

# Technological solution for vulnerable communities: Questioning the sustainability of Appropriate Technology

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**Abstract.** Vulnerability eradication has become an emerging concern in today's society following the increasing uncertainties in achieving societal resilience, particularly in vulnerable communities. Furthermore, incorporating technological solutions, especially appropriate technology (AT), into such concern requires interdisciplinary understandings to achieve a holistic eradication based on the particularities of each community. This study aims to briefly reveal existing scholarly discourses and investigate potential gaps between previous research. Literature, particularly consisting of meta-analysis on previous scholarly discussions, are surveyed. The findings reveal three progress among scientific discourses. The first one is the paradigm shift of developmental purposes from typical development to empowerment. Next, concerns in technology development indicate the parallel movement toward empowerment. Then, previous methodological developments, including approaches to sustaining AT, indicate the need to assess the future based on sustainability. Therefore, new research is proposed to develop an assessment framework on AT for vulnerability eradication on the basis of the empowerment paradigm, extended focus on technology development, and extended coverage of future changes in dynamic matter. The framework needs to be developed based on the combination of positivist-deductive-qualitative research paradigms. This intends to generalize the framework for being used in different cases, build an applicative framework as an integral part of the existing body of knowledge, and develop an enriched and flexible construction of the framework. Looking at existing researches, this brief study proposes insights to move scientific progress toward a more holistic vulnerability eradication using AT solutions both on conceptual and practical levels.

## 1. Introduction: Technological changes for vulnerability eradication

The increasing uncertainties in today's complex world have shifted attentions of scholars and practitioners to vulnerability-related issues. While discourses on world's worst problems, i.e. poverty or environmental hazard, focus on the importance of distinguishing between symptoms and root problems in order to do decision making for taking strategic problem solving, vulnerability-related studies propose a more integrated understanding to put any societal attributes as having reciprocal influences each other, creating a holistic understanding in eradicating vulnerabilities. The term vulnerability itself has an interdisciplinary understanding (Cutter *et al.*, 2003; Turner *et al.*, 2003b) due to those reciprocal influences between fundamental factors in an observed societal group. Furthermore, the critical position of vulnerabilities in exposing a societal group to crises has made concerns on vulnerability eradication to target developing communities (Sianipar *et al.*, 2014a; Robards and Alessa, 2004). These kind of communities is recognized as the most critical type of



communities which might fall into crises due to the instability of its fundamental factors of survivability. Vulnerabilities critically embedded in a particular community then makes the community to be stated as a vulnerable one.

On the other hand, implementing vulnerability eradication with an additional attention to the particularities of each vulnerable community requires an interdisciplinary solution. In such understanding, technology has emerged as a strong solution to eradicate vulnerabilities directly from interconnected characteristics of a technology to many facets of daily routines of local people (Turner *et al.*, 2003b; Sianipar *et al.*, 2014a; Garniati *et al.*, 2013). Also, particularities in vulnerability eradication has triggered the further potential of Appropriate Technology (AT) to be a powerful technological solution. AT itself is an approach for providing a technological solution that is founded on the particularities of addressed problems in a specific area. Its strongest power is stated as technological appropriateness, by which the solution is developed based on local problem solving and matched to specific requirements on field since the earliest stage of technological development. In facts, characteristics of every vulnerable community as a fragile societal entity indicate the need of a technological solution which has strong technological appropriateness to precisely address its vulnerabilities (Sianipar *et al.*, 2014a). Furthermore, as vulnerability eradication is considered as a continuous process, there is also a need to apply technological changes. The solution is therefore stated to incorporate technological changes on AT to conduct a sustainable vulnerability eradication. Based on such concerns, recent developments on both technological changes and AT have proposed an important progress toward vulnerability eradication (Sianipar *et al.*, 2014b). In technological changes, recent discourses have begun to propose a more sustainable change based on bottom-up approach. Researchers agreed that technology developments need to incorporate global concerns, yet the actions must be local in order to seamlessly diffuse those concerns into local activities. Those understandings are parallel with the development of thoughts on AT. When concerns should be global yet actions are local (Few, 2003; Leichenko and O'Brien, 2002), AT is the right way to do those combination. Recent developments of AT indicate that its concept has been widely recognized in putting technological appropriateness as an ultimate characteristic of any technologies. The concept of AT is hence diffused also into any effort to produce technological solutions for vulnerability eradication.

