

Using ‘design thinking’ to enhance urban re-development: a case study from India

Ajay Kumar^a, Dinesh Lodha^b, Ashwin Mahalingam^c, Vishnu Prasad^b and Anand Sahasranaman^b

^aLand Transport Authority, Singapore; ^bIFMR Finance Foundation, Chennai, India; ^cDepartment of Civil Engineering, IIT-Madras, Chennai 600036, India

ABSTRACT

The discourse on urban planning and development has evolved over the last century with top-down methods of planning urban spaces giving way to bottoms-up approaches that involve residents and other stakeholders in the design process. While the notion of participation and user involvement is considered critical to the design of appropriate and acceptable urban forms, there is no clear consensus in the literature on the methodology to be used to involve users and stakeholders in the design process. In this paper, we propose that the use of ‘Design-Thinking’ – a methodology for Human-Centred Design that is often used in product design and related industries – may be an effective methodology for engaging stakeholders in the urban design domain. The Design-Thinking approach iteratively encompasses an empathizing phase where deep-dive studies are conducted to understand the users’ needs, a project brief definition phase, an ideation phase and rapid-prototyping and testing phases to arrive at an appropriate design solution. Taking the example of the redevelopment of a slum in the city of Srirangapatna in South India, we describe how we implemented the Design Thinking process over a period of one year to involve slum dwellers in the re-design of their own neighbourhood. We then show how designs developed through this process were different from a design developed prior to the use of Design Thinking due to the generation of new insights in the process. Furthermore, the residents of the slum almost unanimously indicated that one of the designs generated through the Design Thinking process was their preferred choice for the redevelopment of their slum, indicating the ability of the process to generate acceptable and potentially sustainable designs. Finally, residents who went through the Design Thinking process also demonstrated greater ownership towards this design choice and expressed an increased willingness to work with the local political authorities to contribute to the development of the selected design. The key contributions of the paper are to highlight the applicability of Design Thinking as a methodology for user-centric design in urban communities and to propose that Design Thinking can lead to the discovery of solutions that enhance the satisfaction of local communities.

ARTICLE HISTORY

Received 4 August 2015
Accepted 15 February 2016

KEYWORDS

Building information modelling; design thinking; participatory planning; urban design

Introduction

The discourse on urban planning has evolved over the last century. As Hall (2014) describes in his historical review of trends in urban planning and design, the planning of urban spaces was once the domain of master planners or ‘anarchists’ such as Lutyens or Corbusier who actively directed the realization of their vision of urbanization. Subsequently, ‘principles’ of urban design were deduced, introduced in curricula, and attempts were made to formalize norms for the design of urban spaces – all of which represented a top-down approach to urban design, under the watchful guidance of centralized planning authorities. Starting from the 1970s, however, greater traction emerged for the view that sustainable spaces could only be created through involvement with local communities and the community design movement emerged to foster greater innovation and creativity in this domain. The USA and the UK were at the vanguard of this movement.

This ‘bottoms-up’ philosophy has been subjected to varying approaches. The ‘New Urbanists’, for instance, acknowledge the need for community-centric design, yet do not necessarily prescribe community participation in the process (Katz, Scully and Bressi, 1994). Elsewhere, communities might participate at the beginning of the process in providing data points leading to design definitions, and/or at the end of the process where the final design is communicated to them. Moughtin *et al.* (2004), for instance, describe such an urban design process in four main phases as follows: Phase 1 – Assimilation (the accumulation of general information and information specially related to the problem), Phase 2 – General Study (the investigation of the nature of the problem, the investigation of possible solutions), Phase 3 – Development (the development of one or more solutions), Phase 4 – Communication (the communication of the chosen solution to the client). While certainly

more inclusive than other approaches, such processes still do not allow for iterative interactions with the community and the subsequent process of discovery and innovation.

Despite policy assurances to the contrary, the urban planning and design process in India has traditionally followed the top-down approach. To be sure, such approaches do have benefits – for instance, they give government planners and designers a feeling of control and efficiency (Cooksey and Kikula, 2005) and are less time consuming as the whole process is predefined and controlled by professional actors (Larice and Macdonald, 2013). On the whole, however, such urban design processes in India have more often than not failed to produce satisfying outcomes (e.g. Dupont et al., 2014). The reasons are manifold. Significantly, however, the process of stakeholder consultations has not been meaningful enough and has not informed the design of urban spaces. Local stakeholders often have particular insights into specific urban design issues affecting a given context and therefore urban design solutions developed through a top-down approach may not be acceptable from the point of view of these stakeholders (Great Britain. Dept. of the Environment, the Regions, Commission for Architecture & Built Environment, 2000).

Contemporary literature on planning has attempted to further unpack the notion of participatory planning and community involvement. The Sustainable Community Planning Guide (Larsson et al., 2007) lists several benefits in adopting such an approach as assistance in formulation of goals and objectives, ensuring that community issues and concerns are taken into account, generating a feeling of ownership of the plan amongst inhabitants, creating a better understanding of the development process and achieving consensus on priorities regarding projects and development programmes. Scholars have suggested methods that can be used to enhance participatory planning such as the use of charrettes, games, workshops and visualizations (Sanoff, 2000). In particular, the use of simulations and visualization tools in the participatory planning process has been shown to have a strong positive relationship with both decision-making and community satisfaction outcomes (Tress and Tress, 2002; Janowski, 2007; Salter et al., 2007). Nevertheless, while there is general agreement on the importance of community involvement in participatory planning and the tools that can be employed, the process or the sequence of steps, through which optimal designs can be achieved through community involvement and the use of tools and participatory methods, has remained largely unexplored.

