# Supporting Social Innovation: Application of InDeate Tool for Sustainable Service Design—Case Study of Community Workshops

**Suman Devadula, Kiran Ghadge, Saritha Vishwanathan, Shuk Han Chan, Quinn Langfitt, David Dornfeld, Anil Gupta, Sudarshan Rachuri, Gaurav Ameta and Amaresh Chakrabarti**

**Abstract** Designing systems for sustainability involves satisfying diverse requirements spanning not just of the object of design but also of the designer, the context in which design happens and the design process. Taking an engineering design approach emphasizes the object of design as well as the process, albeit neglecting the designer and the context in which design happens. Taking a Gandhian approach to design necessarily emphasizes the designer and the context in which design happens, while the object of design could take a backstage. In this regard, this article applies the InDeate tool, developed to balance design approaches, for innovating a 'service design' for the community workshops of National Innovation Foundation (NIF). NIF is involved in supporting grassroots innovators and leverage their innovation for social and hence national benefit. On observing two comparable student groups conceptualizing for 'service design' with and without using the InDeate tool, as the variety of conceptual propositions is higher with the group using the tool, it is proposed that the tool could be a candidate for supporting design for social innovation.

**Keywords** Grassroots innovation · Service design · Social innovation · Lifecycle design · Design for sustainability

S. Devadula (✉) · K. Ghadge · A. Chakrabarti
Indian Institute of Science, Bangalore, India
e-mail: devadula@cpdm.iisc.ernet.in; devadulas@gmail.com

S. Vishwanathan · A. Gupta
Indian Institute of Management, Ahmedabad, India

S.H. Chan · D. Dornfeld
University of California, Berkeley, USA

Q. Langfitt · G. Ameta
Washington State University, Pullman, USA

S. Rachuri
Department of Energy, Washington, USA



A. Chakrabarti and D. Chakrabarti (eds.), *Research into Design for Communities, Volume 2*, Smart Innovation, Systems and Technologies 66,
DOI 10.1007/978-981-10-3521-0_12

# 1 Introduction

Design for Sustainability is arguably the grandest in the series of DfXs. The profile of requirements that need to be met cannot probably get wider than those necessary for sustaining human development. At the core of the concepts of sustainability, design, and hence, design for sustainability, lies a human-centric approach. Consequently, the importance for human development and designing for human development is foremost. As stated in the path-breaking World Commission on Environment and Development (WCED) report, "the limitations that prevailing social organizations impose on environmental resources can potentially impede the process of sustaining human development" [1]. This calls for innovating new forms of social organization that foster sustainability. As the iterative and empathetic nature of human-centric design process makes design central to innovation, it is appropriate to innovate social organizations by design. Efforts such as this could be categorized as social innovations. The Stanford Graduate School of business defines social innovation as, "…a novel solution to a social problem that is more effective, efficient, sustainable, or just than current solutions. The value created accrues primarily to society rather than to private individuals." One such example is the National Innovation Foundation's (NIF) endeavor to leverage creativity at the grassroots manifested in innovations that people without formal education come-up with ingeniously within available resources for the immediate benefit of the local community. NIF considers innovation central to driving national growth, and leveraging grassroots creativity assumes significance although its implementation faces challenges. As a methodical experiment that could potentially inform systematic support of social innovation, this research article reports the observations of using the InDeate tool for designing the services through the community workshops of NIF better. Due to its benefits to the immediate community, and the nation at large, this service design can be a social innovation.

The InDeate tool is a computer-based platform called InDeaTe—Innovation Design Database and Template, a tool for supporting the design-led innovation process, with two modules: a design process template, and a linked database with sustainability definitions, indicators, design methods and tools, for supporting designing of sustainable systems [2]. InDeaTe tool is a knowledge-driven sustainable design process support. It is meant to be a comprehensive yet generic tool to support innovation across domains of product, manufacturing and service systems. This research article reports the observations from applying the tool to innovate service design for NIF in the series of articles related to innovating for product, manufacturing and service systems. The tool is envisioned to be a web-based, user-friendly, open-source support, with a growing repository of information in its Database that can be used alongside the encompassing design process template.

