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Systemic Approaches and Technological Fixes

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Abstract: The main contribution of the paper is a categorisation of different types of solutions for (complex) problems based on the difference between fixes and systemic approaches. Unlike other approaches, the salient factor is not whether an approach is based on technology, but whether it only includes one component of the problem or takes a holistic approach which considers the context, all components of the problem and the relationships between them. This categorisation has been illustrated by examples of genetically modified rice, the Zimbabwe bush pump, screen readers for print disabled people and socially assistive robots and assistants for older people. Discussion of the examples has been used to give greater understanding of the factors which have led to a focus on technological fixes.

Keywords: fix, systemic solution, technological fix, holistic, examples, categorisation.

1. Introduction

Despite the generally derisive use of the term, the dominant trend in the minority world ('developed') countries is a preference for technological fixes (Scott, 2011). Definitions include reframing a fundamentally social problem as a technological one; only considering technological factors and solutions (Weinberg, 1967); and attempting to solve social or human problems using technological devices or systems without resolving the underlying social or human problem(s) (Douthwaite, 1983). The technological fix approach is instrumental and rarely considers the underlying causes of the problem (Drengson, 1984), frequently resulting in unforeseen consequences (Scott, 2011). Despite recognition that the distinction between technological and social problems is not clear cut (Volti, 1995) and that problems are generally multi-causal (Scott, 2011), discussion of the limitations of technological fixes has rarely concluded with the need for holistic or systemic solutions.

Holism from the Greek holos, whole or entire was first used by Smuts (1961) to denote 'the whole-making, holistic tendency ... seen at all stages of existence'. The parts of 'wholes' are interdependent and interacting and can only be understood in relationship to the whole and not on their own. Thus, the whole is 'more than the sum of its parts' (Sengupta, 2011). Holism has led to systems theory and thinking and chaos and complexity theories (Anon, 2015a). It is often counterposed to reductionism which involves decomposing complex systems into their parts and determining the behaviour of the whole from that of the parts without considering any interactions or interdependencies (Østreng, 2006). A system consists of components, their attributes and relationships between the components and attributes, with these relationships determining system behaviour. The same principles can be used across different types of systems and fields (O'Connor and McDermott, 1997). Systems have emergent, possibly unexpected, properties which emerge from the interaction of the different components of the whole system (Checkland and Scholes, 1999; Hersh, 2006). Systems approaches provide tools for structuring complex situations and making tradeoffs between the complex interacting factors and interests without losing a sense of the whole (Hersh, 2006).

2. Categorisation of Different Types of Solution

The model is presented in figure 1 and illustrated by four examples in Section 3. The difference between systemic solutions and fixes is the basis of the classification. The definition of fix used here is a short term and partial solution which focuses on a particular aspect of a problem and ignores the underlying causes, other aspects of the problem and the relationships between them, and the potential medium and long term consequences. A systemic solution involves a holistic approach which considers all aspects and dimensions of a problem, the context, the underlying causes the relationships between them and both long and short term consequences. The model is based on systemic rather than (other) holistic approaches, as systems are fairly well known and accepted in science and engineering, a variety of methods have been developed for analysing them and their use is compatible with many other analysis techniques.

The model has the following three main components: (i) systemic approaches; (ii) fixes; and (iii) intermediate solutions. Systemic approaches can be further divided into global, local and partial. Global systemic approaches consider all the factors of a problem and the relationships between them in its global context, whereas local solutions consider all factors and relationships in a local context. In practice, global solutions may require such sweeping changes that they encounter barriers to implementation. While the focus in the literature has been on technological fixes, other types of fixes are possible. This gives the

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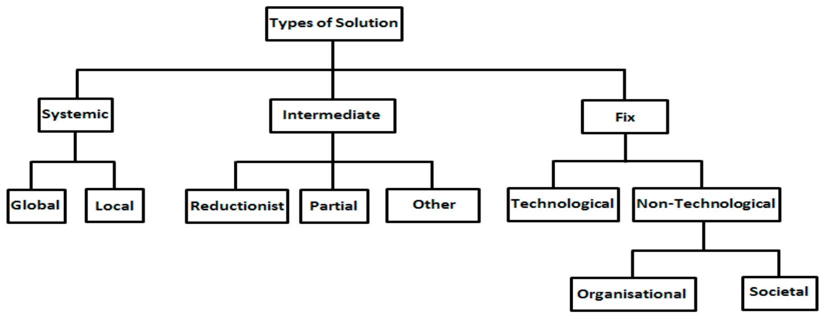

