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Constructing Empirical Public Decision-Making: The Application of Situated Data to Development in Consolidated Informal Settlements
Division of Social, Behavioral, and Economic Sciences

Year 1 reporting

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What are the major goals of the project?
Like other cities in Latin America, approximately 30% of São Paulo, Brazil's urban fabric is informally constructed. The government's successive redevelopment of these areas over decades has resulted in highly heterogeneous environments whose nexus has yet to be evaluated. The lack of empirical data about the impacts of these dynamics on people and urban form limits the ability of residents to participate in the planning processes that change the future of their own neighborhoods. It also limits the extent to which cities in developing regions can claim equitable planning processes and outcomes, and suppresses public knowledge about the efficacy of development in improving urban livability.

In response to these challenges, the primary research goal is to use the participatory creation of source data to transform informal settlement redevelopment. To achieve this goal, the research is guided by three core objectives, including (1) designing a survey instrument that evaluates the social and physical patterns of redevelopment in the Heliopolis and São Francisco settlements; (2) applying the instrument to the analysis of five development types shared by these two settlements: (1) Mutirão / Assisted Self-Help; (2) Autoconstrução / Unassisted Self-Help; (3) Cingapura; (4) Urbanization of Favelas; and (5) Minha Casa Minha Vida; and (3) creating a new parametric urban digital tool that visualizes data findings in 3D to facilitate decision-making about future informal settlement redevelopment. While this study is being undertaken in low-income areas of São Paulo, Brazil, it is designed for replication in peer cities.

What was accomplished under these goals? (you must provide information for at least one of the 4 categories below

Major Activities

Three major areas of activity support the achievement of these objectives.

1 – Survey Instrument Development, Random Selection, and Implementation
The survey instrument was informed by a literature review and work previously undertaken by the Latin American Housing Network (LAHN), developed over four workshops with community leaders in the fall of 2015, and refined through piloting in the spring of 2016. This led to a (1) a block level survey (20 questions) for measuring physical consolidation and presence of commerce at a neighborhood scale; and (2) an integrated household survey questionnaire (150 questions) and post-occupancy documentation of physical space (50 questions) of 1183 households for measuring the impacts of government housing

redevelopment policies on technology, social agency, and physical consolidation, and the relationship of these dimensions to the broader political economic context of which they play a part. From the 1183 households, 30 interesting cases will be selected for a (3) in-depth interview and physical analysis of lot-level housing dynamics.

A two-step stratified random selection process is described in the attached PDF “16_NSF Sample Size.”

The implementation of the surveys is being undertaken by a team of three people in each of the two case study communities: one Research Assistant (a Graduate student of Architecture and Planning) and two community members, all of whom underwent four phases of training in the spring of 2016. The survey began in May of 2016 and is currently on target for completion in October 2016. As of 7/19/2016, data from all but the Autoconstrução and Minha Casa Minha Vida types have been collected.

2 – Graphic and Numerical Database Construction

Digital 2D and 3D models have been constructed for both study areas to organize the fieldwork and visualize the multiple at various scales and levels of detail the multiple typologies present in the two case study areas.

The 2D models created for each of the two case studies merge multiple graphic datasets (Computer Aided Design – CAD and Geographic Information System – GIS) and indicate randomly selected blocks and, following survey implementation, selected lots. This drawing “16_NSF_2D Model of Heliopolis” is updated on a weekly basis.

The 3D models include topography and structures in and around study areas (approximately 50,000 buildings). The construction of accurate 3D models required merging CAD and GIS with Google Street View into one file type which is Rhino – a 3D modeling software. In order to accurately represent the height of structures in and around the study areas, height data was collected from the City of São Paulo's digital database and supplemented with Google Street View imagery. This height information was linked to each individual structure and a script was created in parametric modeling software, Grasshopper (a Rhino plugin). This script links metadata tables (height data) and vector polygons (building footprints) to accurately construct urban-scale 3D models in Rhino. Rendered diagrammatic images were created with Vray rendering software (a Rhino plugin) and edited in Photoshop. The model images included in the PDF “16_NSF_3D Model of Heliopolis” are diagrammatic representations of the four constructed development types currently being surveyed. The Minha Casa Minha Vida type is not represented in the renderings because it has yet to be constructed.

