Green Building Policy and Real Estate Development:
A Causal Mapping Study Derived from Qualitative Data

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Abstract

Policymakers in the U.S. have taken steps to slow climate change, and significant policy activity has taken place at the local level with a focus on the built environment. An investigation of the dynamics which influence business responses to sustainable building policy is timely as regulatory changes oriented toward resiliency of the built environment are under consideration by cities and states. This paper presents the results of a study of the dynamics of public policy and corporate decision-making and action. Qualitative data drawn from interviews with professionals in corporate decision-making roles suggests that green building policy change is a mechanism which ignites forces driving practice changes across a production ecosystem of companies linked by business relationships. Causal maps derived from multi-pass coding of qualitative data reveals the perceptions of real estate developers and describe the dynamics of a complex ecosystem including policy, market and project forces. Policy-oriented practice change is driven initially by two sets of forces – those of public interests as expressed through policy, and those of the marketplace understood in terms of supply and demand. The propagation of these forces through a production ecosystem is studied at three levels – the cause and effects as perceived by developers, the behaviors as described by developers, and the interpretations and responses to specific types of climate change regulation.

Keyword: Green Building Policy, Real Estate Development, Grounded Theory.

1. Introduction

The real estate industry is a large and influential commercial sector of the U.S. economy which derives income from creating, renovating and managing the built environment. Starting in 2005, municipalities across the U.S. began to impose new built environment regulations aimed at reducing the impact of building construction, renovation and occupation on climate change. Because these regulatory changes introduced new models of compliance and implementation into the marketplace, they provide a context for inquiry into the thought and value systems which govern how businesspeople map their understanding of regulation to the processes of business and profitability. The pervasive activity of the real estate industry provides opportunities to study the dynamic relationship between forces of policymaking and of the marketplace, and to gain a deeper understanding of the way these forces interact and result in practice change. The fundamental question of this research is – how do individuals with authority to make real estate investment decisions respond, and how do professional practices evolve in dynamic economic, social, and marketplace contexts, when policies change.

Built environment changes are executed by commercial businesses including real estate, architecture, engineering, and construction companies which form business networks to execute specific projects. As a first step in understanding the impacts across the wider network of businesses which participate in the transformation of the urban environment, this study focuses on the perceptions of individuals who launch the development process and initiate the formation of project teams, the professionals who work actively on projects in the commercial real estate industry. When regulators implement green building policies, it is generally with a clear understanding of the objectives that are being sought, combined with a hypothetical understanding of the way that regulated parties will behave in response. By providing insight into corporate processes, thoughts and values, in order to increase policymaker understanding of the likely consequences of specific regulations, the research aims to improve the effectiveness of policymaking related to the built environment. A better understanding of the dynamic system of

actions, causes and effects leading to specific investment decisions will enable policymakers to more effectively create, adopt and enforce policies aimed at driving desired behaviors and practices.

How do perceptions and attitudes evolve, in light of policy change as well as economic change? How do investors interpret policy amid the complex set of factors surrounding investment decisions? This research proposes a theory about the way real estate developers change their practices and experience the process of discovering new business opportunities and executing business in light of green building policy change through the development of a causal map. Real estate developers must anticipate and ameliorate risks associated with transforming the urban built environment, while they manage a complex set of business partner, consultant and policymaker relationships. By studying the dynamics of practice change propagating throughout a network of affiliated real estate professionals and partners, this research observed that green building policy change is a mechanism for transformation of the entire production ecosystem, in which the real estate developer is the initiator.

Sustainability and Green Buildings

In the past decade, municipalities incorporated climate actions among high priority objectives targeting the built environment. Since 2005, hundreds of U.S. mayors opted to sign the "U.S. Conference of Mayors Climate Protection Agreement"[1] drafted and endorsed by the 73rd annual U.S. Conference of Mayors meeting in Chicago, committing to reduce climate impacting emissions in their respective jurisdictions to seven percent below 1990 levels by 2012 ("The U.S. Mayors Climate Protection Agreement," 2005). Municipalities observed that action was not being taken at the Federal level and over six hundred cities and towns in the U.S. opted to create their own policies aimed at reducing the impact of the built environment (Millard-Ball, 2012). Stated objectives of these policies focused on the intention to make good on climate

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[1] http://www.usmayors.org/climateprotection/documents/mcpagreement.pdf

action commitments and make urban environments more energy- and resource-efficient, healthful and appealing[2].

Climate Change action plans adopted by states or municipalities incorporate regulations specific to the development or management of the built environment. For local governments in the US with climate action plans, the plans are used at the strategic or overarching policy level. Climate actions and their measurements focus on reducing climate-impacting emissions in regulated areas. These plans set targets for emissions reduction, establish measurement practices and lay out initiatives designed to achieve reductions. Recognizing the significant impact that occupation of built environments has on urban emissions, actions often include extensions of traditional building regulations – such as building codes or zoning ordinances – to limit the greenhouse gas production caused by building development, and to require completed building projects to be more energy efficient through design and construction innovation.

2. Theoretical Background

This study builds on existing theories about the perceptions of regulation and their impacts on the behavior of individuals in roles with corporate decision-making authority. By studying the perceptions of regulated company representatives in the specific context of building regulation, it is possible to formulate a theory about the way businesspeople convert their understanding into action and gain insight to inform future policy design. (Millard-Ball, 2012)

Mental Models and Dynamic Systems

A concept which the research explored is whether perceptions of the dynamic relationships between the work of development corporations, the regulatory environment and the marketplace impacts the way decisions are made and the eventual outcomes and effectiveness of policy. To this end, the application of causal mapping to business strategy was incorporated. Models of real estate and construction which appear in the System Dynamics Modeling literature

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[2] http://www.epa.gov/statelocalclimate/local/local-examples/action-plans.html

support the value in applying causal models to this specific industry literature (Sterman, 2000) (Ford, 2010). Causal or system dynamic models of the intersection of green building policy change and real estate development have not yet been developed. Texts covering model-building in groups (Vennix, 1996) and in communities focused on environmental issues (Van den Belt, 2004) provide context for structuring causal mapping sessions to gather data for the research. This study applies qualitative coding procedures to the development of causal maps of mental models, adopting a method of coding and identification of causal references which system dynamics modeling researchers have applied in other policy and economic contexts, including that of the Federal Reserve economic policy discussions and of floodplain management (Kim, 2012) (Deegan, 2011).

