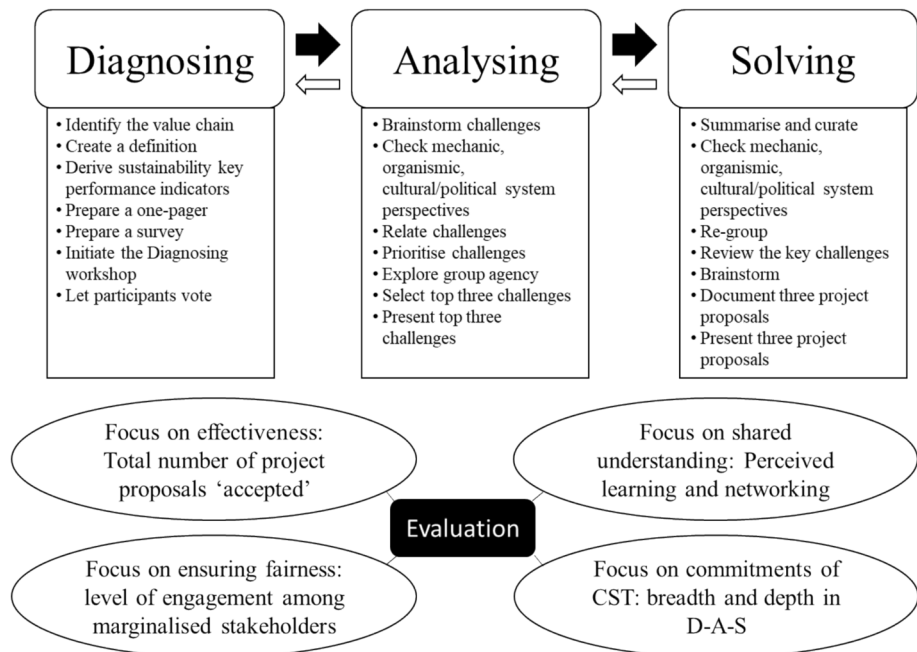


Fig. 13 Overview of the revised Sustainability Opportunity Study, its three stages Diagnosing, Analysing and Solving, each stages' activities and four suggested focuses for evaluating an SOS based on different main purposes

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing Interests The authors declare no competing interests.

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