Design thinking as a process of co-creation of urban forms

The domains of Product Development and Management have recently witnessed the rise of a paradigm popularly referred to as ‘Design Thinking’ or ‘Human Centered Design’ (Brown, 2008). What is Design Thinking? Johansson-Skoeldberg *et al.* (2013) in a recent review of this discourse note that the origins of the term ‘Design Thinking’ are murky, are rooted in both practice and academia and that there is no ‘sustained development of the concept’ leading to the lack of a unified or well-accepted set of definitions and a body of knowledge. Dorst (2011) traces the rise in popularity of the term to Rowe’s book published in 1987 bearing the same name (Rowe, 1987). In order to understand the popular discourse on Design Thinking, it may therefore be important to understand how design is conceptualized. Owen (2007) describes design as a process by which culturally appropriate and effective forms are created. Design is characterized as a synthetic as opposed to an analytic process, intended to produce real as opposed to symbolic outputs (Owen, 2007). Design is further theorized to consist of two elements – an element that focuses on ‘discovery and finding’ or, in other words, a common definition of the problem, and an ‘invention and making’ phase where the contours of the design are fixed (Owen, 2007). Design thus requires a mix of inductive, deductive and abductive reasoning skills (Dunne and Martin, 2006). Pena and Parshall (2012) provide a similar description of the design process splitting it into a programming phase which is more analytic and which leads to the formulation of a design brief, followed by a design phase which synthesizes to create an integrated design. In addition to these generic principles, Norman (2002) notes that for design to be effective, there should be greater alignment towards users and their needs in the design process. Brown (2008) further develops on this and argues that the design process should be systemic in scope, user-centric in nature, and designers should focus on both form and function. Design processes that follow this line of reasoning are said to exhibit ‘Design Thinking’.

Beckman and Barry (2007) break down the process of Design Thinking into four iterative components – Observation and an understanding of the needs of the potential users; Contextual Framing or parsing through observed data to identify patterns and gaps that can help define contours and parameters for the design; Specifying a finite set of design principles or design imperatives based on an analysis of patterns in the data; and Generating, selecting, prototyping and testing alternative design

solutions. Brown (2008) further suggests that prototype development and testing must be rapid, and that the emphasis should lie on understanding whether user requirements are met, and not to create a 'finished product' straightaway. His framework for Design Thinking is analogous to that proposed by Beckman and Barry (2007) and is broken into three categories: Inspiration – where observations are made and insights discussed; Ideation – where solutions are brainstormed, prototyped and tested, and Implementation, where this vision is executed (Brown, 2008; Brown and Wyatt, 2010). The Hasso Plattner Institute of Design or the d.School at Stanford University that has helped to popularize Design Thinking as a problem-solving paradigm, and has attempted to analytically separate the various steps in the design process and offers an iterative five step methodology – Empathize with the users, Define a problem brief, Ideate on solutions, Rapidly prototype, and Test. This is also analogous to Pena and Parshall's (2012) paradigm, where five stages are involved in the programming phase – establishing goals, collecting and analysing facts, uncovering and testing concepts, determining needs and, finally, stating the problem with a view towards developing the design. However, the d.school's philosophy emphasizes spending considerable time with potential users understanding their needs – primarily through ethnographic discussion and first-hand observation – and rapidly prototyping and testing options more with a view towards learning from each iteration as opposed to creating the final solution. As Schrage (2013) notes, '... the value of prototypes resides less in the models themselves than in the interactions they invite'. Being able to create a variety of models or simulations can lead to the generation of 'useful surprises' that resonate with user groups eventually leading to more accurate specification design and effective products being built.

By placing an emphasis on empathy and observation, and by highlighting the need for rapid-prototyping and testing, 'Design Thinking' automatically embraces a participatory design approach which is user-centric, and attempts to systematically set out a series of 'spaces' (Brown, 2008) or iterative steps that can result in the development of designs that are both innovative and simultaneously satisfy user needs. While the 'Design Thinking' approach may have originated in the domain of project design, it has been applied elsewhere as well with considerable success – in Health care (Brown and Wyatt, 2010), Management (Dunne and Martin, 2006) and Public Policy (Cowan, 2012). As a result, it is worth understanding whether this systematized approach can be used for participatory and effective urban planning.

The specific research questions that we ask in this paper are therefore:

- (1) How can the systematic process of 'Design Thinking' be operationalized as a methodology for participatory design of urban communities?
- (2) Is there any evidence that designs resulting from this approach are likely to be more effective or appropriate than designs resulting from conventional urban planning approaches?
- (3) We now describe the methodology that we used to address these research questions.

Research design and method

In order to answer our research questions, we decided to re-design an actual urban settlement. We selected the town of Srirangapatna in the state of Karnataka in southern India. Srirangapatna is a small river island with a population of 23,700 people living in 23 wards (divisions). The Town Municipal Corporation of Srirangapatna was interested in re-developing a poor slum in ward 2 called Ranganatha Nagara 2 consisting of 283 people living in 75 households and we decided to focus our urban design initiative on this slum.