With the objective of making India a leader in sustainable technologies and building a national register for grassroots innovations and outstanding traditional knowledge, NIF [3] works with the informal sector covering the entire gamut of

activities from scouting and documentation of grassroots innovations and traditional knowledge, to their value addition, intellectual property protection, business development, social diffusion and commercialization. NIF is unique in supporting common people without formal education beyond secondary schooling and professional training who nevertheless could fathom technological solutions and implement them to avert problems in some measure without any external help. NIF has been able to build up a database of over 2,10,000 ideas, innovations and traditional knowledge practices (not all unique) from over 575 districts of India. NIF has filed over 725 patents (including 8 filed in the USA) in the name of the innovators and outstanding traditional knowledge holders of which 35 patents have been granted in India and 5 in the USA.

## 2 Problem Brief: Case Study of NIF Community Workshops

Most of the scouted grassroots innovations are at the level of rudimentary proof of concept, and the rate at which they are being converted to marketable products does not meet the demand for such products. In-order to increase this conversion rate, NIF is in the process of setting-up 37 community workshops (CW) located all over India with seasoned grassroots innovators who have distinguished themselves in their communities to be innovative problem solvers. The thinking behind having these CW is to facilitate innovators with decentralized manufacturing and scale-up of their grassroots innovations while also potentially familiarizing and inspiring local populations about technical problem solving and prototyping activities. It is hoped that through these CW more rural innovators would emerge to be ingenious in solve more local problems. These then could be taken up for refinement into making marketable products and scale-up, thereby contributing to national leadership in sustainable technologies. However, the adoption of the CW as a service design problem has not been thought out in detail, due to which their acceptability, use and potential impact thereby are hazy. As NIF perceives a national need for bold initiatives and new models for harnessing the creative potential of the society based on compassionate, caring, and sustainable models of development, the particular problem for this research article is to improve the service delivery through the CW by appropriate service design.

## 3 Design Exercise

Students distributed in two teams, who have not worked with NIF earlier either on the problem of service design for CW or anything else supplied by NIF, were tasked with suggesting improvements to the services at the CW.

## 3.1 Exercise Summary

The design exercise was conducted for approximately 16 h in June 2015 at Centre for Product Design and Manufacturing (CPDM), Indian Institute of Science (IISc), Bangalore, India, involved the following steps, two steps each per day with intermittent breaks:

- Introduction to the service design problem by an NIF representative
- Design exercise, conducted in two sessions per day, each with a distinct Student Design team as described below.
  **Team 1: With InDeate Tool**
  - A Ph.D. Student from IISc, working on Design for Sustainability, with background in Mechanical Engineering and Product Design;
  - A Ph.D. Student from UC Berkeley, working on Hydrogen fuel cells, with background in Mechanical Engineering;
  - A B.Tech student in Production Engineering from IIT Roorkee, India.
    **Team 2: Without InDeate Tool** ('tool' hereon, unless specified otherwise)
  - A Ph.D. Student from IISc, working in the area of Network-enabled Manufacturing, with background in Mechanical and Biomedical Engineering;
  - A Ph.D. Student from IIM Ahmedabad, working in the area of Water-Energy nexus for sustainability, with background in Environmental Engineering;
  - A Ph.D. Student from WSU, USA working in the research area of Life Cycle Assessment (LCA), with background in Mechanical Engineering;
  - A B.Tech student in Mechanical Engineering from IIT Ropar, India.
- Presentation of design outcomes to and feedback from NIF representative
- Assessment of improvement in service design (sustainability of it) with/without InDeate Tool.