Figure 1, Categorisation of different approaches to solving complex problems

division of the fix category into technological and non-technological fixes. At the next level, the non-technological, but not the technological, fixes are divided into organisational and societal fixes. The third category of intermediate solutions has been included to cover types of approaches which are neither systemic or fixes. It has been divided into reductionist, partial and other solutions, but further work on this category is required. Many different technologies and analytical tools can be used with all the approaches in the model, though some of them will be better suited to certain types of approaches than others.

3. Examples

3.1 Genetically modified rice with beta-carotene

Genetically modified (GM) rice containing beta-carotene, so-called 'golden rice', has been proposed as a solution for vitamin A deficiency. This is a serious problem in the poorer countries and to some extent in low income groups in the richer ones and has a particular impact on children. It is responsible for an estimated 13.8 million children having some degree of vision impairment (Rahi et al., 1995) and a quarter to half a million children in majority world countries becoming blind each year, with half of them dying within a year of becoming blind (Anon, 2015b), for instance due to increased susceptibility to infections. Treatment involves the provision of vitamin A supplements, adding vitamin A to food, and eating a more diverse diet. A diverse diet is the best option, since it improves all round nutrition (Stein et al., 2006). The Vitamin Angels programme (http://www.vitaminangels.org/programs/international) of giving children of six to 59 months of age one or two high vitamin A doses a year is sufficient to prevent blindness and deficiency related life-threatening diseases in the period of greatest vulnerability.

Polished rice does not contain beta-carotene, which is converted in the body to vitamin A (retinol) and whole grain rice only has minute amounts. Research on GM rice with beta-carotene started in the 1990s. The current strain of GM rice has up to 35 µg of beta-carotene per gram of rice (Tang et al., 2009). While studies (Tang et al., 2009, 2012) show good conversion of beta-carotene in GM rice to retinol, they have small sample sizes, use well-nourished participants not the malnourished people this rice is targeted at, and the rice is consumed in oil, which facilitates take-up by the body and is probably not available in significant quantities to target users. Calculations indicate that three and a third 30 gram servings would provide only 4.4% of the recommended daily amount and there are many other much richer sources of vitamin A commonly used in Indian foods (Shiva, 2001).

Despite claims that GM crops are required to feed the increasing world population, per capita increases in food supplies over the last 40 years have been much greater than the increase in world population, giving an average of just under two kilograms of varied food per person per day, more than sufficient for a healthy active life (Rosset, 2005). In addition, overproduction has reduced crop prices and consequently the viability of small-scale farming, thereby increasing unemployment and poverty (McMichael, 2005). GM rice is clearly a technological fix. It ignores the possibility or even likelihood of low take up by farmers, due to concerns about being unable to sell rice in European markets (where there is currently a moratorium on GM products), contamination of other crops, lack of acceptability to the local population and providing insufficient vitamin A, particularly when consumed with only minimal amounts of oil.

Monocultures such as GM rice lead to a reduction in biodiversity and associate threats to food supplies. One example is the potato famine in Ireland that led to about a million deaths, an eighth of the population, in the mid-nineteenth century (Scholthof, 2007). Monoculture also generally leads to a decline in soil fertility and an increase in pests and diseases and has contributed to a decline in food quality (Igobozurike, 1971). It is also one of the factors responsible for vitamin A deficiency (Shiva, 2001). Any toxins or unforeseen health effects associated with GM rice will be increased due to the high concentration of rice in the diet. There may also be impacts on women and gender roles in majority world countries, where women have been the biodiversity experts and keepers of seeds and the knowledge of plants and their uses (Shiva, 2001). Although Monsanto, Novartis and Astra-Zeneca are providing royalty-free licenses, they are not giving up their patents and could therefore claim royalties in the future (Shiva, 2001).

Local systemic solutions would involve providing micro-credits to local small farmers, including women farmers, to