Figure 1 Digital model of the Heliópolis and São Francisco communities, with all buildings coded relative to type. These categories informed the weighted survey sample size.

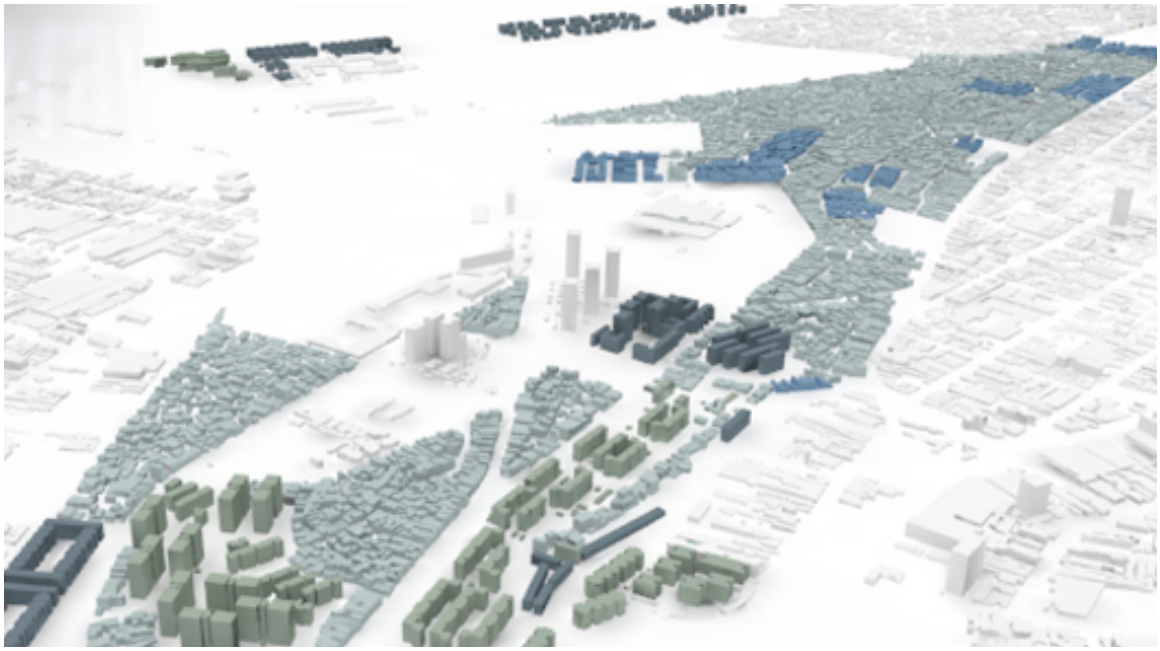


Figure 2 Morphology studies of two types of incremental housing: sites and services “core” housing and autoconstruction.