## 3.2 Solution of Team 2 (Without Tool)

Team 2 started with the triple bottom line and identified design criteria within the three dimensions of sustainability as per the triple bottom line. Team 2 created flowchart as a method for understanding the service delivery better and identified objectives for the CW. Team 2 discussed ways to address the identified design criteria and meet the objectives and suggested improvements as listed against the criteria within the sustainability dimension.

**Social dimension**:

*People in charge*: Use the proven innovators for training new users on equipment.

*Attracting innovators*: Make people aware of the opportunity and generate excitement to use the CW by: displaying posters at public facilities that have last mile connectivity, like post offices and ration shops, govt. offices (*gram panchayat, tehsil* level, etc.) schools; advertising on radio, local newspapers, local cable news channels, and; hold competitions/exhibitions showing people what can be accomplished at CW.

*Access to CW*: Regionalize CW to ensure those in rural and remote areas have access to a CW; have a shuttle to ferry people to and fro to increase access to CW; provide an accessible road and encourage personal vehicles to ride-share towards the CW.

*Occupational safety and health*: Provide personal protective equipment and specific training to ensure everyone is safe working at CW; display safety information sheet at every CW equipment in relevant languages; ensure adequate fire extinguishers which are operational; mark emergency exits clearly; have first-aid kits handy; attaining an ISO 9001 certification could demonstrate that these good practices are in place.

*Networking of Innovators*: As increased external networking increases innovation [3]. an important way to increase innovation and help innovators create more successful, sustainable projects in the rural setting is to build a networking mechanism; Using a shared online sheet, which contains CW usage log information and is accessible by each CW, allows users to search for other who might be able to provide prompt advice; after such a system matures, other resources, such as experts from industry and academia, could be added to give innovators further contacts for networking and idea sharing and development.

*Training on using equipment*: Trainers other than the innovators could hold periodic training sessions on the CW machines; Employing female trainers might encourage more female innovators to use the CW;

**Environmental dimension**:

*Waste management policy*: Waste from CW should be disposed by proper methods; scrap from machining and other operations at CW should be collected and recycled; if scrap is large enough it may be fit for other projects and directly reused.

*LCA for setup of CW*: Lifecycle Assessment (LCA) could be done to determine eco-friendly choices of machines and building materials for the CW.

*Source of power for CW*: Renewable source, such as micro-hydro or solar power, should be used depending on location and availability of water and solar radiation; Life cycle-costing can be used to examine if that is also a cost effective strategy in the long-run, which could offset some operating costs for NIF down the road.

**Economic dimension**:

*Sustainable funding*: Develop sources of revenue to make the shops financially independent; make local industries pay to get their employees trained for certain skills at the CW; CW can conduct informal trainings for people who could not attend a vocational training institute (e.g. ITI); a percentage of royalty from successful innovations marketed has to be given back to the respective CW; make hand-tools free for use, but charge nominally for certain machines (CNC, lathe, etc).

## 3.3 Solution of Team 1 (Using InDeate Tool)

With the object of design now being the CW services, this interpretation as well as the process of designing the lifecycle of service is guided by the InDeate tool. Due to the limitations of time and resources, design process was limited till conceptual design stage. Following are the outcomes of applying the InDeate tool to CW service design:

**Task Clarification**: On interpreting the problem brief (Sect. 2) in the context of the lifecycle phases of the CW service, the tasks:

- *Material Extraction*: Irrelevant, as the object of design is intangible service
- *Manufacturing*: How best to involve as many people as possible to build CW?
- *Distribution*: How best to disseminate the CW services?
- *Use*: How to effectively use CW services to support grassroots innovation?
- *End of Life*: How can the CW service design be so that it could be replicated (reused multiple times) at multiple places (scaling-up)?

Using the lifecycle phases of the CW service and the tasks interpreted within them as cues, the team arrived at a list of possible stakeholders (Table 1) using brainstorming, as the method chosen for its simplicity amongst others suggested by the InDeate tool.

