Development of a Knowledge Base for Social Experimentation

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Abstract: Social experimentation could be useful for testing the feasibility and effectiveness of technologies and policies in achieving more sustainable social systems. However, classical social experiments are costly and can only be applied in a limited range of situations due to the requirement for randomized assignment of subjects to experimental and control groups. Here, we reconsider the role of social experimentation within the framework of the feasibility of technology and policy interventions for creating societies that are more sustainable, particularly in regard to mitigation of CO_2 emissions and aging populations. From a review of more than 100 social experiments from the literature, we develop a knowledge schema and knowledge base system for structuring and managing the valuable knowledge that has been produced under the scientific theme of social experimentation. The knowledge base contains classical randomized social experiments, but it also includes studies that are less rigorous from the point of view of random assignment.

1 INTRODUCTION

Meeting future global challenges requires coordinated efforts of a wide range of knowledge experts and social actors to establish new technology and policy interventions that enable societies to mitigate and/or adapt (Takeuchi and Komiyama 2006). Interventions having the greatest potential for increasing the sustainability of a region must be identified and decision-makers informed as to how to get those interventions accepted by society. Scientific evidence regarding the feasibility and effectiveness of different interventions must be managed effectively. We consider the feasibility of technology or policy interventions at four levels: theoretical, technological, economic, and social.

Economic feasibility concerns "external" barriers to technology adoption such as legal mechanisms, support infrastructure and supply channels. Social feasibility addresses "internal" barriers (McKenzie-Mohr 1996). Even if all of the external barriers are overcome, barriers associated with consumer values and perceptions, information transparency, and the agenda of major stakeholders can still prevent successful introduction. Furthermore, although external barriers can usually be addressed by models which assume that all participants will act rationally, internal barriers often involve irrational aspects of

human behaviour and decision-making. While internal barriers can be externalized, for example by offering economic subsidies, often an internal barrier can defeat externally driven attempts to get the technology adopted (McKenzie-Mohr 1996).

Of the four levels of feasibility, social feasibility usually has the highest dependency on context. Measures to overcome internal social barriers require changes in the attitudes and behaviours of local stakeholders, which can differ greatly in different contextual settings. Technologies for sustainable societies are particularly sensitive to context because of the large number and diversity of stakeholders (McKenzie-Mohr 1996). Due to this contextual dependency, even if an intervention is demonstrated to be effective in one context, additional social feasibility studies will often be necessary when considering it for another context.

Social experimentation, which was developed as a technique for providing information that helps policy makers make decisions about public policy (Orr 1998), is a powerful tool for assessing the social feasibility of a proposed intervention. Social experiments are used to 1) "influence specific policy decisions or address unresolved scientific or intellectual issues;" 2) "influence core policy decisions or general intellectual orientations;" 3) "influence relatively narrow elements of policy and

its implementation" 4) offer pre- and post- decision support (Greenberg and Shroder 1997).

In classical social experimentation, "selection bias" is avoided by random assignment of people from a target population to two groups: an experimental group to which the intervention is applied, and a control group which experiences conditions identical to the experimental group except for the intervention. This is the only way to guarantee that there is no systematic difference between those participants who are subjected to the intervention and those who are not (Orr 1998).

However, randomized social experiments are costly and difficult. As policy makers face the need to rapidly make decisions about social interventions, "social experimentation" has come to be understood to mean "'trying out' a new program on a small scale, to see if it 'works'", e.g. in the form of a pilot demonstration (Orr 1998). Although the scientific validity of such non-randomized studies may be suspect, given that the role of social experimentation is to provide policy makers with information on upon which to base public policy, it is worthwhile to re-examine the conditions under which a study could be considered to be a "social experiment".

A major concern in Japanese public policy is how to design societies with low carbon emissions that still support "successful aging" of Japan's rapidly aging society (Platinum Concept Network 2012; Bright Low Carbon Society 2012). Japanese policy makers could benefit from social experiments that provide useful knowledge on the effectiveness and costs of different interventions for removing internal barriers to technologies and policies aimed at improving the health and quality of life for elderly people while simultaneously reducing energy consumption or switching to low carbon energy in a target urban region or for a target population.

The expected value of a social experiment is the value of a change in policy times the probability of that change occurring as a result of the experiment minus the experiment cost (Orr 1998). Because the realization of a policy change depends on many complex factors, the use of random sampling to eliminate selection bias may be less important than other factors in whether or not a social experiment will influence public policy. Orr (1998) notes that "even if one cannot confidently assert that the treatment-control service differential represents the service increment that would result from adoption of the program, the impact estimates based on that differential may still…provide valid estimates of the effects of a wellspecified policy change."

Here, we have reviewed over 100 studies of social interventions in the areas of aging populations, energy consumption and environmental behaviour that fit the following minimum specification: "*some experience-based knowledge about the effect of some technology and/or policy combination on changing some aspect (e.g. population behaviour) of a target region so as to improve some combination of the targeted conditions.*"

2 SCHEMA DEVELOPMENT

The studies that we examined reveal a tension between traditional social scientists interested in developing a statistically rigorous body of knowledge on factors controlling human behaviour and more problem-driven studies such as action research. We observed a tradeoff between several dimensions of experiment design, listed below.

- representativeness of sample population
- adequate sample size for statistical validity
- adequate temporal length / followup studies,
- controlling for confounding factors
- use of well-established, quantitative measures
- useful and relevant intervention designs
- provenance issues, replicability

To examine the variation of the studies in more detail, we developed a schema for social experiments based earlier reviews (Greenberg and Shroder 1997, Abrahamse et al 2005, Cattan et al. 2005, Dwyer et al. 1993, Hogan et al. 2002). The following questions motivated schema development:

- What is the proposed intervention?
- Who (and where) does the intervention target?
- What change (e.g. in behaviour) is intended?
- Who are the major social actors involved?
- What does the intervention cost to implement?
- Who/what was actually studied?
- What are the main results and future topics?
- Are there reusable project deliverables?