However, those scientific progress – the parallel developments of conceptual thoughts, field researches, and technological solutions that contribute to the evolution of vulnerability eradication over time – are rather discrete than unified. Despite their parallel developments, they require new researches to move the progress toward both unified conceptual understandings and practical actions. Vulnerability eradication using AT as the solution, therefore, is first waiting the answers for these following questions:

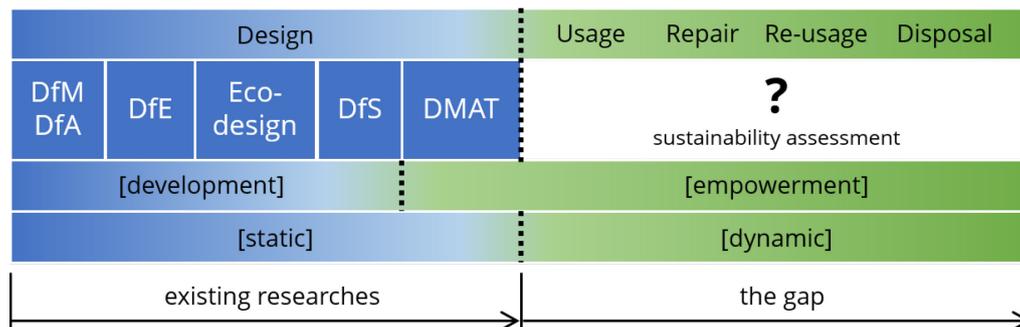
**RQ1** How scientific progress relate each other? What kind of further researches required?

**RQ2** How researchers are advised for conducting the kind of researches revealed from the RQ1?

## **2. Research gap: Dynamic assessment below the radar**

The scholarly discussions on the paradigm shift in the study of technology, particularly technological changes, for vulnerability eradication in vulnerable communities (Sianipar *et al.*, 2014c; Heinen, 1994) have indicated that there is an ongoing progress in scientific communities to put empowerment as the ultimate intention of developmental works (Sianipar *et al.*, 2014c; Narayan, 2005; Alsop *et al.*, 2006) (Figure 1). In such discourse, the intention is to put local people as the subject of development, meaning that they become the main conductor of cyclical developmental progress in their own future. The vulnerability eradication is hence taken as a sustainable process which covers future decisions related to changes on vulnerabilities as the root problem and changes on applied solutions taken in the eradication. Furthermore, when technology, particularly AT, is taken as the solution in vulnerability eradication, the shift of paradigms also affects the focus of technology development (Sianipar *et al.*, 2014b; Sianipar *et al.*, 2014c) (Figure 1). In the typical development paradigm, technology development is only focused on two matters: how a technology is designed by foreign partner(s) and is introduced to general vulnerable communities. Indeed, technology is seen as merely a product of

design process behind-a-closed-door that would be taken as a solution for vulnerability eradication by local people in their local activities. On the other hand, the shift to empowerment paradigm requires an extended focus of technology development (Sianipar *et al.*, 2013a) to cover more applicative activities such as the usage, local repair, re-usage, and local disposal of an AT. Those four activities are the minimum requirements of observation in understanding the sustainability of a technological solution. Besides, some other particular process, *e.g.* material degradation, trial & error, *etc.*, are possible to be incorporated if necessary. By covering a wider observation, analysis on the sustainable technological appropriateness and predicted changes on vulnerabilities could be conducted through an explicative and more holistic investigation.



**Figure 1.** The research gap: Dynamic assessment.

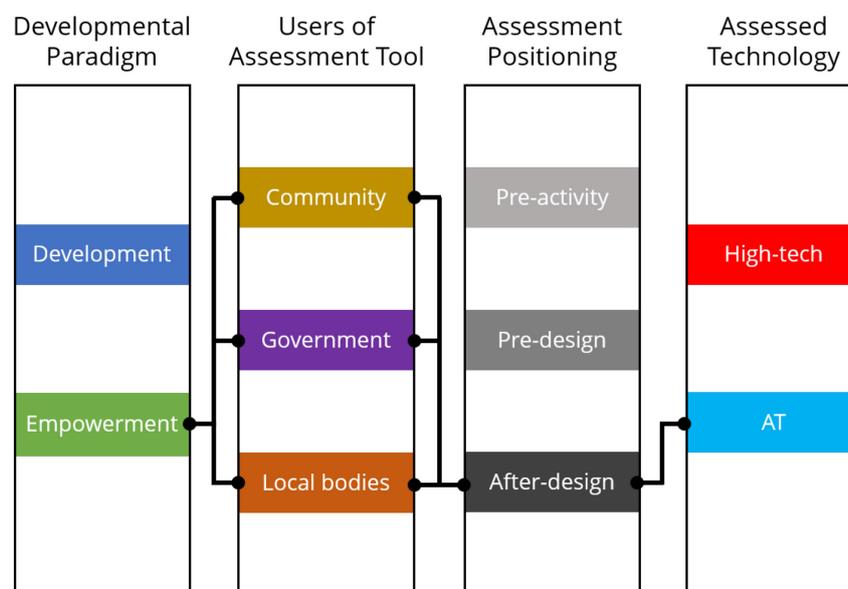
While the shift of paradigms is widely discussed in terms of purely conceptual understandings, scientific progress on methodological development (Sianipar *et al.*, 2014b) is also increasingly interesting for scholarly communities. However, the shift is not devoted to completely replace previous methodologies with a new one. In other words, applied paradigms in different methodologies are rather incremental than absolute, meaning that many newly developed methodologies are intentionally purposed to cover more specific area to refine the coverages, qualities, and characteristics of previous ones. Based on the spirit to refine the coverage of previous “Design for X” methodologies, Eco-design and DfS (Fiksel, 1996; Clark *et al.*, 2009) have initiated a shift towards empowerment-based ones. Despite the critical focus of Eco-design and DfS on environmental issues, there are big parts of their approaches still stand on typical development paradigm (Sianipar *et al.*, 2014c). After that, DMAT emerges to clearly bring technology development into a more empowerment-based one (Sianipar *et al.*, 2013b). The purposeful methodology is stated as an important breakthrough to put local people as the subject of development. Therefore, the DMAT could be distinguished to previous methodologies as it stands on empowerment paradigm (Figure 1). However, either DMAT or DfS and previous ones are strongly focused on design process (Sianipar *et al.*, 2014b). In spite of the improved coverage of DfS and DMAT to consider future changes of technology usage and affected prosperity of its users, their focuses are intentionally directed on the design process. Other applicative process are hence posited as additional considerations, yet the investigation takes static calculation on present situations to predict the future.