To ensure that the requirements of important stakeholders are met before meeting those from others, the following exercise was undertaken: the list of given requirements was assessed to understand if they were common to all stakeholders, or if not, for how many stakeholders it was common (Table 2); Requirements in bold in Table 2 are those that are common to most stakeholders. Weights were assigned to indicate the priority of the requirement (last column in Table 2) and to the stakeholders (last row in Table 2).

Table 2 shows that the innovator has a stake in most of the requirements followed by the users, trainers, funding agency and trainees. Therefore from the perspective of requirement satisfaction it was appropriate to use these weights normalized on a scale of ten while evaluating candidate concepts. However, if stakeholders needed to be prioritized in terms of mutual importance based on any other perspective, then a pair-wise comparison matrix could be made as suggested by the InDeate tool.

**Table 1** List of stakeholders identified through brainstorming

| Stakeholder | Identifier | Stakeholder | Identifier |
|---|---|---|---|
| Funders (NIF) | f | Trainees | te |
| Innovator | i | Users | u |
| People fearing failure (skeptics) | s | Government | g |
| Trainers | tr | Raw material suppliers | r |
| Machine builders | m | Local artisans | la |

**Table 2** Prioritizing stakeholders based on stake in requirements

| List of requirements given | i | u | tr | f | te | g | m | la | s | r | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Provision for safe use of CW** | | 1 | 1 | 1 | 1 | 1 | 1 | | | | **6** |
| **Machine specific training** | 1 | 1 | 1 | | 1 | | 1 | | | | **5** |
| **Repeatability** | 1 | | 1 | 1 | 1 | 1 | | | | | **5** |
| **Provision for differently abled users** | 1 | 1 | | 1 | | | | | 1 | | **4** |
| **Affordability** | 1 | 1 | | | | | 1 | | | 1 | **4** |
| Training for different age and gender groups | | 1 | 1 | 1 | 1 | | | | | | 4 |
| **Cultural acceptability** | | 1 | | | 1 | | | 1 | 1 | | **4** |
| To remove dependency on sophisticated manufacturing systems for building initial prototypes and prove out of built parts. | | | 1 | | | 1 | 1 | 1 | | | 4 |
| **To promote the zeal of technopreneurship among the innovators** | 1 | | | 1 | | 1 | | | 1 | | **4** |
| Provision for disposal of generated waste | 1 | | | | | 1 | | 1 | | 1 | 4 |
| In situ first level value addition research development support for creation of prototype (Proof of Concept) with the involvement of trained local fabricators | | | 1 | | 1 | | | 1 | | | 3 |
| Joint product development with peer to peer learning and knowledge sharing | 1 | | 1 | | 1 | | | | | | 3 |
| Setting up the enterprises and providing them basic technical support | | | | 1 | | 1 | 1 | | | | 3 |
| Demonstration of technological innovations of grassroots innovators | 1 | 1 | | 1 | | | | | | | 3 |
| End to End value creation and in situ Incubation | 1 | 1 | | | | | | | | | 2 |
| Expert opinion | | | 1 | | | | | 1 | | | 2 |
| Value addition in terms of testing, calibration, fine-tuning | 1 | | | | | | 1 | | | | 2 |
| To help convert ideas to prototypes at a very low cost | | 1 | | | | | | | | | 1 |
| **Prioritized stakeholders** | **10** | **9** | **8** | **7** | **7** | 6 | 6 | 5 | 3 | 2 | |

**Conceptual Design of CW service of NIF**: The conceptual design stage started with a concrete list of requirements, which are taken as the ones prioritized (in bold) in Table 2. Due to the limitations of time and resources available to the design group, the Team 1 conceptualized only for these. On laying out the prioritized stakeholders and list of requirements on the first column and first row of Table 3 (Part 1 and Part 2) respectively, cells at the intersection of any row and column are filled in, being empathetic to the stakeholder, suggesting ways in which the requirement could be met. These ways could be using existing products, processes and institutional systems as tools for meeting the requirement, suggesting modifications to them, or suggesting completely novel conceptions of meeting the requirement. On populating the matrix a combination of one or more conceptual solutions for meeting all the requirements could be chosen based on constraints at hand, thereby enabling Table 3 to be used as a morphological chart also. The priorities (weights, w) for the requirements and stakeholders could be multiplied as a first-estimate of the contribution of the social design in meeting that stakeholder requirement, within the overall conceptual solution combination within which all stakeholder requirements will have been variously met.