Industry Practices and Norms in Real Estate

The field of real estate development has, over time, evolved more rigorous standard practices pertaining to investment and project execution. Prior to 1960, the field of real estate investment lacked a development methodology for evaluating real estate investment property. There was a need for better understanding of modeling and theory building at that time. Practitioners now have access to a range of standard tools and methods to support analysis of business alternatives and decision-making. These methods include a number of financial calculations which compare parameters such as a loan to value ratio - the dollar value of the loan required to complete a project compared to the expected value of the asset. Researchers have compared these financial measurements to project outcomes, such as revenue, and come to conclusions about which variables shed the most light and most accurately predict project profitability and success (Jaffe & Sirmans, 1995) (Jaffe, 1979; Jaffe & Sirmans, 1982)

Industry practices in real estate suggest that decisions are made according to established rational models and processes. The literature of real estate development practices provides a useful set of tools and calculations for investment evaluation (Lindholm, 2008) (Miles & Urban Land Institute., 2007). Economic models for real estate markets in urban settings provide a useful

context for development of system dynamics models which capture the elements of these complex systems and their interactions. (DiPasquale & Wheaton, 1996)

References in real estate economics (Geltner, 2007) and market analysis (Schmitz & Brett, 2001) suggest how specific projects should be evaluated in terms of risk and potential reward as investment opportunities (Long, 2011) (Sah, Gallimore, & Sherwood Clements, 2010) and (Lützkendorf & Lorenz, 2007) conducted research on the process of investment decision-making which provides insight into the ways that real estate investment decisions diverge from established practices such as Markowitz portfolio theory[3], and are impacted by non-financial parameters (Markowitz, 1952). The backdrop of assessment and professional practices, including financial modeling, projection and evaluation, are important contexts for discussions with real estate industry participants. Behavioral theory for questions of capital asset investment has been studied in the context of corporate real estate decisions made by manufacturing companies under environmental regulation (Bromiley, 1986). A comparable study of which includes real estate developers in the context of green building policy is needed to expand this discussion, and a qualitative investigation yielding insights about behavioral factors would augment the body of work based on quantitative studies.

Market Transformation

The final idea which informs this study is the concept of market transformation, which has been defined as a policy objective to drive changes in energy industry and increased adoption of innovations termed "clean", such as solar, wind, biofuel-based energy disassociated with climate impacting greenhouse gas emissions. Researchers have begun to approach market transformation with theories connected to the idea of ecosystems of interlocked providers. There is an opportunity for this research to study the concept of market transformation within the production ecosystem of real estate companies, architects, engineers, contractors and interlocked providers for the buildings in urban environments. (Blumstein, Goldstone, & Lutzenhiser, 2000)

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[3] Modern Portfolio Theory is a theory about how portfolios should be optimally constructed.

3. Methodology

This study investigates the way green building regulation affects industry practices in the design and construction of major buildings in urban environments. Commercial or multi-family residential construction is executed by groups of companies with specialized expertise. It is comprised of many disciplines, including architecture, engineering, interior design, construction, sub-contracting, finance, brokerage, building product manufacturing and specialized consulting. A study of real estate development is confronted by the complexity of the design, construction and asset management process, which is executed as a collective undertaking by a group with many perspectives. One way to gain insight into this process is to focus on a single group in order to develop a theory about the overall system through their perspectives. In order to gain insight into the workings of this complex industry sector, this research focused on the business practices and perspectives of one set of especially influential actors – the individuals with authority, accountability and resources to launch and complete projects. The scope of this research project was limited to gathering data directly from individuals in real estate roles - individuals with authority to make decisions and to respond to policy and regulation changes within their professional responsibilities – as opposed to the other professionals active in the process of delivering completed buildings or renovations to a client, owner, potential customers or occupants. The research focused on the changes in practices and perspectives of real estate developers who produce new buildings or renovate existing buildings in urban environments.

Grounded Theory and Causal Mapping

The two primary areas of focus which drove the grounded theory research direction were

> a> *understanding the thoughts and actions of real estate professionals given changes in green building policy, and*
>
> b> *understanding the real estate professional's perceptions of economic and social systems, in other words, the context for these changes.*

Empirical data consisted of expressed perspectives of individuals with authority to make real estate decisions. By gathering the perspectives of professionals working in organizations which initiate and complete urban building projects - real estate developers or corporate business entities charged with overseeing real estate – this research proposed a theory about the interactions between policy and market factors in this economic sector.

The principle research question described in this paper is:

Research Question: How is the system of policy and market forces perceived by individuals who execute urban development or renovation projects?

To gain insight into the nature of practice change and formulate a theory about policy impacts, the grounded theory method was combined with causal mapping to derive a theory from qualitative data. Grounded theory method (GTM) was developed by Barney G. Glaser and Anselm L. Strauss nearly fifty years ago (Glaser & Strauss, 1968) and the method has been applied to many research areas, including questions of corporate activity and management decision-making which are related to the focus of this study (Goulding, 2002). GTM provides a means for researchers to build theory in a topic area which has not yet been thoroughly investigated. Practitioners in real estate make decisions based on an understanding of the likely consequences of specific actions, based on their professional training and experiences. A theory about the impact of policy on real estate decisions benefits from insights about ways practitioners conceive of the economic and social systems within which they operate to achieve their objectives. The concept of mental models and the value of representations of these models in the form of images or diagrams has been demonstrated through research, which defined types of mental representation such as "strings of symbols that correspond to natural language, mental models which are structural analogues of the world, and images which are the perceptual correlates of models from a particular point of view" (Johnson-Laird, 1983). A causal map or causal loop diagram (CLD) is a method of depicting relationships as they are understood in mental models. Causal mapping is particularly useful in understanding systems where factors or resources interact in complex or unanticipated ways, such as when two factors combine to

counteract one another, or to form a feedback loop. Applications of cognitive mapping in the context of complex policy situations incorporated causal assertion and demonstrated impact in decision-making in military and political arenas (Axelrod, 1976).

Causal maps provide insight about the way a system is understood to be organized by the participants. Studies of the application of causal mapping in qualitative research suggest that eliciting information from mental models of individuals experiencing a phenomenon could lead to the creation of useful theories about the system as it is conceptualized by participants and described through focus groups or individual interviews (Luna-Reyes, 2003). A technique for coding cause and effect was drawn from causal mapping studies applied to related situations of policy impacts in natural resources and economic situations, which share aspects of the problem of sustainable buildings which are developed through business enterprises (Morecroft, 2007) (Deegan, 2011) (Deegan, 2009) (Kim, 2012).

A theoretical sampling strategy was employed to gather data from twenty-four individuals in professional roles which enabled them to influence real estate projects in Boston or New York City. The objective of the sample selection was to gather responses from a wide range of individuals so as to yield sufficiently diverse points of view from which to draw theoretical observations. A focus on commercial or large scale residential development (i.e. multifamily) was emphasized so that the sample could reflect the perspective of industry segments critical to urban growth and economic development, and which have been a focus of green building policy. By keeping the industry focus consistent, while varying the sample by firm and interviewee characteristics, geographic location and degree of sustainable project focus, the intention is for the research to yield a theory with broad applicability.

Following the protocol of grounded theory, analysis of the data began with open coding. The list of codes was grouped by characteristic and initial approaches to categorization, which related the actors, actions, events, and decision-making, was developed. Ultimately, the open coding and categorization process yielded a code hierarchy with 230 code items grouped into eleven main categories. The main categories were Causes and Effects, Company, Ecosystem,

Governance, Groups, Marketplace, Measurement, Policy, Professional, Project Examples, and Sustainable Tactics.

The Straussian GTM concept of "axial coding" is a means to organize the fragments identified by open coding into more coherent structures. The use of a well-defined paradigm or framework to guide coding is advocated (Strauss & Corbin, 1998), suggesting that codes will emerge from the data based on specific categories – conditions, actions, consequences. For the purposes of this project, axial coding focused on causality progressed as transcriptions were closely coded for evidence of cause and effect perceptions. Each instance was noted in a cause/effect chart which provided an identifier, a cause and an effect interpretation, and a direct quote of the associated text as evidence. For example, when the interviewee said "So for me it's an opportunity to be somewhat more daring because I have some equity to spend down", this was interpreted to represent the fact that "Financial Resources" (Cause) is a condition which leads to Openness to Risk (Effect on a Resource) (Figure 1).