Following the Design Thinking framework, we intended to first 'empathize' with the residents of the slum in order to understand their needs and challenges. This stage is analogous to what Brown (2008) refers to as the 'Inspiration' stage, and what Beckman and Barry (2007) refer to as the observation and understanding stage. As Brown and Wyatt (2010) note, this process of engaging with the community should be an immersive one with a reliance on primary sources of data such as direct conversations and observations in addition to secondary sources of data such as surveys and focus group discussions. Furthermore, this phase is expected to be lengthy in order to afford enough time to learn about the requirements for the design. Accordingly, we spent an eight-month period conducting various activities aimed at helping us to better understand the needs of the community with regard to shelter and infrastructure, as described below. In order to develop a basic understanding of the population that we were designing for, we conducted a basic household survey to capture details such as demographics, occupation, income, infrastructure quality and access to basic services. For all activities on the ground in Srirangapatna, we set up a local team that was based there and working under our guidance. From this survey, we learnt that there were marginally more female (52%) than male members in the community, that 92% of households had lived in that slum for

the past 15 years or longer and that 52% of the slum population was employed, mainly in other areas of Srirangapatna. We also learnt that only 41% of the households receive drinking water and only 7% had access to sanitation facilities; 81% of the households also did not have access to garbage bins and dumped garbage in open areas. Only 11% of households had title deeds for their houses and 56% of houses had either thatched roofs or metal sheets that led to leakage and flooding in the rainy season. However, 92% of houses received electricity and most children in the 5–18 age range were enrolled in local schools. On completion of this survey, the first author whose background was in civil engineering and design attempted to create a new urban layout for the slum, using standardized design principles as well as an understanding of the community's needs thus far. This model was created to serve as a baseline and to mimic the kinds of models that may be created without following the Design Thinking approach. Our intention was to compare this model with those generated at the end of the process to understand the efficacy, if any, of the Design Thinking process.

We then attempted to speak to the residents individually or in small groups to better understand their challenges, needs and aspirations. Prior to doing this, we recognized the challenge of building trust and gaining entry into the community to ensure that the residents would have open discussions with us. We therefore embarked upon a series of 'Build-Up' activities where we attempted to convey our roles and intentions, and incentivize the residents to communicate with us. With the help of our local team, we visited every house individually and explained who we were, the process that we wished to undertake, what community participation meant, and the roles we expected the residents of the slum to play within the larger design process. In order to ensure deeper comprehension, the material that we used in communication with these households was largely visual in nature and any written material was crafted in simple sentences in the local language, *Kannada*. In order to prepare them for discussions, we then encouraged each of the households to think about three specific questions: (a) What are the things you want to preserve in your community? (b) What are the things you want to change in the community? and (c) What are the things you want to create in the community? A 'Vision Sheet' with each of these three questions listed was also provided to the participants and they were encouraged to write their thoughts down on this sheet. Members of the local team helped to fill in sheets for residents who were unable to write themselves. Finally, we also conducted a drawing competition where each household was supplied with drawing sheets and coloured marker

pens and were asked to draw a scene under the theme 'My House'. While the competition was aimed at children in the households, adults were also encouraged to participate. The intention was to enable the community to think creatively about the process of redesigning their slums. During this entire stage, the first, second and fourth authors made multiple visits to Srirangapatna to observe the layout and amenities of the slum first hand and to understand the common routines that people in the slum practised.

After these 'Build-Up' activities, we conducted a series of group sessions or workshops with members of the slum. The entire area was divided into three zones, and we had a facilitated discussion with households from each zone. Members of our local team were trained in terms of facilitating these discussions. In each of these discussions/workshops, we gave each participant some more time to think about the answers to their questions on the Vision Sheet. Participants then spoke to each other to understand how others in the community had responded to the questions on the Vision Sheet. The participants in each workshop then attempted to identify the top 3 answers to each of the questions in the Vision Sheet. Figures 1 and 2 show photographs of these workshops.

At the end of this process, the residents who participated in the workshop had discussed several of their unmet needs that could be critical design parameters in a redesign exercise. The residents were also encouraged to discuss potential solutions, as well as barriers to implementing these solutions in the community. The facilitators also took down detailed notes to help us understand the key requirements from the community's perspective.

After spending eight months on this effort, we then entered into the next phase of the Design Thinking framework, that Brown (2008) and Brown and Wyatt (2010)



Figure 1. Facilitated discussion.

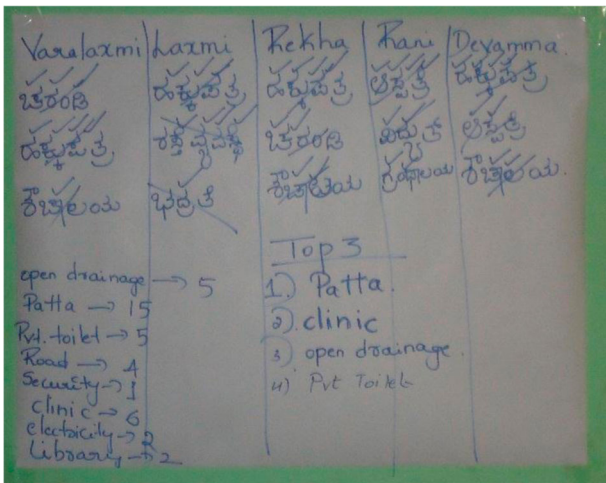


Figure 2. Listing needs from the residents.

term as the 'Ideation' phase. Here, the design problem is defined, ideas are generated and preliminary prototypes are developed. Alternatively, as Beckman and Barry (2007) describe, this stage involves parsing through the observed data and defining the contours of the design problem. Initially, the data collected in the 'Inspiration' or 'Empathy' phase were mapped on to a GIS-based map of the area for enhanced spatial visualization. While a number of issues and needs had surfaced in the discussions and workshops such as the need for a medical clinic, a library, more garbage bins and so on, the following six issues were repeatedly expressed by the residents of the slum and were also often observed by the research team: (a) the need for private water taps in households, (b) closed drainage systems to replace open sewers, (c) provision for private toilets (d) proper roofing for each house, (e) a wide road within the community and (f) the provision of a community centre.