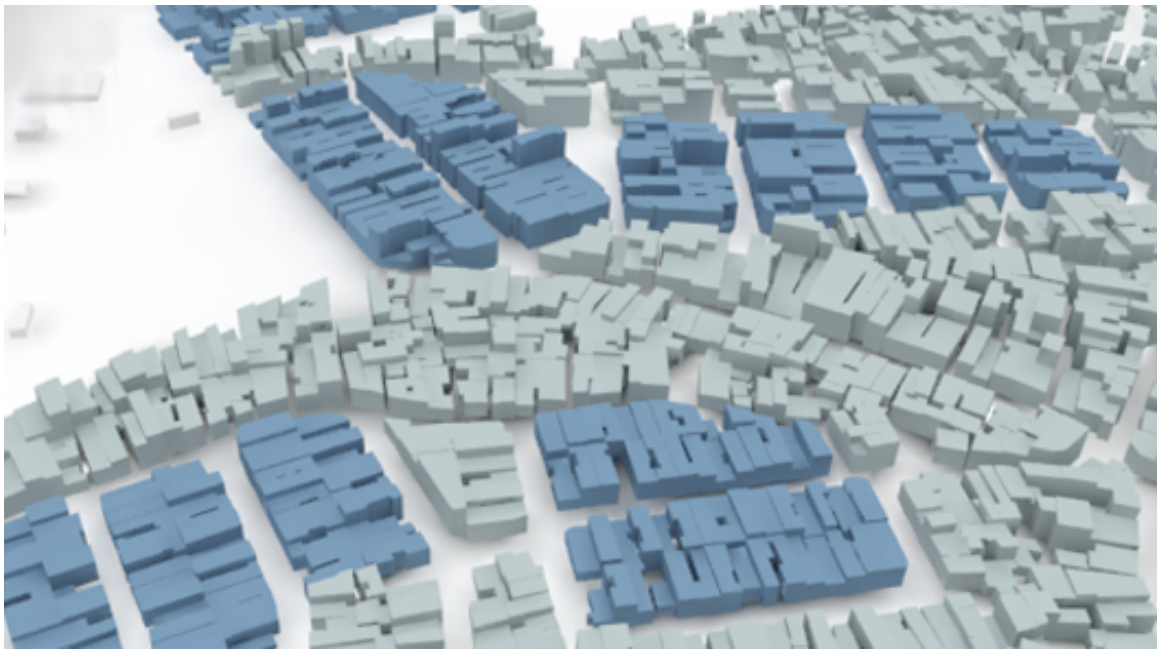
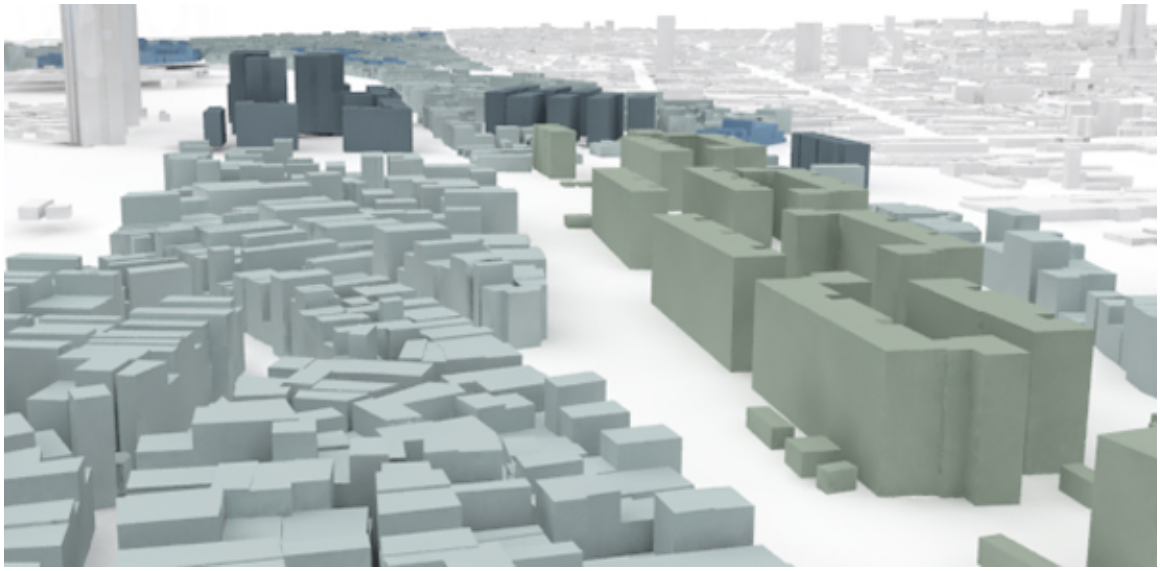


Figure 3 Modeling of State-led redevelopment (social housing projects that replaced informal housing)