## 4 Discussion

The objective of this design research article is 'Service Design' specific to the community workshops of NIF and not the Service Delivery Model directly. However, because of the use of the InDeate tool, that imbibes a 'lifecycle design' perspective, to support 'Service Design', considerations beyond 'service design' in the service delivery lifecycle stated in the 'Service Delivery Framework/Model', i.e. service development, deployment, operation and retirement of services also happen to be attended to in the design process. For this reason it could argued that the outcomes of applying the tool as done here, indirectly address the innovation of Service Delivery Models or Frameworks. Akin to the product lifecycle, where design offers the best leverage to intervene into product development due to the fact that the design phase in the product lifecycle commits 80% of the invested cost and time of the overall product development [4], the service design phase in the lifecycle of the service, i.e. in the service delivery model/framework, offers the best leverage to intervene as the implications to infrastructure and associated people here could arguably be equal or more than with product design and development. Further, supporting design in the conceptualization phase of the service design process assumes significance and these processes are supported well by the InDeate tool as demonstrated in the results of this preliminary yet extensive design exercise.

Assessment of improvement in service design (sustainability of it) with/without InDeate Tool has been done comparing the variety of solutions i.e. number of dimensions across which the interventions could have also been thought about. It is observed that Team 1 has come up with a better variety of solutions in comparison with Team 2. From Table 3, over 50 conceptual solutions have been proposed

**Table 3** Conceptual design suggestions for improving service design of CWs

| Stakeholders | Requirements | | | | | | |
|---|---|---|---|---|---|---|---|
| | Provision for safe use of CW (use) (w = 12) | Machine specific training (manuf.) (w = 7) | Repeatability (distr., EoL) (w = 6) | Affordability (distr.) (w = 10) | Accessibility for different age groups and gender (distr.) (w = 8) | Cultural acceptability (distr.) (w = 9) | To promote the zeal of technopreneurship among innovators (EoL) (w = 5) |
| Innovator (w = 8) | To be trained on machines/tools new to him and provide personal protective equipment | Ensures all innovator to complete all levels of training first, because innovators could lead by example | Geographically gauge requirements for similar innovation | Strategize to reduce consumable costs and running costs | Have dedicated dates of CW for differently abled and age groups, categorize aspect of innovation that involve users of different ages and groups for having separate slots/session | Imbibe cultural sensitivity into innovator (products innovations serving different needs of communities need to be manufactured in the CW) | Popularize innovators efforts across different CW (provide business training for innovators) |
| Users (w = 4) | To be trained on all tools and be provided training manuals and personal protective equipment | Ascertain competency and trainability of users | Communicate with relatives and friends about their involvement and benefit from CW | Provide instructions to use facility properly | Cater to demographics (have dedicated CW dates for differently abled and age groups) | (Products serving different needs of communities could be manufactured in the CW) | Train well and fast to work as an employee to the innovator |

(continued)