The research team then brainstormed to determine potential layouts that might satisfy the resident's requirements. Here, Brown and Wyatt (2010) mention that such ideation is often done best through the use of an interdisciplinary team where multiple areas of expertise are present and the possibility of collaborating across disciplines is high. Our team consisted of a civil engineer (first author), an engineering management scholar (third author) as well as three social scientists working in the development field (the second, fourth and fifth authors) who jointly engaged in developing prototypes. This interdisciplinary approach contributed to the generation of multiple ideas. Several sketches were made and ideas discussed. During this process, the research team realized that several trade-offs needed to be considered. For instance, due to the layout of the slum as well as space constraints, it was not physically possible to widen the road and simultaneously lay pipelines for individual

water connections. Wider roads would necessitate the construction of public water taps. Also, several options were available for the development of the community centre ranging from a closed and compact design with space for 'rooms' and 'shops', to a larger and more open design with room for playgrounds and community activities. Multi-storey dwellings could in turn be built to create space for both a larger closed community centre and a park. However, in this process, the residents would have to compromise on having their own individual houses.

Having ideated on potential solutions for a period of one month, we then embarked upon the next and final phase in the Design Thinking process – the 'Implementation' phase (Brown, 2008; Brown and Wyatt, 2010). Here, design alternatives are selected, prototyped and tested in order to further our understanding of the design challenge and also to generate insights that can help us quickly converge on to a final, usable solution. Given the emphasis on generating a large number of prototypes so as to provide ample space for feedback and discussion, we generated a set of five potential designs. Each of these designs featured concrete roofs, closed drains and private toilets. However, some designs featured narrow roads with private water taps while others featured wider roads with public water taps. Some designs also featured only single-storey housing units, while other designs featured a combination of single-storey and double-storey housing blocks. Finally, some of these designs featured closed community centre designs, while the others had more open community spaces for interaction. Various combinations of services such as a fair price shop, a library and so on were integrated into the community centre designs. Table 1 describes the various combinations that the research team came up with.

While there are a number of ways in which prototypes could have been built based on these designs, we chose to use Information Technology to represent our prototypes. Specifically, we chose to use a technology called BIM (Building Information Modelling) that is relatively well known in the Architecture-Engineering-Construction (AEC) industry, to build our prototypes. BIM is a digital platform through which project teams in the AEC industry can build parametric models of the built environment, share information better, visualize project processes and take decisions that can improve project performance (Teicholz, 2004; Construction Users Roundtable (CURT), 2005; Mahalingam et al., 2015). While enhanced coordination during design and construction is touted as one of the key benefits of using the BIM platform (Azhar, 2011), one of the most common uses of BIM currently in the AEC industry is to visualize 3-Dimensional models of buildings and

Table 1. Details of models built.

Model	Housing	Road	Water supply	Drainage	Amenities
Model 1	Single storey	Narrow	Private tap	Closed	Clinic, library, ration shop, community centre, childcare centre
Model 2	Single storey	Narrow	Private tap	Closed	Park, ration shop, childcare centre
Model 3	Single storey	Wide	Public tap	Closed	Clinic, library, ration shop, community centre, childcare centre
Model 4	Single storey	Wide	Public tap	Closed	Park, ration shop, childcare centre
Model 5	Double storey	Narrow	Private tap	Closed	Clinic, library, ration shop, community centre, childcare centre, park

structures with a view towards showing stakeholders with little building experience what the finished product might look like. The parametric nature of the BIM platform also allows users to interact with the 3D model, quickly change parameters and develop walk-throughs and videos that can enhance the experience of viewing the model. The research team reasoned that by developing and showing graphical 3D simulations of the proposed designs, and by allowing the residents of the slum to ‘play’ with the models, we would be able to better gauge the user’s receptivity to the models built.

Having built BIM models of each of our design options, as well as a model of the design generated at the start of the Design Thinking process, we proceeded to have further consultations with the users. A walk-through video presentation of each option was created to give the users the impression of what it would be like to walk around the redesigned community. In addition, three static 3D views of the building were also shown – a plan view of the entire slum, an elevation view from the entrance of the slum and a view from the community centre. We arranged consultations with selected residents in a room equipped with a computer and a projector so as to show them the 3D models. Eight residents were selected at random from the group that had participated in the earlier workshops and were shown each of the models sequentially. At the end of each model, they would discuss the characteristics shown. An average of around 15 minutes was spent discussing each model. After all models were shown, the residents would then each select their top three choices. Every first-choice vote was awarded five points, every second-choice vote was awarded three points and every third-choice vote was awarded two points. The model with the highest cumulative score was then shown to the group again to obtain their feedback as to whether they would appreciate such a design being implemented in their community. Each participant was also asked a series of structured questions as part of an ‘exit interview’ process aimed at gauging their understanding of the process, their satisfaction as well as their level of ownership over the most popular design alternative.