On the other hand, investigating extended focuses of technology development for vulnerability eradication, including the shift from typical development to empowerment, also requires an extended analysis that covers many possible changes in the future. While present situation changes in the future, addressed vulnerabilities and applied solutions would also change to be in conformity with required actions in each circumstance (Turner *et al.*, 2003b; Sianipar *et al.*, 2014a; Turner *et al.*, 2003a; Richmond, 1993; Bagheri and Hjorth, 2007; Hjorth and Bagheri, 2006). Indeed, those changes may happen as several dynamic possibilities depend on some possible scenarios. In fact, those possibilities are parallel to the understanding of shift toward empowerment-based analysis. Scientific progress on pure conceptual discourses and refined focuses on methodological development indicate that the development of a technological solution for vulnerability eradication in a particular vulnerable community ultimately requires dynamic assessment on some possible scenarios which incorporate

alternative solutions possibly happen or taken in the future (Figure 1). In such understanding, the sustainability of both technological solution, particularly AT, and vulnerability eradication determines the resilience of a particular community. In other words, the sustainability of solution and process produces the survivability of targeted societal group. Looking at the existing scientific developments (Figure 1), there is a lack of research on the dynamic analysis to assess the sustainability of AT and affected prosperities of local people. Therefore, research is required to develop a new assessment framework/tool for conducting dynamic investigation on alternative technological solutions, particularly AT, as a means to understand the dynamic behavior of the solutions in a sustainable manner. The research needs to cover both required focuses based on both development and empowerment with more focus on the later paradigm. Then, the product of the research should be in line with the ongoing scientific progress, meaning that the new dynamic assessment would become an integral part of the existing body of knowledge of technological solution for vulnerability eradication in vulnerable communities.

### 3. Research scopes and positioning

Based on the research gap, including required research to fill in the gap, there are several scopes which need to be taken as the guidance of analysis. An adequate research scope means that the required research would consist of enriched contents without ignoring the appropriateness of covered boundary. Looking at previous discussions, there are four groups of optional coverages (Figure 2). The incorporated coverages are then selected among options in each of those groups to indicate the research positioning among available combination of coverages. The first group is the developmental paradigm, consisting aforementioned typical development and empowerment ones. As previously discussed, the selected paradigm is empowerment. In spite of possible coverage on some characteristics of typical development, empowerment paradigm is intentionally selected as the basis of the new dynamic assessment framework to be parallel with recent scientific progress. The purpose is also affected by the concern of putting local people as the subject of development, creating a more survivable societal group with a good resilience.



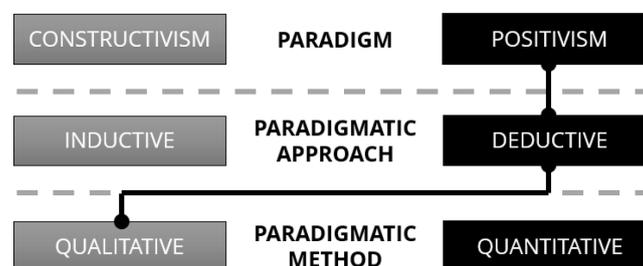
**Figure 2.** Research scope & positioning.