ERH- Cause/Effect Table

Causal Link ID	Cause	Effect on Resource	1	Evidence	2	Description	Comments	#
14062 4-1A	Financial Resources	(Openness to) Risk.	+	So for me it's an opportunity to be somewhat more daring because I have some equity to spend down.		Having financial resources available, cash or access to funding for innovation, to invest in practice change.	Being open to risk; Taking opportunity to innovate; (positive = willing to accept risk)	1
14062 4-1B	Ambition of Project Goals	Demand for Technical Expertise	+	We setup a goal of building a building which would cut into use by 80% and we had architects who were very willing to say that they could do that and they could not -- we went to five architects. … and so this became a Passive House building and we brought in German Engineers to help design it. So they can do it, no question. The architects -- the local architects who sort of bought on and that includes COMPANY were completely incapable of doing it and once they were dragged through it they weren't capable of doing that in a cost effective way.			Change technical knowledge in community	2
14062 4-1C	Divergence of Project Goals from Policy Requirements	Project Requirements and Cost	+	The architect or is it that Passiv House in general is hard to build, but they essentially overdesigned it in order to make sure they met it's certification program and huge amount of superfluous work.		When client goals are not aligned with policy requirements, even if they are both aiming for the same result, developers face practice challenges.	Rigor of Requirements for design and construction of a specific project	3
14062	Ambition of	Project Cost	-	So we were looking at Passive House pricing at 20% to 30% above			Ambitious goals for	4

Figure 1 - Cause and Effect Chart Excerpt

In order to gain insight into mental models and the perception of the system of economic and social factors, diagrams were created to illustrate the model fragments identified in the cause and effect analysis. Each cause/effect instance was diagrammed individually (see appendix for

illustrations). The cause and effect diagrams were then aggregated and restructured around three theoretical codes – Discovering Opportunity, Experiencing Difficulty and Changing Practices. The three aggregated diagrams suggested a theory about the way these theoretical concepts were impacted by forces such as policy change, economic, social or technological factors. Throughout the mapping process, the researcher was mindful of the fact that the diagrams represented the interviewee perception of causality rather than actual causality.

Elements of extant theories were employed as relevant concepts emerged in data analysis. For example, as the formation of professional norms reoccurred in a number of conversations, the code "attitude about practice change" began to capture individual progression through a social space of professional expectations. The connection of this attitude to established theories about behavioral change, such as the Theory of Reasoned Action (Fishbein & Ajzen, 2010), aided in understanding and led to theory-building (Charmaz, 2008).

4. Discussion

The data indicates that real estate professionals perceive that their work is impacted by two sets of forces – social forces which include the attitudes and perceptions about policy, social inputs which affect policy, the specific requirements, and changes and implementation of those requirements, and market forces which include the social context which enables the market to function, the economic context and demand factors which drive performance.

In this analysis, cause and effect coding revealed the mental models and identified instances where interviewees described perceptions of the economic, social and technical systems in which they operated. The set of cause/effect relationships spanned policy, market, ecosystem and project situations. To compile the fragments into aggregations, each C/E relationship was sorted into sets based on common cause or effect elements. For example, an interviewee commented on the impact of agency communication about changes in policy. This relationship was coded as a Cause Effect where "Cause" was "Communication about Programs and Benefits" and "Effect" was "Awareness, assessment, ultimately adoption". The interpretation of this relationship was that Program Communication had a positive impact on

Developer Awareness which had a positive impact on Developer Engagement. In this case, a new implicit element was incorporated into the Causal Fragment Diagram to represent the intermediary step of awareness between communication and engagement.

| 140624-1N | Communication about programs and benefits | Awareness, assessment, ultimately adoption | + | Not that I can keep up, I'm just -- there so much going on that there are things that are going on that I just don't -- haven't heard about. I had no idea that -- well, we had a boil of conversion which is part of our mortgaging and cost is going up. So I said what if we got this offline and got separate financing. I had no idea that Mass Save would give us $500,000. So I just poked around the website. | Increased publication about programs through public channels enables developers and owners to adopt them. The other channel of specialists is not able to reach everyone. | | 15 |
| 140623- | Growth which | Infrastructure | + | That's right, and if it… But, I mean that's… a lot of it's driven… I | Policy to address | | 16 |

Figure 2 - Cause Effect Coding Chart element
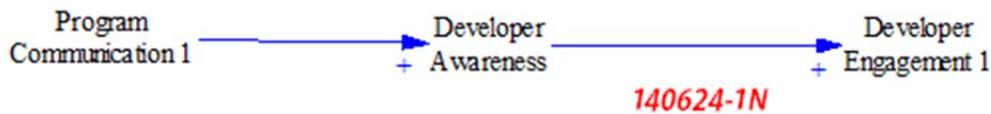
Figure 3 - Causal Fragment Diagram

The total set of causal fragment diagrams were generated and sorted according to their association with one of the three primary categories - "discovering opportunity", "experiencing difficulty", or "changing practices". The fragments were then combined based on common elements. For example, the causal fragment in Figure 3 was combined with two other fragments which shared the Effect element of "Developer Engagement" (Figure 4).
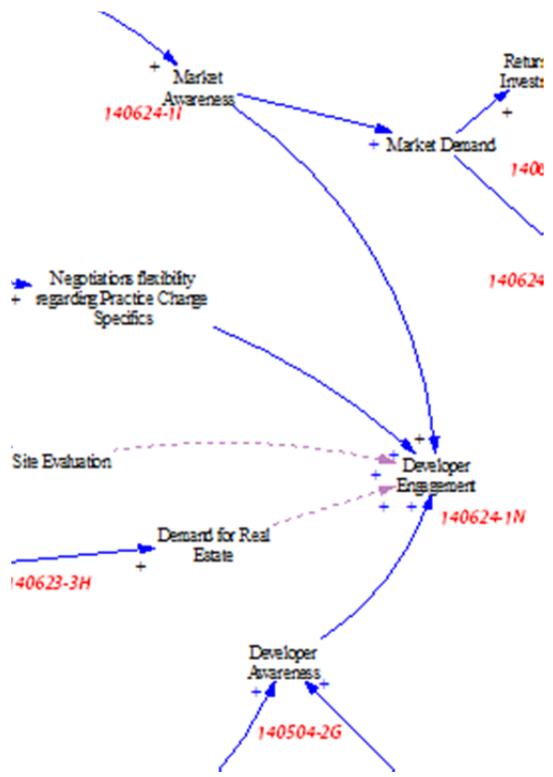
Figure 4 - combination of multiple causal fragments which share an effect on Developer Engagement in "Discovering Opportunity"