Finally, in order to understand whether participation in the design process itself affected any of the outcomes that we wished to observe such as satisfaction over the

design or ownership of the process, we visited nine adult residents who had thus far not been a part of any of our workshops and discussions. Each of these residents was shown the most popular model as decided in the earlier workshop and was asked to comment on the design as well as on the effort that they were willing to take to ensure that the design was realized.

Having described the methodology and actions that we employed, we now discuss our analysis and findings.

Findings

Our engagement with the Ranganatha Nagara community was done over a 10-month period. Throughout, we qualitatively observed progressively increasing levels of interest and interaction with the design of the slum. When we conducted our first set of discussions during the ‘Empathize’ or ‘Inspiration’ phase, very few of the residents showed up on time at the location of the workshop. All of the workshops started late. Individual households had to be visited and personal invitations had to be made before people gathered for discussion. Getting people to air their views was quite challenging in these sessions. On the other hand, the final workshop where the prototypes were shown was far more interactive. While presenting each design, the presenter was often stopped multiple times by questions and discussions among the participants. The static 3D views that were generated for each design option were printed out and pasted in the room. Participants formed small groups, walked back and forth between the pictures, talking to themselves and directing several clarification questions at the researchers. On seeing the visual models, participants were quick to reject certain choices such as the use of multi-storey houses and arrive at an aggregate consensus for the kind of urban form that they required. Overall, the level of interaction in this session was far higher than we had previously encountered.

On evaluating the various prototypes, Prototype #1 received the highest cumulative score of 30 points and was the only prototype to be picked as a top 3 choice by all the participants. It is significant to note that this prototype was created through the brainstorming exercise in the Ideation phase after the immersive experience with the community. Prototype #6 received the second

highest cumulative score of 23 points, while Prototype #2 scored 11 points. Prototypes #3, #4 and #5 scored single digits. Surprisingly, Prototype #6 was the design that was created right after the initial demographic survey was conducted and was therefore not a result of the Design Thinking Process. Yet, it was the second most popular choice. On discussion with the participants, however, they clarified that while this option was not their preferred choice, it was the only solution that featured the use of tiled roofs which they believed was a solution which could be implemented quickly by the municipal authority. It was therefore perhaps the combination of a general lack of confidence in the municipality's ability to implement large projects and the potential 'ease of implementation' of Prototype #6 that prompted participants to score this option highly, as opposed to satisfaction with this design solution.

The prototype testing phase yielded several new insights into user behaviour and requirements, as predicted in the Design Thinking methodology. First, participants unanimously agreed that they would prefer single-storey houses over double-storey ones since they anticipated difficulties in deciding who would be allotted to which floor and who would have access to the space on the ground. They also declared a unanimous preference for private water taps over wider roads. Most significantly, the participants preferred a closed community centre with virtually no open space. Their reasoning was that open areas could attract drunks and vagabonds that might be detrimental to the well-being of the community. The participants discussed the most popular option – Prototype #1 in great detail towards the end of the workshop and agreed that it could form a template for urban re-design of the slum. However, they suggested some improvements to the model including developing an even more self-contained community centre and changes in the installation of streetlights, the lack of which became apparent during the walk-through. Participants agreed that with these changes, a model of

the slum could be designed that would both satisfy and meet the needs of the residents in Ranganatha Nagara. Finally, in their exit interviews, all participants expressed a willingness to take ownership of this project and work with the municipal authorities in realizing the final design.

Following this discussion, the final prototype was then shown to the nine residents who had not participated in the process. Since none of the invited residents showed up at the venue, the local team visited each of them at their doorstep. This group of residents also expressed satisfaction with the one Prototype that they were shown, appreciating its features and acknowledging that it met their needs. While they had no other solutions to offer, several indicated that they did not believe that the municipality would actually implement the plan, and were not willing to take ownership of the project.

Discussion

Our methodology attempts to answer our first research question and indicates how a Design-Thinking approach can be adapted to urban design. By empathizing with residents, developing 3D parametric visual models and animations of urban spaces using a multi-disciplinary team, and by engaging residents in evaluating design solutions, we believe that the 'Inspiration', 'Ideation' and 'Implementation' phases of the Design Thinking framework can be transposed on to the process of urban design.

Our results also indicate that the Design Thinking process led to a different outcome from what would have been achieved without the process. Figures 3 and 4 show the model that was developed prior to engaging with the community on the left (Model #6) and Model #1 on the right that was developed after engaging with the community in the design process. Furthermore, the fact that the residents rated Model #1 higher than the model that was built at the start of the exercise indicates



Figure 3. Model #6 (left) and Model #1 (right).

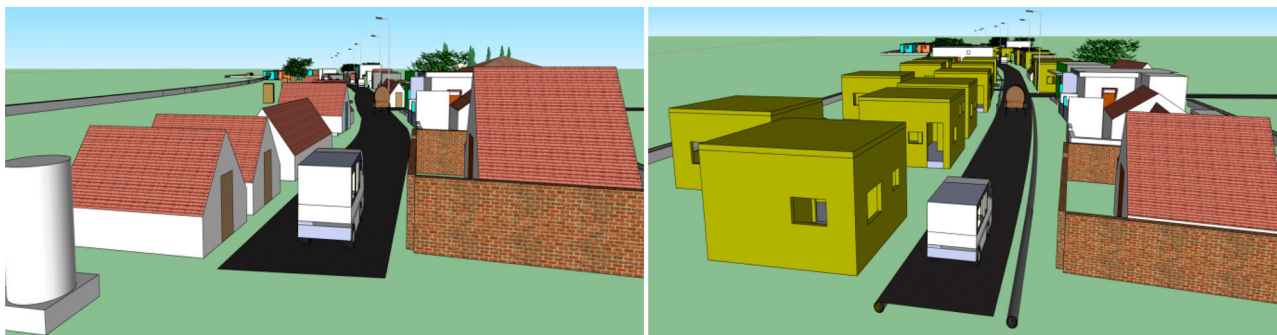


Figure 4. Walk-through views of Model #6 (left) and Model #1 (right).