**Table 3** (continued)

| Stakeholders | Requirements | | | | | | |
|---|---|---|---|---|---|---|---|
| | Provision for safe use of CW (use) (w = 12) | Machine specific training (manuf.) (w = 7) | Repeatability (distr., EoL) (w = 6) | Affordability (distr.) (w = 10) | Accessibility for different age groups and gender (distr.) (w = 8) | Cultural acceptability (distr.) (w = 9) | To promote the zeal of technopreneurship among innovators (EoL) (w = 5) |
| Trainers (w = 6) | Provide personal protective equipment | Determine what comprises training levels for users and innovators | Developed easy-to-learn and follow training manuals | Development of training manuals should be economical | Flexible hours, after school hours, availability of trainers after school hours | Should be able to communicate in local language (situate CW at the border of state) | Train users and trainees to work fast |
| Funders (NIF) (w = 7) | Provide personal protective equipment | Skilled at negotiation in acquiring trainers as and when required | Standardize and improve pitch for CW model to the decision makers who approve funding | Strategize to reduce capital costs, cost of acquiring trainers, and trainers salaries (channelize CSR funds of banks towards high risk loans) | Bring in school involvement and pension funds | Source from religious group funds | Training on business basics, assistance with business model writing, foreseeing alternative uses of innovations, sourcing similar geographic requirements, disseminating and marketing innovations |

(continued)

**Table 3** (continued)

| Stakeholders | Requirements | | | | | | |
|---|---|---|---|---|---|---|---|
| | Provision for safe use of CW (use) (w = 12) | Machine specific training (manuf.) (w = 7) | Repeatability (distr., EoL) (w = 6) | Affordability (distr.) (w = 10) | Accessibility for different age groups and gender (distr.) (w = 8) | Cultural acceptability (distr.) (w = 9) | To promote the zeal of technopreneurship among innovators (EoL) (w = 5) |
| Trainees (w = 5) | Safety briefing, manuals, and personal protective equipment | Training levels should be to trainees' level of knowledge | Communicate to relatives, friends about involving and benefit from CW | Less time per trainee, facilities for training enmasse (collaborate with local community centres) | Incentivize probable trainees to take up work in CW (award academic credits students) | Have trainees from different communities mingle | Train fast and work efficiently under innovator |

making it one and a half proposal per every systematic pair-wise comparison (cells in the table). From Sect. 3.2, it could be observed that Team 1 proposed approximately twice the number of ideas/concepts as Team 2. Though this does not conclusively establish the sole contribution of the tool, it could be considered a promising start which expands the options that can be considered for evaluation rather than to find oneself in a situation wherein an idea/concept has to be accepted due to their paucity. This is also reflected in the team members' responses to the questionnaire in two ways: first, members from a non-design background within the Team using the tool appreciated the design process aided by the tool commenting that if not for the tool and other members with a design background in their team they would not have contributed to the outcomes, and; second, members with or without design background in the Team that did not use the tool relatively appreciated their peers outcomes with the tool and the systematic and integrated lifecycle approach that the tool took. Assessment of improvement in service design (sustainability of it) with/without InDeate Tool has also been done based on consulting experienced people at NIF who have been involved in taking decisions regarding the implementation of the CWs, on whether the suggested improvements would be better in terms of the CWs fulfilling their purpose of establishment.

## 5 Summary and Future Work

In the context of assessing the benefits of using the InDeate tool for supporting 'service design', it was observed that during the first two stages of the design process the tool showed promise. The granular detail to which the process of design could be taken systematically provided more opportunities for generation of alternatives and their evaluation throughout the CW service's lifecycle design. The potential that the use of InDeate Tool for designing sustainable systems showed for the first two design stages could extend to the other stages too as the approach could use more methods that the tool and its database have to offer in supporting the design process as fitting to social innovation requirements. Conducting such work spanning the entire design cycle is work for the future.

**Acknowledgements** The authors express their gratitude to the Indo-US Science and Technology forum for funding this research through the Joint CoE on Design of Products, Services and Manufacturing Systems.

## References

1. Brundtland, H.: Our Common Future. Report of the World Commission on Environment and Development (WCED), Oxford University Press (1987)
2. Chakrabarti, A. et al.: Supporting design: indeate tool and template design. In: Proceedings of the International Conference on Research into Design, Guwahati, Springer (2017)

3. NIF Activities: National Innovation Foundation, India. [Online] [Cited: September 15, 2015]. http://nif.org.in/our_activities
4. Love, J.H., Roper, S.: Location and network effects on innovation success: evidence for UK, German and Irish manufacturing plants. Res. Policy **30**, 643–661