This first stage analysis resulted in four aggregated causal loop diagrams containing all 83 causal fragments – "Discovering Opportunity", "Experiencing Difficulty", and two separate variations of "Changing Practices", reflecting the Developer perception of the policymaker practice change and Developer practice change.
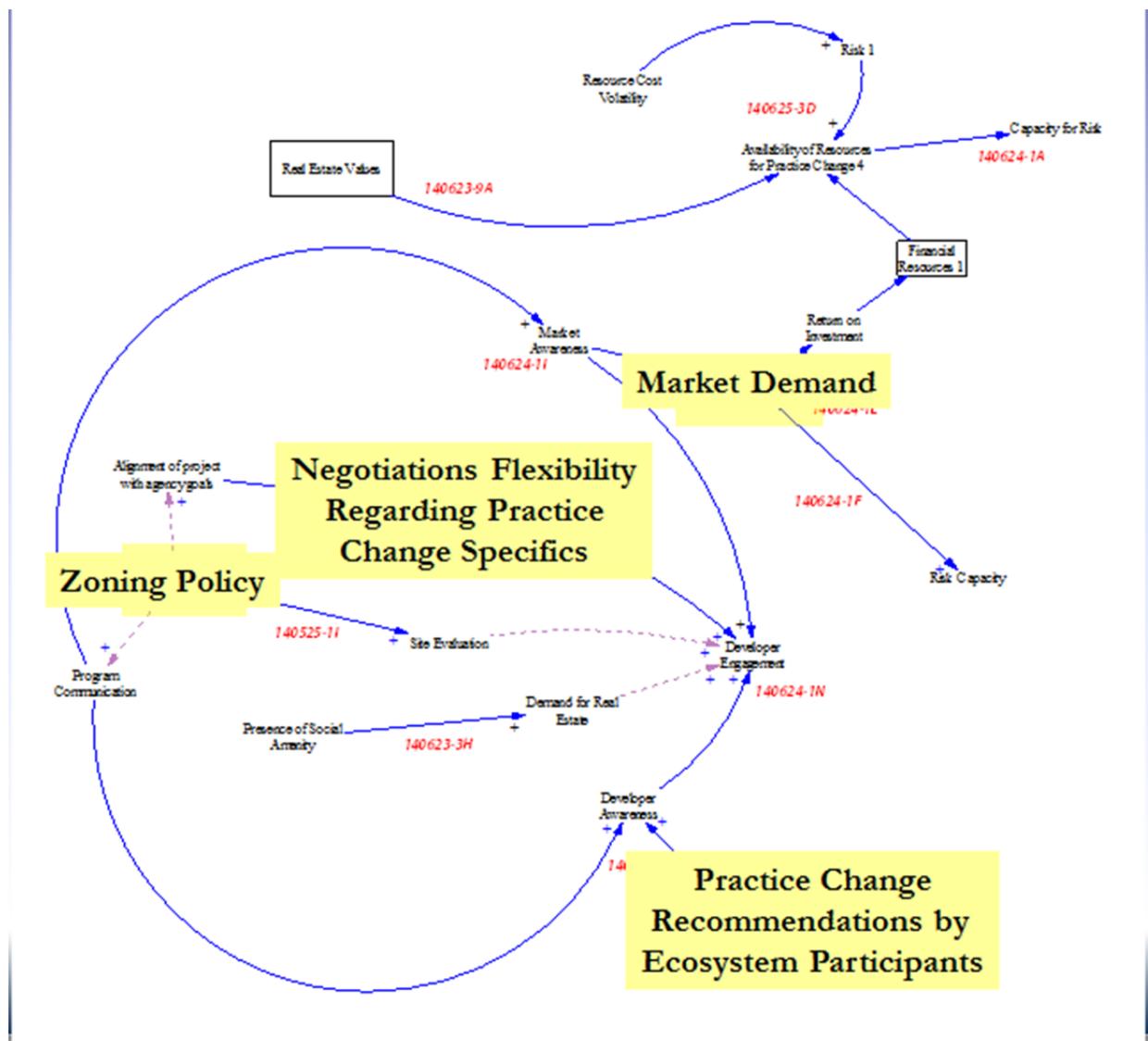
Figure 5 – Policy Elements among Causes and Effects when Discovering Opportunity

In Figure 5, policy oriented cause/effect relationships are highlighted to distinguish the role that policy is perceived to have when developers seek and evaluate new business opportunities. Developers perceive that the way a particular zoning policy is communicated impacts both market awareness of a trend and shifts in market demand. As market preferences change, program communication helps developers become aware that these shifts produce

business opportunities. There is also a perception that projects which align with agency goals as expressed by regulation increase the flexibility in negotiations between agencies and developers. In other words, as developers adopt the practices motivated by regulatory changes, agencies look favorably on projects and may be willing to consider alternative solutions or proposals which benefit the developer. A final element that factors into developer awareness and engagement with practice change is the recommendation or perceived position of other businesses in the production ecosystem. If architects who provide design services to developers are advocating for more sustainable project features and anticipating regulatory pressure and market demand for such, developers are more likely to be aware and engaged by the prospects of practice change.
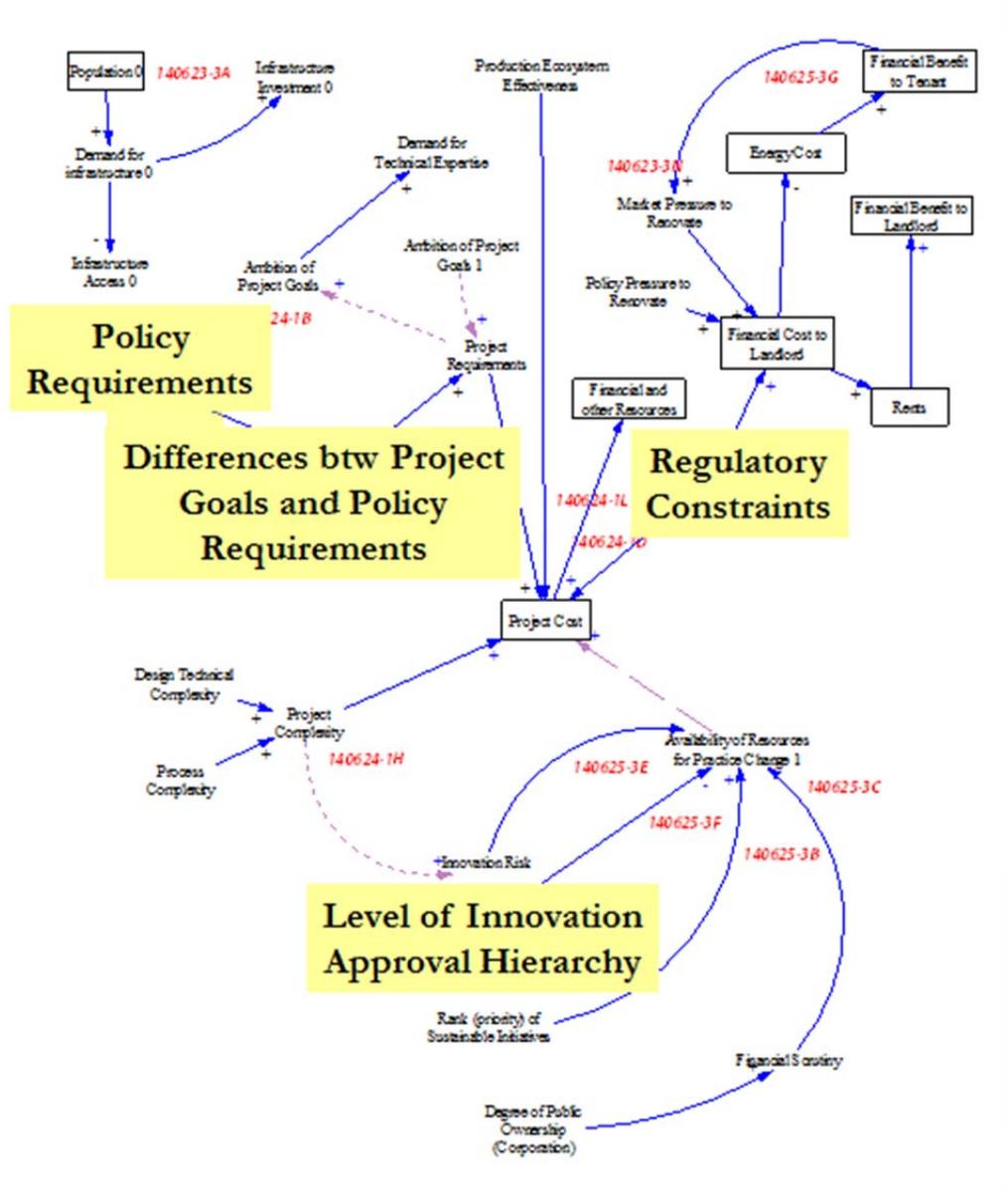
Figure 6 - Policy Impact on Cause and Effects for Experiencing Difficulty