that the design thinking process produced not only a different outcome, but also a more effective one from the perspective of the residents. This observation helps to answer our second research question and shows that a Design Thinking approach to urban design can lead to more effective and appropriate designs than traditional urban planning approaches. Even so, Model #1 that was deemed the most appropriate of the models that were displayed was not the final design. On discussing with the residents, a revised model incorporating the use of streetlights and optimizing the design of the community centre was added. The residents held that this was an even better model than the previous one. In line with Brown (2008), prototypes in the Design Thinking process were essentially artefacts that allow the designers to learn and refine their design objectives better in order to produce a fresh generation of prototypes that could further enhance community satisfaction and contribute to the finished project. Our iterative approach of testing prototypes, learning and recreating new models thus led to a design solution that was widely accepted.

The benefit of using the Design Thinking approach is not merely the creation of designs that may be more appropriate than those created through traditional top-down design approaches. An unanticipated benefit that we observed was that the Design Thinking process instilled a strong sense of ownership within the community. In the final workshop and in the exit interviews after the event, all eight participants who helped to make decisions amongst the models shown expressed a high level of satisfaction with the design process and were

grateful to have been involved in the design effort. Six of these participants expressed a strong willingness to participate in such design efforts in the future, citing that the methodology and the outcome would be of great benefit to the community. Most importantly, all 8 participants expressed a strong willingness to work with the Municipal Corporation to ensure that the final design would be implemented. These respondents also expressed a strong desire to see their selected solution implemented, thus displaying a sense of ownership with the project. Table 2 summarizes some of the scores of the respondents on a selected set of questions that they were asked during the exit process. The participants were surveyed on a 5-point Likert scale with 5 denoting strong agreement with the related statement. The average scores and the standard deviation across participants are reported. The table indicates strong support among the participants in favour of the Design Thinking process as a tool for participatory urban planning, the acceptability of the outcome of the process, and their belief and willingness to proceed from design into actual implementation. In their exposition of a 'Fair Process', Kim and Mauborgne (1997) note that engaging the stakeholder community, providing periodic and transparent explanations and clarifying outcome expectations often lead to an increased acceptance of a proposed change. Consistent with these findings, we observed that engaging with the stakeholder community early in the process by allowing them to provide inputs into the design, explaining potential solutions as well as constraints and seeking feedback at frequent intervals, and clarifying expectations in a transparent manner appeared

Table 2. Participant responses.

S. no	Criteria	Mean score (out of 5)	Standard deviation
1	Hopeful of prototype getting implemented	3.375	0.74
2	Satisfaction with final prototype	3.75	1.16
3	Satisfaction with overall process	4.625	0.52
4	Willingness to participate in a process like this in future	4.375	0.92
5	Willing to take responsibility for selection of final model	4.75	0.46
6	Willingness to take actions for implementation of the final model	5	0.00

to lead to greater acceptability, as well as to the generation of trust and ownership due to the perceived 'procedural equity' in the nature of the design process.

Our study was conducted on a single project in a small urban community in a specific geography. In addition, while our team was multi-disciplinary in nature, we did not have a member with a direct background in urban planning. The inclusion of an urban planner may have allowed us to generate a different (additional) set of prototypes based on creative uses of space and form that may have elicited a different range of responses. Several other such studies that are conducted in different contexts involving urban planners and architects and with larger, more diverse communities are required before a generalization of findings can be attempted. It is therefore not our intention to imply that Design Thinking is guaranteed to succeed in all circumstances, nor do we intend to suggest that the Design Thinking process – or our instantiation of it – be used as an exemplar or be construed as the pre-eminent method of collaborative design. In this paper, we merely seek to propose and demonstrate the usefulness of Design Thinking in urban planning. We learnt several lessons as we implemented the Design Thinking process in Srirangapatna and have several suggestions to offer practitioners and researchers endeavouring to undertake such efforts in the future. First, there are several possible ways of developing empathy with the target population, through the use of ethnographic techniques. We relied on a strategy of visiting the site from time to time and holding detailed discussions with the residents to understand their needs and desires. A more situated approach where researchers spend more time living with the target population may have yielded additional insights.

Our process of prototyping and testing was only mildly iterative – we were able to show one set of prototypes, obtain feedback, and improve upon it in the second time before completing our exercise. Ideally, we would have liked to have done multiple rounds of prototyping and testing to ensure that the final prototype was the one that was most appealing to the community. Unfortunately, local elections during the course of our study reduced the amount of time we were able to spend with the community.