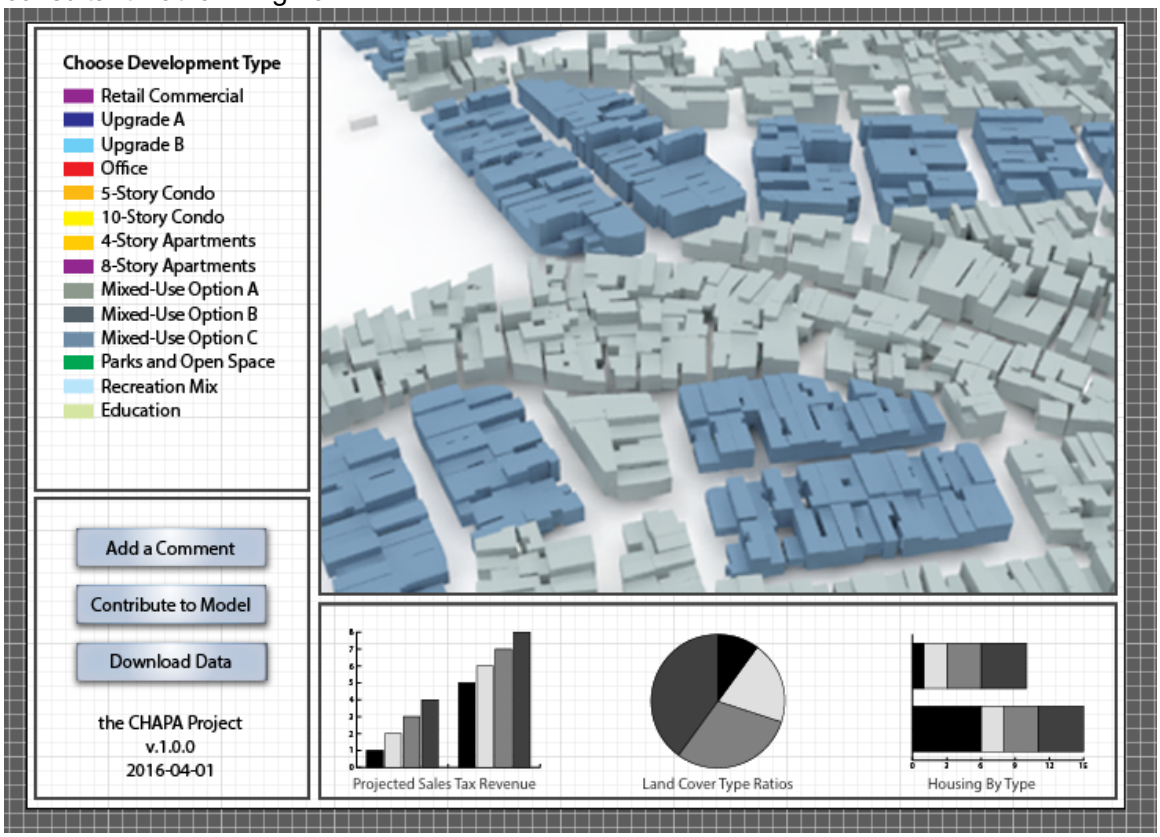
3 - Design Tool Framework

The underlying method behind the parametric design tool is scenario planning using Envision Tomorrow (ET). ET is an open-source scenario-planning tool that measures impacts (e.g., environmental, transportation, economic, health) to communities by connecting building data to land area. ET is built around a series of Microsoft Excel Workbooks that describe the physical and financial parameters for individual buildings. Those buildings are then bundled into “Development Types” along with provisions for neighborhood block areas, sidewalk widths, road widths, and park space. Traditionally and in the context of the United States, the analysis is done using ESRI’s proprietary ArcMap. For the purposes of this project, ET will be modified into another system in order to translate the data collected through the survey and the mobile App (description to follow) into 3D scenarios. These scenarios will be based on the physical and social parameters of buildings and development types unique to informal settlements.