In Figure 6, policy oriented cause/effect relationships are highlighted to distinguish the role that policy is perceived to have as developers encounter obstacles when constructing new buildings or renovations. Often, obstacles are interpreted as situations which negatively impact project cost or which increase the risk of project success. Regulations are perceived to pose obstacles to projects when there is gap between the goals of a project and policy requirements.

The gap drives changes in project requirements, which in turn is perceived to impact project costs. After projects are completed and as building owners move into business operations, regulatory constraints are perceived to pose increase costs to landlords. There is a positive opportunity when compliance with regulation enables landlords to gain increased rents or to realize gains through reduced energy costs, since that benefit is sometimes associated with green building requirements. Within organizations, approval hierarchy levels are mentioned as a factor which can impact the availability of internal resources to execute practice change in the development company. Within organizations, the complexity of the way regulatory changes are processed can prove an obstacle to compliance.
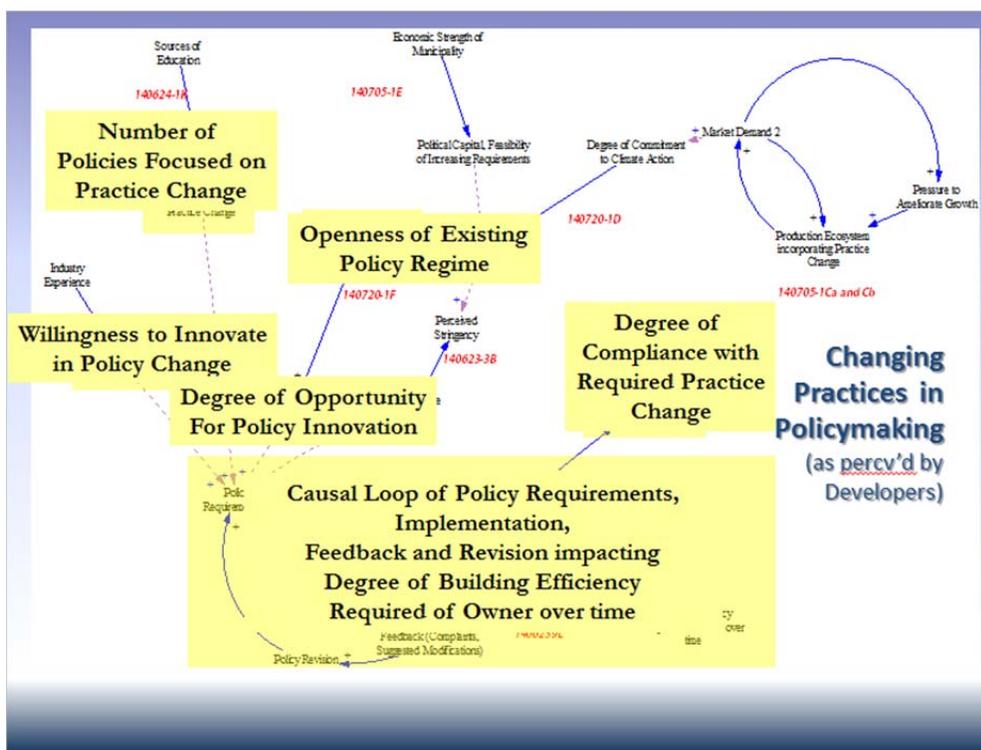
Figure 7 - Policy Impacts on Cause and Effects for Changing Practices - Policymaker aspects as articulated by Developers

The causal map in Figure 7 depicts developers' perceptions of the forces associated with policy development, implementation and change. Developers understand the loop which drives ongoing changes in policy requirements. As policies roll out through implementation, policymakers receive feedback, complaints, and suggestions for modifications, which in turn lead to revision. Developers also observe that increasing stringency, such as through changes in the standard building energy code, is a common factor over time. Other factors impacting the degree of opportunity for policy innovation, which in turn affect requirements over time, include education of the professional community and the marketplace about the need for regulation and its impacts, industry experience in observing actual impacts of regulation on projects, and the openness of agencies and companies to innovate.
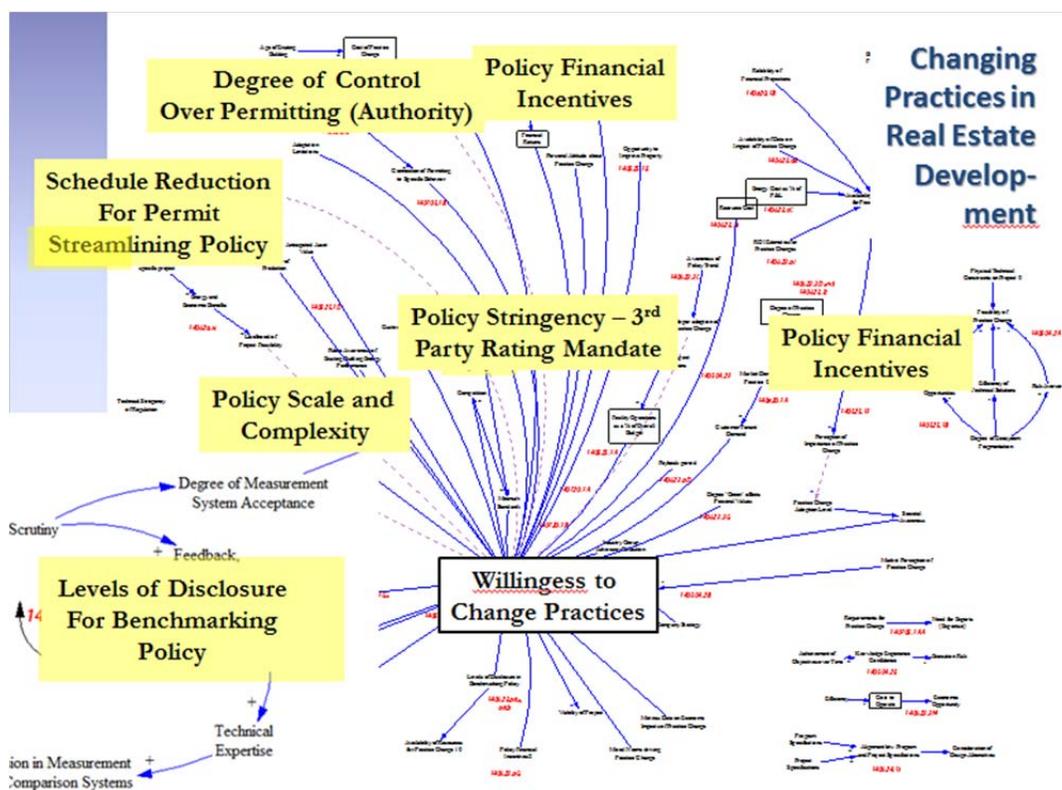
Figure 8 - Policy Impact on Cause and Effects for Changing Practices - Developer aspects