For each study, we created entries for the fields in the schema that were applicable to that study. The complete schema with totals for how many studies had entries for each field is shown in Table 1.

The reasoning capability of the knowledge base is realized by grounding the entries for each field in the schema to a "heavy weight" ontology based on description logics that supports semantic reasoning based on logical inference (Guo and Kraines 2008).

Table 1: The proposed schema and its usage in the knowledge base for social experimentation.

Target Population: the population that the intervention is intended to target
  demographics (147); location (124); recruitment method (87);
  living condition (57), job type (24); education Level (21); disabilities (28)
Study Goal: major search condition
  hypothesis (81); outcomes of interest (193); targeted behaviour (135); problem addressed (86)
Intervention: major search result
  cost of economic interventions (32); tech type used (105); group/individual (134);
  number and duration of sessions (62); issues (54); theoretical basis (87)
Study Setting: of the actual social experiment or study
  duration (111); start & end dates (101); researchers (232); study location (170);
  study cost (8); funding source (91); study resources (16)
Study Groups: type of participants (115); group sizes (113); control? (132); random assignment?(109);
  specific activities (126); intervention types (140)
Measurements: assessment method (67); timing (27); scales/instruments used (51); follow-up (78)
Results: summary of effect (116); time trends (34); quantitative measurements (38);statistical significance (47);
  generalizability (64); replicability (52); limitations (40); design issues (36)
Deliverables: databases, techs, software (1, 15, 10); Future topics (45)

Figure 1: Semantic graph representation of the intervention details for the social experiment "Social Activation of the Elderly: a Social Experiment" by Arnetz et al. 1982.

Figure 2: Natural language generation results in English for the semantic graph in figure 1.

We extract noun and verb phrases from each of the field entries, and then we normalize the terms to classes from the SCINTENG ontology (Kraines and Guo 2011) augmented with the terminology from the WHO international classification of functioning, disability and health. Term normalization was done by mapping the ontology to WordNet via the SUMO ontology. Finally, we generate semantic graphs representing the knowledge in the schema fields in a form that can be "understood" by a computer. The graph generated for the intervention details of an entry in the knowledge base is shown in figure 1.

 We consider three kinds of users for the knowledge base. People studying the effectiveness of interventions in meeting some societal need can examine previous social experiments studying similar interventions and/or similar societal needs could produce valuable hints. Local governments can find informat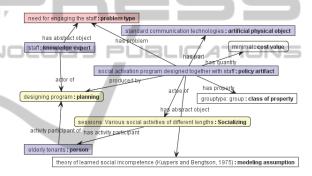ion on interventions to help address problems in the governed region from social experiments used in similar locations. Funding programs and national policy development can use the structured knowledge base as a map of the existing scientific knowledge for achieving a sustainable society, e.g. to identify "knowledge gaps" requiring more research support. The knowledge base could also guide a process for building and reviewing empirical evidence for a particular intervention, e.g. prior to providing "social venture capital" or a regional contract by a local government (see for example Orr 1998 Part 7).

 Consider the following use scenario. A researcher wants to study an intervention that is produced in part by the people who are the targets of the intervention. This search condition could be described using the following SPARQL query:

```
select distinct ?s1 where {
    ?s1 a <#policy_artifact> ?s2 a <#person> .
    ?s3 a <#human_activity> ?s4 a <#planning> .
    ?s1 <#related_to> ?s3 .
    ?s3 <#has_participant> ?s2 .
    ?s4 <#has_participant> ?s2 .
    ?s4 <#produces> ?s1
}
```

A description logics reasoner could then determine that this query matches the semantic graph shown in figure 1 because "Socializing" is described in the ontology to be a subclass of "human activity".

Consider adding a query constraint specifying that the persons involved in both the planning *and* the activities of the intervention were the focus of the problem type addressed by the intervention. Although the problem type "need for engaging the staff" exists in the graph, it applies to persons involved in the planning of the intervention but not in the activities of the intervention. Thus, the query would no longer match with the semantic graph.

3 FUTURE DIRECTIONS

Future work on this knowledge base will focus on developing effective applications in areas that are most likely to be beneficial to the envisaged users. Natural language generation can be used to generate accurate representations of the semantic graphs in any language that is handled by the generator, as shown in figure 2. Knowledge mining techniques can be used to extract common semantic motifs from the knowledge base on what kinds of interventions are most effective in what kinds of social contexts.

Obtaining feedback from potential users of the knowledge base will be critical in guiding the development of these applications. For this purpose, we hope to establish a "community of practice" through the Platinum Concept Network in Japan and other entities around the world, such as the United Nations HABITAT program (www.unhabitat.org).

Feedback from these test users will also help to identify what modifications to the knowledge base schema are needed. Under the theme of "social entrepreneurship", a new class of NPOs is emerging that shares some of the flexibility for experimental trial-and-error provided by venture capitalists (Tanimoto 2008). These NPOs may be valuable sources for knowledge on what works in addressing specific social issues in specific social contexts.

System development is focused in the human-computer interface. We are testing different methods for accessing the knowledge base, one of which is based on semantic similarity calculated between cities using semantic attributes from DBpedia (Guo and Kraines 2010). We are also using knowledge mining and natural language processing techniques to further assist researchers and social entrepreneurs to create semantic graphs that accurately express the knowledge that they want to share.

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