This modification responds to four major critiques of ET: (1) that its outputs do not measure building level impacts; (2) that ET’s measurement of only physical and economic impacts excludes social impacts from planning consideration; (3) that ET seeks only to measure higher level, collective impacts that often have little import for immediate needs in low-income communities; and (4) that ET lacks a visual component beyond 2D mapping imagery produced by ESRI’s ArcMap. The translation of ET’s core functionality into another system responds to these limitations by translating data into an interactive mobile web Application and a plug-in for Grasshopper, a graphical algorithm editor integrated with Rhino, for exploring block and building level scenario impacts in 3D.

The benefit of an interactive web application and a plug-in 3D design tool is a set of metrics for improving decision-making processes related to land use and design decisions. By measuring the relationship between building level details and broader urban patterns, these metrics hold significant potential to help community organizations, governments, NGOs, academics, professionals in architecture and planning, and policy makers increase the efficacy and equity of development in vulnerable urban areas. The preliminary dashboard of the 3D design tool with the 3D model of Heliopolis can be seen in PDF “16_NSF_ET Simulation_Heliopolis.”

Figure 4 Schematic of interactive mobile scenario planning tool created by contracted consultant Nathan Brigmon.



A mobile application is being developed to disseminate the data findings and support an ongoing data collection process linked to GPS coordinates. Currently in a nascent stage, the mobile application will work on both iOS and Android platforms using Ionic's open source mobile software development kit. The goal of the mobile application is to empower residents to contribute data to their community's development and to explore its relationship to the dataset produced by this research. The user will have the ability to explore alignments and discrepancies between the data collected through this project's fieldwork and their own perceptions, and have the ability to inform a collective dataset. A secondary goal is the creation of a digital repository for use by programmers, researchers, and developers focused upon the intersection between technology, participation, and redevelopment in the urban Global South

As illustrated in the PDF "16_NSF_Mobile Application Platform," user interface with the application segues through five main pages. The first offers the user two options: contribute data or explore data. If the user selects the explore option, a variety of tools will be presented (e.g. maps, data dashboard, summary tables) to explain the current community conditions according to the dataset produced through the survey. Upon selection of the contribute option, the user will be guided through a process that allows for the addition of qualitative and quantitative data. First, the user will encounter a series of icons that represent common community challenges, such as trash, crime, noise, and flooding. Selected challenges may

be identified in space and the user may submit a report about its practical, historical, and cultural gravity.

The outcomes of the application are three-fold. First, it provides an easily accessible digital space for residents to anonymously participate in the identification, resolution, and spatial articulation of current community issues. The ability to visualize problems, compare various datasets, and visualize potential solutions creates real-time metadata with the potential to inform city officials, planners, and architects of communities whose issues are often overlooked. Second, the evolving dataset could be used by data scientists in conjunction with machine learning algorithms to predict the needs of citizens based on historical data, and connect citizens to local resources for preempting foreseeable neighborhood problems.

Third, the App will enable the project team to maintain a continuing dialogue with the community following the conclusion of the survey data collection period. While the initital data collection will yield in-depth results, the App's ongoing data dialogue will calibrate findings to emerging evidence. As an example, the App dialogue may shed unexpected light upon the accuracy, disparity, or ephemeral nature of the survey results.

What opportunities for training and professional development has the project provided
The project has involved new technical and management training opportunities for three main groups: PIs, Support and Consultants, and Community Partners. Within the first PI group, the candidate fellow is very generally learning how to undertake a quantitative research project, including (1) developing research project management skills by constructing and coordinating a transdisciplinary team; (2) becoming facile with survey design using the Qualtrics digital survey suite, and managing its implementation through a stand-alone application on four IPads; (3) re-engaging Computer Aided Design (CAD) and Rhino – digital architectural tools – for improving their interface with the digital tool that the project will produce; and (4) learning SPSS. The two mentors are learning about the capacity of the digital tools described above to contribute to answering new kinds of research questions. Within the second Support and Consultant group, the two research assistants have learned the Qualtrics digital survey suite, and the IT expert has taught himself how to build the project's interactive App as well has initiated the reconfiguration of Envision Tomorrow, an open-source land use planning tool, so that it meets the purposes of this project. The third, community partner, group has undergone Institutional Research Board, fieldwork support, physical space documentation (including photography and measurement), and Qualtrics training.