- Figure 8 depicts developers' perceptions of the forces associated with business practice change within the developer organization. The hub of this causal map is clearly the willingness to change practices, which is influenced by a range of marketplace and policy factors. Practice change – new methods or approaches to completing tasks associated with the business - results in changes in the demand for products in the marketplace, changes in the products themselves, and changes in the process by which products are developed. Practice change willingness is impacted by the degree to which disclosure of building performance impacts business performance, as evidenced by the causal loop which connects levels of disclosure to scrutiny to complaints to expertise to measurement revisions and ultimately to increased practice change willingness.
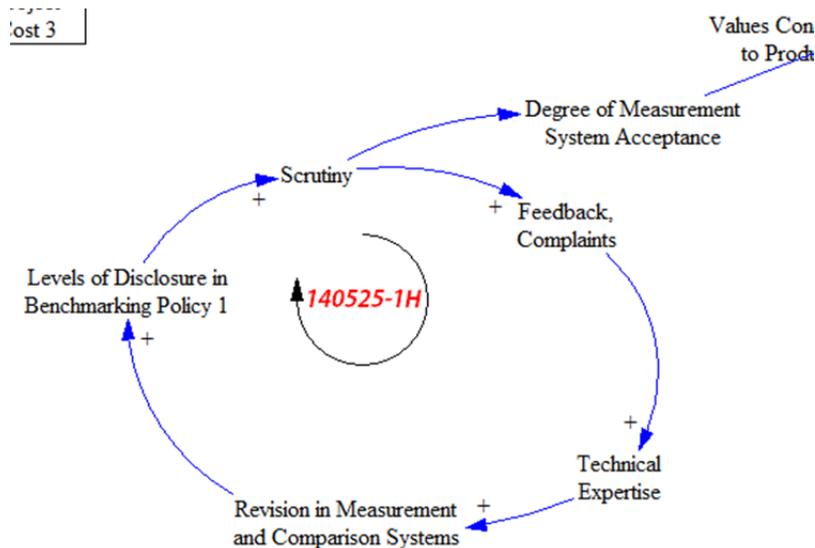
Figure 9 - "Disclosure/scrutiny" excerpt from Figure 8

The degree of difficulty of policy compliance also has an impact on willingness to change. Respondents mentioned the connection with regard to the level of stringency of green building rating systems as well as disclosure or benchmarking. The opportunity for financial advantage, either in the form of outright incentives given for compliance, or when compliance leads to favorable treatment such as permitting schedule acceleration, is noted by developers as a factor which can influence whether or not a project investment goes forward to completion.