Next, the second group is three possible users of the new assessment framework/tool, namely Community, Government, and Local bodies. Considering the usefulness of a dynamic assessment, those three options are selected. For Community, a dynamic assessment means their capability to understand the effects of any proposed ATs on their future prosperity. For Government, assessing

alternative technologies through a dynamic analysis is critical to ensure a continuous vulnerability eradication in their jurisdiction. Then, local bodies such as NGOs or association could take the advantage to offer a more holistic assistance for local people. After that, regarding the positioning of assessment process itself (Figure 2), the option pre-activity means the assessment is taken before the decision of using technology as the solution for eradicating vulnerability. The second option, pre-design, refers to the decision taken to choose existing alternative technologies as the basis of design. Then after design is taken in deciding which AT would be applied among some alternatives. By considering the research gap and the intention of dynamic analysis, assessment is only posited to cover after-design, meaning that dynamic assessment is taken on some alternative technologies that have been designed in order to choose the best design for being applied further. Moreover, the last group indicates the type of technology covered in the research (Figure 2). The framework/tool is intentionally purposed to assess AT as the technological solution, hence high-tech is not covered by the research.

#### 4. Research paradigms

Besides the scope and positioning, a research requires a set of beliefs and assumptions taken as the base reference in conducting step-by-step research activities (Guba and Lincoln, 2005; Morgan, 1983). To distinguish applied paradigm(s) taken in current research (Figure 3) with applicable paradigm(s) of research product (Figure 1), existing research paradigms are categorized into three kinds, namely paradigm itself, paradigmatic approach, and paradigmatic method (Haase and Myers, 1988; Neuman, 2006). Roughly-speaking, research paradigm indicates the standpoint of current research in developing the dynamic assessment framework/tool (research product), while paradigm of research product refers to the standpoint taken as the basis of incorporated understandings in the framework (Sianipar *et al.*, 2014c). For each paradigm category, there are two options to simplify many available options throughout scholarly literatures. The understanding hence requires non-dichotomy which refers to approximate meanings of each option. In other words, both options are legitimate and valuable in conducting any research.



**Figure 3.** Paradigms, paradigmatic approach, & paradigmatic method.

In the first category (paradigm), two options are available, namely constructivism and positivism (Guba and Lincoln, 2005; Jaccard and Jacoby, 2010; Krauss, 2005). Considering the purpose of assessment development to produce distinguishable scientific contribution to existing body of knowledge, positivism is selected (Schrag, 1992). Thus scientific discovery could be maintained on a single cycle of research with a focus on the top-down side of research wheel (Neuman, 2006). Also, the development of assessment framework is posited in a controlled reality to avoid bias perception if constructivism is taken (Neuman, 2006; Mills *et al.*, 2006). In the paradigmatic approach category, deductive approach follows positivism to strengthen the top-down development of assessment framework (Neuman, 2006). However, this needs to be distinguished with the application of assessment framework as a more bottom-up usage based on empowerment paradigm. In terms of deductive approach, assessment framework is constructed based on analysis on scholarly literatures in order to establish an applicative ones based on existing discourses (Jaccard and Jacoby, 2010). The inductive paradigmatic approach is not selected to avoid an infinite cyclical development process of the framework, including some possible particularities as the strengths of inductive approach which

may prevent the framework to be a generalized model (Neuman, 2006; Jaccard and Jacoby, 2010). Then, the research is intended to be a more qualitative one, meaning that analysis on existing literatures, including any types of analysis taken as the process guidance, is conducted based on qualitative method. The quantitative method is not selected to avoid tricky analysis that is possible to bring a prolonged development process within research timeframe (Neuman, 2006; Jaccard and Jacoby, 2010). However, dynamic assessment as the research product is intended to be a quantitative framework.

## 5. Conclusions

Vulnerability eradication using AT as an interdisciplinary technological solution requires a unified understanding of those idea. Among related concepts, there is a parallel scientific progress towards a holistic approach in conducting the eradication. The main conjunction is the shift from typical development paradigm to empowerment. It is the driving force behind other developments in scholarly discourses. In short, there is a need to develop a new dynamic assessment framework for deciding the most appropriate technology for vulnerability eradication. The dynamic assessment would extend the focuses of both technology and methodological developments to cover more empowerment-based understandings. Furthermore, a combination of positivist-deductive-qualitative research paradigms in the development of the proposed framework is advised in order to: develop an enriched yet flexible construct of the framework; produce a generalized framework that is possible to be used in different cases; build the framework as an integral part of existing scientific progress. Moreover, every explanation in this brief study is critical to be posited as the basis of any future researches related to the methodological development for vulnerability eradication in order to push scientific progress towards an incremental and integrated development of both conceptual understandings and practical actions.

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