How have the results been disseminated to communities of interest?
The results of this project have been and will be disseminated to communities of interest through four primary modes of communication: (1) two conference papers to be delivered at the 4S (The Society of the Social Study of Science and Technology) annual conference in Barcelona (September 1-4, 2016) and the ACSP (Association of the Collegiate Schools of Planning) annual conference in Portland (November 3 – 6); (2) a symposium "New Measures: Frontiers in Post-Occupancy Analysis of Social Housing," at the University of São Paulo's Polytechnic School; (3) informational meetings with local government (Municipal Secretariat of Housing and State Housing Company - CDHU); and (4) a project website and cards with its address that are distributed to all surveyed households and any interested individuals. We have applied to hold a side event at the 2016 UN HABITAT-Quito conference to present the research and launch the App.

What do you plan to do during the next reporting period to accomplish the goals?

The goals of phase two, the next project year, are to (1) further develop and refine the interface between data collection and its application through the digital suite composed of the community development App and the open-source digital urban design tool for use by professionals and governments; and (2) produce peer-reviewed articles about the project's process and findings. To achieve these goals, the second year of funding will be directed to the project's technical achievements and their presentation to primary users in the two case studies and within the fields of architecture, planning, engineering, and real estate development. My time will shift from fieldwork management to analysis and writing. We are currently discussing the pursuit of an ICorps grant in further support of expanding the reach of the projects technical achievements among professional communities in design, planning, government, and non-profit worlds.

Products - What has the project produced?

To date the project products include (1) Post-Occupancy Survey Instrument for multi-family and single family building typologies of formal, informal, and hybrid construction; (2) Previously non-existent two and three dimensional drawings and maps of two of São Paulo's largest informal settlements; (2) an emergent library of 3D modeled building typologies encountered in the study areas; (3) the base framework for a 3D digital tool, including an interactive App and a modified Envision Tomorrow framework; (4) approximately 300 completed surveys of a 1183 sample size.

What individuals have worked on the project?

There are 13 individuals currently worked on the project during Funding Year 1.

PI Group
Kristine Stiphany
Peter M. Ward
Steven A. Moore

Support and Consultant Group
Nathan Brigmon
Kirsten Larson
Alessandra Figueiredo

Community Partner Group
Adalgisa Oliveira (ANESF, São Francisco)
Flavio Teixeira (ANESF, São Francisco)
Dayse Verderinho (ANESF, São Francisco)
Eliane dos Santos Simões (ANESF, São Francisco)
Barbara Bethania de Paulo Pinto (UNAS, Heliopolis)
Steffani Renata da Silva (UNAS, Heliopolis)
Manoel da Silva (UNAS, Heliopolis)

What other organizations have been involved as partners?

(1) The University of Texas at Austin
(2) The University of São Paulo's Polytechnic School has provided institutional support.
(3) UNAS in Heliopolis and ANESF in São Francisco have provided community support.
(4) SIAA has provided office space in São Paulo.

What other collaborators or contacts have been involved?

The research is inspired by the fieldwork methods established by the Latin American Housing Network at The University of Texas at Austin (https://www.lahn.utexas.org), a major research initiative established by the postdoctoral fellow's mentor, Peter M. Ward.

The São Paulo Secretary of Housing has been engaged.

John Fregonese, the creator of Envision Tomorrow, and his team provided initial technical support and a metric template for Envison Tomorrow. While we will likely distill ET to its basic code and reconstruct it for application in global urban contexts, Fregonese's involvement was helpful for considering how ET might translate to contexts of the Global South.

Brazilian colleagues from the fields of architecture, planning, and public policy have consulted about the project's general goals and anticipated outcomes. These local contributions have been critical for thinking through technical issues related to shapefile acquisition and development, the practical issues of community engagement, and the project management of transdisciplinary teamwork.