However, the lack of comments on our first generation of prototypes is not necessarily surprising when we consider the size of the community and the length of the Empathy process. It is important to note that the Ranganatha Nagara settlement is a small community of 75 households and the time investment in the Empathy phase meant that at least one member of each household could be part of the process. This could have resulted in us getting a deep granular understanding of

community needs, meaning that the first prototyping phase essentially captured the specific needs of the community in an adequate manner. Implementing this approach in larger communities and perhaps more heterogeneous communities will be more likely to require multiple rounds of prototyping. In addition, when dealing with larger communities, it may also not be possible to survey or conduct ethnographic interviews with each household. While, a sampling methodology can be adopted to undertake deep-dive studies with a representative set of stakeholders, information technology can be leveraged in creative ways to connect the larger community with the design thinking process. For instance, given the proliferation of smart phones, design specifications or virtual models can be easily transmitted to a broad variety of stakeholders seeking their input. Kiosks can be located at various strategic points that allow stakeholders who do not have access to mobile telephony to cast opinions on design alternatives. Crowd-sourcing platforms with or without financial implications on the part of the users could be yet another way by which ideas can be sought, and prototypes can be evaluated in order to foster a democratic process of design selection.

The use of BIM tools greatly enhanced our ability to prototype and test, as we were able to quickly process the discussions during the display of the first set of prototypes to create a second-generation prototype. Furthermore, we were able to animate the prototypes and provide walk-through simulations of the neighbourhood to allow residents a 'feel' for how the model would look like in practice. However, there is considerable scope for improvement in these processes. More realistic prototypes that are more responsive to users and allow the users themselves to play with and modify layouts and structures can be used to obtain a better understanding of stakeholder preferences and optimal design solutions (Yan et al., 2011). It must also be noted that there is an expense involved in procuring BIM tools that all organizations may not be able to afford. One option in such cases may be to use visualization tools that belong to the larger BIM family but are relatively less expensive – Trimble's Sketch-Up tool, for instance, where models can be quickly developed and modified in real time – and to then combine the use of such tools where necessary with alternative visualization platforms such as the kiosks, crowd-funding platforms or mobile applications discussed above.

Finally, improvements can be made in our scoring system and thereby the way in which we were able to evaluate and determine the extent of improvement that the Design Thinking process offered as compared to traditional design processes. Also, it would have been

informative to study the actual process of implementation to confirm whether the residents of Ranganatha Nagara exhibited similar levels of satisfaction with the built outcome, as they showed when viewing the virtual prototypes. During the process of implementation, it is also possible that budgetary or other economic constraints could hinder the process of project execution. In situations where budgets and timelines are fixed, it may be imperative to involve the implementation agencies (in this case, the municipality of Srirangapatna) through the design-thinking process to help select designs that are not only acceptable from a form and functionality viewpoint, but are also implementable based on time and budget constraints. Furthermore, in addition to using BIM models for 3D visualization, 4D BIM models that integrate geometry with time schedules and 5D models that map project costs on to project design can also be built in the prototype development stage to obtain real-time trade-offs between the geometry, time and cost of the proposed solution, thus increasing the chances of selecting a design that is both acceptable to the residents and which can also be executed within existing economic and temporal constraints. This is also consistent with the notion of finding trade-offs between Form, Function, Economy and Time, in order for sustainable designs to be developed (Pena and Parshall, 2012).

This study was undertaken in response to a gap in knowledge on participatory urban planning. While it is well accepted that stakeholder involvement in the planning process is critical to the development of sustainable and acceptable solutions, there is a lack of understanding on the methods by which stakeholders can be effectively involved in the design process leading to successful outcomes. Our results indicate that the Design Thinking approach presented and demonstrated in this paper can be one such systematic approach that can help in the generation of sustainable urban settlements. On the face of it, the Design Thinking process does not seem to be very different from conventional design processes that understand the needs of the users and then proceed with the development of a design. However, we believe that there are some distinct differences. First, there is a greater emphasis on the empathizing phase. Nearly 80% of the time we spent on the overall exercise was spent on this phase conducting detailed studies of the behaviours of the community, which is a marked difference from conventional approaches where the proportion of time spent in early engagement with communities is often considerably less. The second difference relates to the notion of rapidly prototyping and testing several options with a view towards learning, thereby continuing the interaction with the community,

but also ensuring greater success and ownership of the design. The latter part was accomplished through tools such as BIM which allow for visualization and easy modification. This again differs from conventional design approaches, where the intention is to directly generate 'solutions' once the design parameters have been identified. Finally, the entire design process under the design thinking approach is an iterative one, where designers are encouraged to move back and forth between phases – for instance, re-testing their hypotheses and design constraints after obtaining feedback on a prototype by moving back into the empathizing phase to reconnect with the users.

Our experience and observations suggest that Design Thinking can be applied to the field of Urban Planning to yield innovative and acceptable solutions. Melles et al. (2011) note that 'design has developed and evolved participatory and co-design approaches . . . proving that early involvement of designers with "wicked" social and environmental problems is possible'. The authors further note that the role of designers has changed from being a solutions provider to a 'facilitator of flexible design solutions that meet local needs and resources' (Melles et al., 2011, p. 143). This philosophical orientation is especially true in the architectural, civil and urban engineering domains where there is an abundance of such 'wicked problems' (Buchanan, 1992) featuring critical trade-offs between the economy, society and the environment. Our study indicates that the Design Thinking paradigm could prove to be an effective approach in understanding such trade-offs and in discovering solutions that may best fit the needs of the community for which they are being designed for. We would like to encourage more designers who design for the built environment to adopt a 'Design Thinking' approach, while keeping in mind some of the lessons we have learnt through our experiences in Srirangapatna, for designing a more sustainable world.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

- Azhar, S. (2011) Building information modeling (BIM): trends, benefits, risks, and challenges for the AEC industry. *Leadership and Management in Engineering*, **11**(3), 241–52.
- Beckman, S. and Barry, M. (2007) Innovation as a learning process: embedding design thinking. *California Management Review*, **50**(1), 25–56.
- Brown, T. (2008) Design thinking. *Harvard Business Review*, **86**(6), 84.