After reviewing the causal maps associated with these four important business aspects, the next step in the analysis was to aggregate the entires set of causal factors into a single map (Figure 10). For clarification and legibility, the integrated causal map clusters the forces into the Policy or Marketplace drivers, the forces which operate within the Project Ecosystem with the particular focus on the owner developer, and the forces with connect directly to specific Projects. The Market and Policy forces are fundamental drivers for change in the Production Ecosystem, which includes real estate companies and other ecosystem participants, as experienced through the decisions made on projects. The data suggest that green building policy change is a mechanism for practice change across the entire production ecosystem, within which the real estate developer plays a key role.
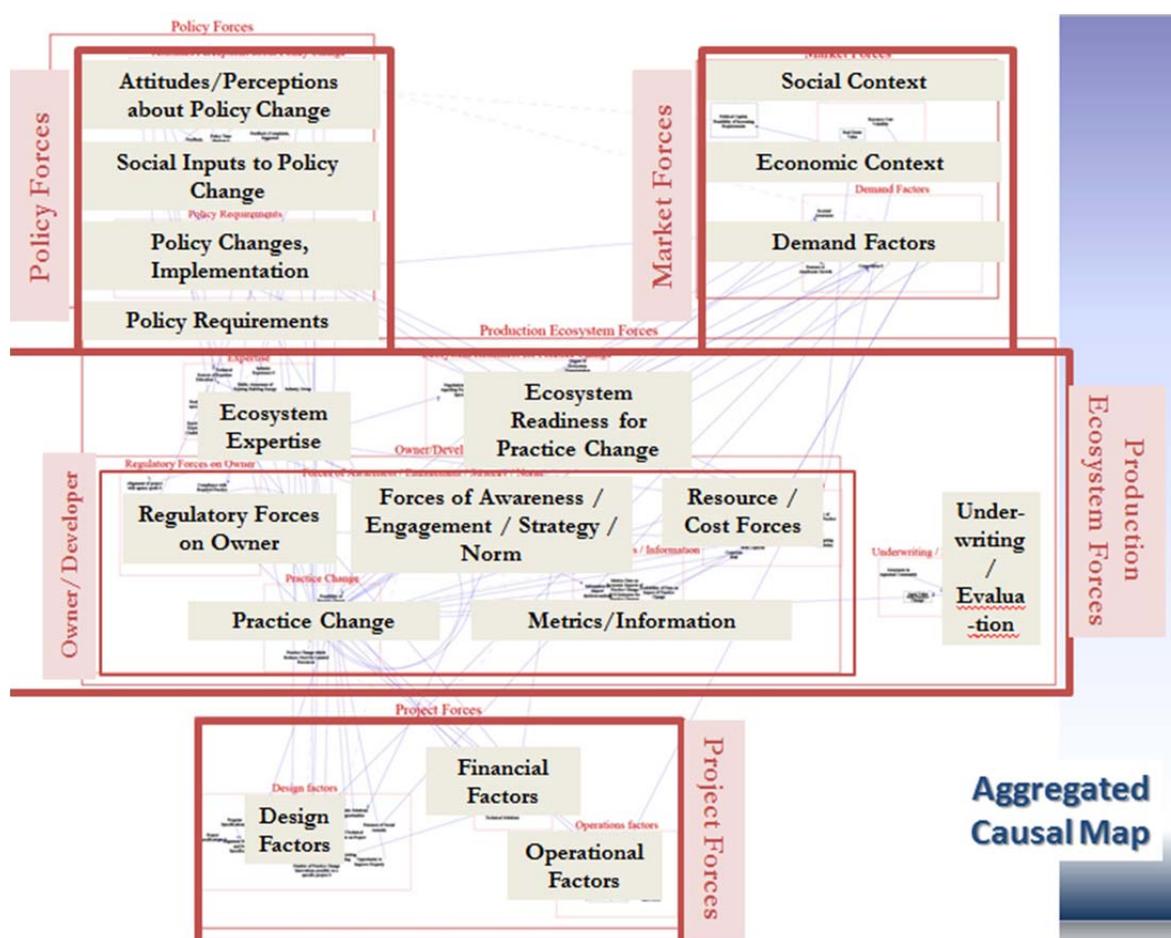
Figure 10 – Integrated Causal Map with Policy, Marketplace, Ecosystem, (Real Estate) Company, Project factors.
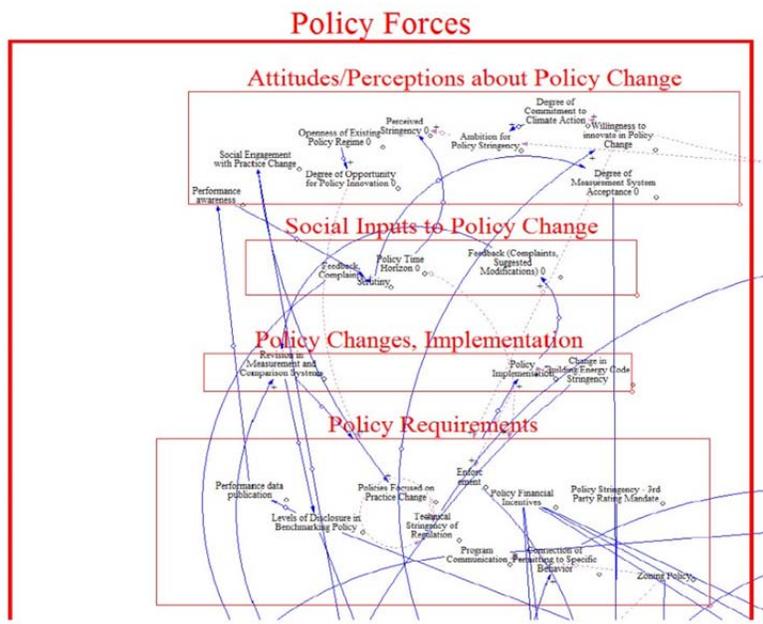
Figure 11 – Integrated Causal Map – Enlargement of Policy Forces segment
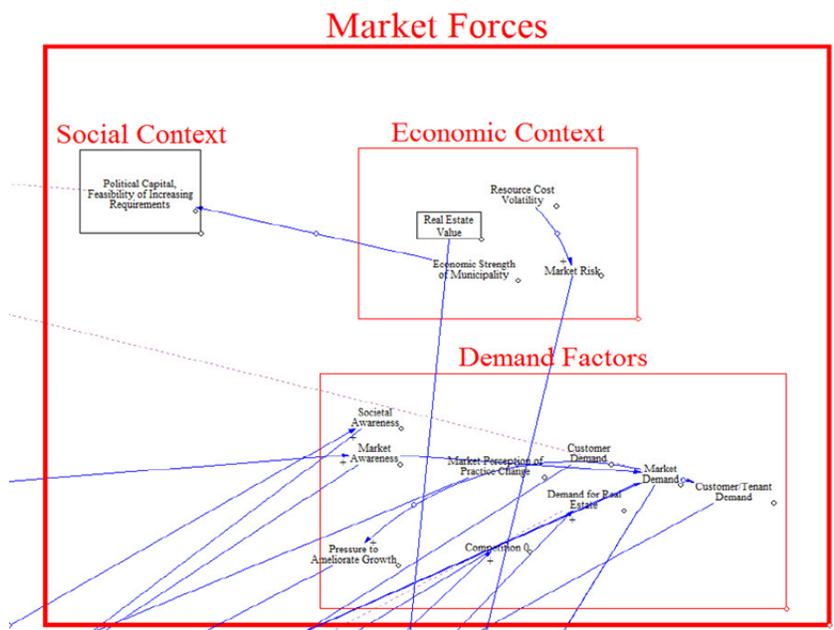
Figure 12 – Integrated Causal Map enlargement of Market Forces segment
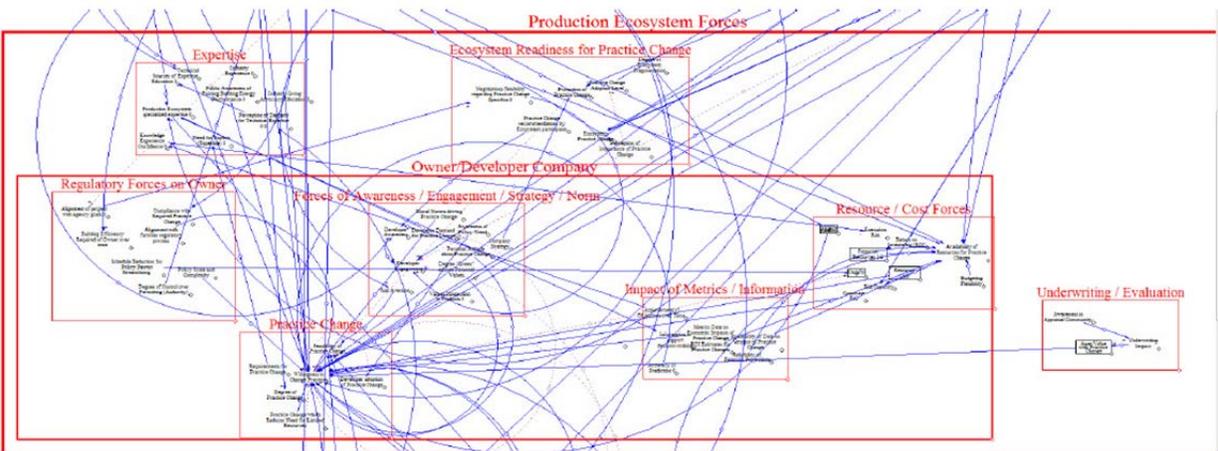
Figure 13 – Integrated Causal Map enlargement of Production Ecosystem segment, containing Owner Company segment
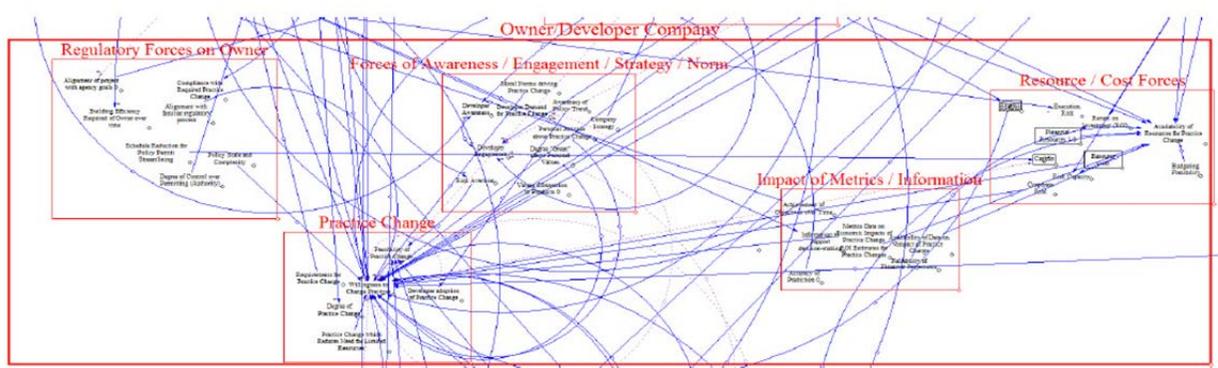
Figure 14 – Integrated Causal Map enlargement of Owner/Developer Company segment
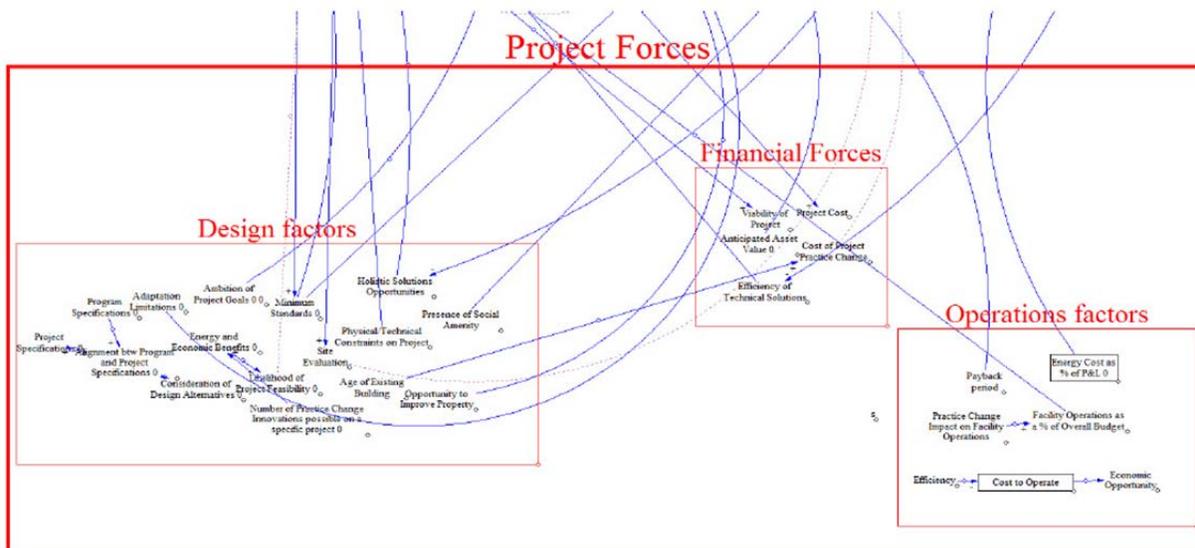
Theory of Practice Change