Impact - What is the impact of the project? How has it contributed?
The project is creating a social impact analysis method and tool for evaluating and visualizing how historical patterns of change impact future development alternatives. This dual analysis – application strategy has significant potential to change how urban development is undertaken in developing and developed world regions. Very broadly and concretely, the project is using empirical evidence to challenge two key paradigms of urban development for marginalized communities: (1) the technological determinist idea that the value of social housing is afforded by politicians and architects, and (2) the social determinist idea that citizen participation in planning is afforded only through contact with experts and elites. The project is engaging an emergent and alternative theory, which is that technological value and social participation are enhanced when users have access to technologies that help them to visualize, communicate about, and make better decisions in support of their immediate contexts. In other words, the argument is not that everyone is a designer, but that everyone has relevant knowledge and the capacity to contribute something to urban design and development.

This research has impacted the fellow's career trajectory in three primary ways. First, the quantitative analysis of two communities previously studied ethnographically has refined the fellow's understanding of what methodological tools to use when, and challenged her previous assumptions about how the interests of community residents relative to development are articulated and achieved. Second, the study's collaborative approach to source data development has led the fellow to more precisely consider how local dimensions of urban change relate to the broader political economic contexts of which they play a part. Third, this research has expanded the technical tools through which the fellow can draw to effectively lead complex, transdisciplinary research projects for integrated social and spatial analyses.

What is the impact on the development of the principal discipline(s) of the project?
The project's principle disciplines are urban planning, policy and international development, and architecture. While these disciplines separately promote participatory practices for urban transformation, most lack technologies for linking local knowledge to

outcomes. The project's focus upon the role of participatory methods for transforming not only how the urban environment is assessed, but physically altered, provides these disciplines with a practical and pedagogical strategy for uniting transdisciplinary actors around shared urban themes – housing, urban livability, and resource management among others. This strategy is unique for balancing the need for external and internal validity expected of any research project with the inclusion of individuals often overlooked as partners within conventional research undertakings.

What is the impact on the development of human resources?
This research has impacted the development of human resources in three ways. First, it has consolidated a range of people, knowledge, and experiences into a team whereby these particular perspectives have begun to influence broader social, community, institutional, and intellectual contexts of which they play a part. Second, the training and development related to the post-occupancy survey and digital tool will lead to a range of impacts in informal settlement development by community participants whose direct involvement in the study is one part of a broad spectrum of community development activities to which these individuals have long contributed. Third, the triangulation of data, intellectual exchange with local government, institutional contacts, and community partners, and measurement of evolving environments has changed how the PI and consultant group participants assimilate social and physical data into subsequent work, disseminate findings through the project's web presence, analyze outcomes with the open source tool, and share new knowledge through scholarly publications.

What is the impact on physical resources that form infrastructure?
The research provides a set of methods and a digital platform for community participation in the conceptualization of new infrastructure. The digital tool provides a way to alert the government to infrastructure problems and a result the development process can fix or supplement where infrastructure is lacking. Be it trash, water, sewage, lacking public space, lighting, schools, etc. As cities densify, new infrastructure interventions must invariably graft onto existing ones. This grafting process is limited by the lack of assessment processes for evaluating the challenges and opportunities of existing conditions relative to proposed projects. As a result, public knowledge about the efficacy of infrastructure is suppressed. While this research focuses upon urban development infrastructure in informal settlements, its contribution of a transparent process for evaluating the co-evolution of humans and physical artifacts that constitute infrastructure is relevant for peer cities and communities across the world.

What is the impact on institutional resources that form infrastructure?
There are three ways that the research impacts institutional resources that form infrastructure. First, the research builds on and contributes to post occupancy evaluation of social housing that has been undertaken within the University of São Paulo's Polytechnic School (Civil Engineering). Second, the research as an infrastructure impacts how partner community organizations engage constituents to build more robust and responsive programs, expand participation opportunities for broader social cohesion, and leverage community assets toward physical improvements. Third, the fellow becomes a point person for planning concerns in the global south that involve infrastructure in informal settlements, to some extent in the case of The University of Texas at Austin but more significantly in the Fellow's future institutional home.