- Brown, T. and Wyatt, J. (2010) Design thinking for social innovation. *Stanford Social Innovation Review*, 30–5. Available at http://ssir.org/articles/entry/design_thinking_for_social_innovation?utm_source=twitterfeed&utm_medium=twitter.
- Buchanan, R. (1992) Wicked problems in design thinking. *Design issues*, 8(2), 5–21.
- Construction Users Roundtable (CURT) (2005) *Optimizing the Construction Process: An Implementation Strategy*, CURT, Cincinnati, OH.
- Cooksey, B. and Kikula, I.S. (2005) *When Bottom-Up Meets Top-Down: The Limits of Local Participation in Local Government Planning in Tanzania*, Mkuki na Nyota Publishers, Tanzania.
- Cowan, J. (2012) Integrating design thinking practices into the public sector, PhD diss., Hubert H. Humphrey School of Public Affairs.
- Dorst, K. (2011) The core of ‘design thinking’ and its application. *Design Studies*, 32(6), 521–32.
- Dunne, D. and Martin, R. (2006) Design thinking and how it will change management education: an interview and discussion. *Academy of Management Learning & Education*, 5(4), 512–23.
- Dupont, V., Banda, S., Vaidya, Y and Shankare Gowda, M.M. (2014) Unpacking participation in Kathputli Colony, Delhi’s first slum redevelopment project Act I. *Economic & Political Weekly*, 49(24), 39.
- Great Britain. Dept. of the Environment, the Regions, Commission for Architecture, & the Built Environment (2000) *By Design: Urban Design in the Planning System: Towards Better Practice*. Thomas Telford, London.
- Hall, P. (2014) *Cities of Tomorrow: An Intellectual History of Urban Planning and Design since 1880*. John Wiley & Sons, Chichester, UK.
- Jankowski, P. (2007) Towards participatory geographic information systems for community-based environmental decision making. *Journal of Environmental Management*, 90(2), 1966–971.
- Johansson-Sköldberg, U., Woodilla, J. and Çetinkaya, M. (2013) Design thinking: past, present and possible futures. *Creativity and Innovation Management*, 22, 121–46. doi: 10.1111/caim.12023
- Katz, P., Scully, V.J and Bressi, T.W. (1994) *The New Urbanism: Toward an Architecture of Community*. McGraw Hill, New York.
- Kim, W. and Mauborgne, R. (1997) Fair process. *Harvard Business Review*, 75, 65–75.
- Larice, M. and Macdonald, E. (eds.). (2013) *The Urban Design Reader*. Routledge, Abingdon, UK.
- Larsson, S., Tyrstrup, O., SSPA Sweden, McCarthy, D., Dyodo, S, Potgieter, S. and Nelson Mandela Bay Municipality (2007) *Sustainability Community Planning Guide*, Land Planning and Management Division of the Housing and Land Directorate of the Nelson Mandela Bay Municipality.
- Mahalingam, A., Yadav, A.K. and Varaprasad, J. (2015) Investigating the role of lean practices in enabling BIM adoption: evidence from two Indian cases. *Journal of Construction Engineering and Management*, 05015006.
- Melles, G., de Vere, I. and Mistic, V. (2011) Socially responsible design: thinking beyond the triple bottom line to socially responsive and sustainable product design. *CoDesign*, 7(3–4), 143–54.
- Moughtin, C., Rafael C., Christine S. and Paola S. (2004) *Urban Design: Method and Techniques*. 2nd ed. Architectural Press/Elsevier, Amsterdam.
- Norman, D.A. (2002) *The Design of Everyday Things*. Basic Books, New York.
- Owen, C. (2007) Design thinking: notes on its nature and use. *Design Research Quarterly*, 2(1), 16–27.
- Pena, W.M. and Parshall, S.A. (2012) *Problem Seeking: An Architectural Programming Primer*. John Wiley & Sons, Hoboken, NJ.
- Rowe, P.G. (1987) *Design Thinking*. MIT Press, Cambridge, USA.
- Salter, J.D, Campbell, C., Journeay, M. and Sheppard, S. (2007) The digital workshop: exploring the use of interactive and immersive visualization tools in participatory planning. *Journal of Environmental Management*, 90(6), 2090–101.
- Sanoff, H. (2000) *Community Participation Methods in Design and Planning*. John Wiley & Sons, New York.
- Schrage, M. (2013) *Serious Play: How the World’s Best Companies Simulate to Innovate*. Harvard Business Press, Boston, USA.
- Teicholz, P. (2004) Labor productivity declines in the construction industry: causes and remedies. AECbytes. Available at http://www.aecbytes.com/viewpoint/2004/issue_4.html (accessed 15 July 2014).
- Tress, B. and Tress, G. (2002) Scenario visualization for participatory landscape planning – a study from Denmark. *Landscape and Urban Planning*, 64(2003), 161–78.
- Yan, W., Culp, C. and Graf, R. (2011) Integrating BIM and gaming for real-time interactive architectural visualization. *Automation in Construction*, 20(4), 446–58.