The analysis of the qualitative data gathered from practitioners resulted in a theory about the way real estate developers experience public policy change specific to green building regulation. The data suggest that green building policy change is a mechanism for transformation of the entire production ecosystem, of which the real estate developer is an igniting element. The theory incorporates causal loop diagrams depicting perceptions of cause and effect in three developer business modes ("Discovering Opportunity", "Experiencing Difficulty" and "Changing Practices") and observations about the drivers of individual professional behavior, suggesting that developers perceive both policy and market interactions as they devise strategies to compete within a private marketplace governed by public regulations.

As real estate developers negotiate the risks associated with transforming the urban built environment, they are positive about the prospects for change and for the collaborative working relationship between company and public agency which enables successful project realizations. Interviewees spoke about alignment of goals, in that developers and agencies share an interest in creating economic opportunity for the community. At the same time, both are aware that at times, they sit on opposite sides of the table. The data suggest that green building policy change is a mechanism for transformation of the entire production ecosystem, within which the real estate developer is an igniting element.

5. Conclusion

The objective of this research was to gain a deeper understanding of the impact of green building policy change and to study policy effectiveness through direct engagement with the targets of the policy, real estate developers. Data supports the argument that policy is understood as a set of elements which echo through the production ecosystem of the built environment as causes and effects. Although there are aims at achieving economic benefits to drive new corporate behavior through practice change which incorporates a strong influence on the real estate developers who invest in the built environment, to be maximally effective policy must be designed and implemented so as to impact the entire production ecosystem as well as the

individual companies which comprise it. Interviewees expressed understanding of the need to navigate the requirements of green building policies impacting their projects. However, the implications of the research are that availability of comprehensive and rigorous data can be a powerful tool to drive marketplace preference for sustainable building and increase policy compliance, and to inform owners and occupants of buildings who might not yet be aligned toward community objectives for increased energy efficiency or carbon emissions reductions.

By understanding how developers process changes through their organizational actions and decision making processes, insight has been gained through this research to support the assessment of new building policies in the future. The opportunity to create a dynamic system model to represent the ecosystem and to quantitatively define its transformation could lead to new assessment models for green building policy change. The potential impact of green imperatives and policies like benchmarking on the different categories of urban building stock is yet to be determined.

The real estate developer has an enormous impact on society by shaping environments in which we work and live. The policymaker transforms the work of the developer and the production ecosystem for buildings, aspiring to provide incentives for innovation. Through innovation, developers can create new models of social interaction and achieve a built environment which sustains our aspirations as well as our economic health and natural resources.

Looking across the landscape as firms execute project after project and drive toward the practice change made necessary by regulation, policymakers can extend policy design and assessment innovation to explore the potential to support practice change within each component of the development ecosystem from developer to designer to contractor to owner/operator. The research has further implications when one considers how the discourse of green buildings and climate action has evolved since the members of the U.S. Conference of Mayors signed the Kyoto Protocol agreement in 2005. While standard updates to building codes proceed in many jurisdictions on a regular basis and Boston and New York continue to improve green building regulations, the emphasis on climate action is shifting towards adaptation and resiliency. The

theoretical model developed through this research provides a method for considering the impact of changes in discourse or technology or economics on the way regulations should be designed, implemented and assessed to greater effect on the overall production ecosystem which drives the built environment in cities.

As policy change interacts with market factors to drive practice change through noted forces, the model can be applied to track and confirm that incentives and causes are driving effects as projected and to answer future questions, such as:

- How can policy shift to a focus on built environment outcomes vs. prescriptive approaches to technology opportunity and trends? Benchmarking is a step in this direction, but the next step beyond energy consumption may be to seek more detailed understanding of the parameters of reduced carbon emissions or increased resiliency and the ability to support human occupation at times of calamity.
- How can policy provide flexibility to reward projects and companies which go beyond compliance while at the same time allowing more lax interpretations as companies move toward higher levels of performance, i.e. to drive towards innovation such as net zero implementations or absolute reduction in municipal energy consumption?
- How can policy enable the production ecosystem to evolve in a more coordinated way, to achieve the benefits of the whole at a faster pace than the benefits of the individual elements?

This theoretical model adds insight about the way causal models can be developed from qualitative data, and suggests a new approach to assessing the effectiveness of policy and the impact of regulation on the dynamics of the production ecosystem. In order to understand the transformation of the entire ecosystem, and impacts that policy change can have in the future, this methodology should be expanded to create a holistic model incorporating the perspectives of other elements of the ecosystem which reveals the nature of practice change which each discipline is experiencing.

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