What is the impact on information resources that form infrastructure?

The impact of the research on information resources will occur in three phases. The first is a post occupancy household survey that draws on the knowledge of residents and observations of community members as a means of systematically evaluating redevelopment projects in informal settlements. The second impact is the as yet to be launched digital tool which will allow for citizens in any urban neighborhood – but especially those in which people fear the consequences of speaking out – to communicate problems related to infrastructure with the government. The third impact is a post occupancy development process and tool that can be utilized as a non-partisan tool in subsequent projects to create feedback loops for institutional memory and expand public knowledge of development efficacy in particular contexts.

What is the impact on technology transfer?
Technology transfer in the context of this research occurs at different scales. The most immediate is the reengineering of the open source land use tool Envision Tomorrow as a three-dimensional visualization tool. Second is the modification of post occupancy evaluation to contexts of the global south and the participatory processes that guide urban planning within them. The third scale is the study's identification of technology transfer from the process of self-building into other community infrastructures as a guide for future community and urban development.

What is the impact on society beyond science and technology?
There are four main impacts on society beyond science and technology. The first is inclusion of women and marginalized populations in research activities for expanding participation of marginalized populations in urban planning processes. The second involves increased security for people who wish to participate in community development but are fearful of the local repercussions for doing so. The third is enhanced public understanding of the changing nature of poor urban neighborhoods for better aligning global policy goals with social needs in vulnerable regions. Finally, the study's process improves the design, implementation, and maintenance of infrastructures toward enhanced social health, safety, and welfare.

Changes in approach and reasons for change
Two changes in approach shaped an emergent research design. The first involved the expansion of the digital tool product to include a parallel mobile app. The reason for this change was to (1) expand to a broader public access to the research and its outcomes, and (2) create a medium through which data collection could be ongoing and the study expanded over the long-term.

The second involved a modification to the random selection process. Given the context of informal settlements, the random selection of study blocks has invariably landed upon areas known for concentrated levels of organized crime and advanced drug activity. For safety reasons and because the specificity of these micro neighborhoods would likely influence the data findings, the small number of known blocks (8 of 290) was eliminated and the sample drawn from the other blocks.

Actual or Anticipated problems or delays and actions or plans to resolve them
First, the Zika virus and political economic crisis led to the data collection being pushed ahead to avoid the summer season (Fall 2017) and São Paulo's municipal elections. Unavoidably, however, initiation in April 2016 meant exposure to volatility and riots around President Rousseff's impeachment, leading to the pilot's delay and its entire period extended by a month due to political marches within the two case studies. Given

the complexity of the data collection process, this shift was beneficial for many reasons beyond that of avoiding Zika infection and political crises.

Second, the fellow overestimated the capacity of four teams to coordinate and produce commensurate data across two case studies, and for each team to gather data on block level and household level phenomena simultaneously. To ensure data collection quality, the household and block level data collection processes were bifurcated, and the PI and research assistants placed in charge of all data entry into the Qualtrics system. The solution was the creation of two teams per case, the first for household level data collection (a research assistant and one or two community members) and the second for block level data collection (the Fellow and one community member).

Changes that have significant impact on expenditures

There were two significant modifications to expenditures in the form of unanticipated costs: the technological tool and the Qualtrics stand-alone app. We realized early on that the goal of applying social data to spatial parameters would require a technology that does not yet exist, and soon after that the product should exist in parallel formats: one, a public, mobile app, and the other, an open-source digital tool for professional use. $5,000 was budgeted for what will be a $14,000.00 total cost. Second, while the internet connection was tested multiple times and in multiple places within each of the case studies during the fall of 2016, connectivity proved spotty during the pilot in March of 2017. This reduced connectivity has been reported and was experienced by the Fellow across São Paulo. As a result, a stand alone app license was needed from Qualtrics, with whom The University of Texas at Austin has an agreement. We were able to procure a one year departmental license for $1000.00, which can be used by up to 24 colleagues in the School of Architecture. The difference of $10,000 has been covered by one of the project's mentors, Steven Moore.