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UNDERSTANDING URBAN SYSTEMS USING COMPLEXITY THEORY: ANALYZING THE INFORMAL RAILWAY MARKETS OF MUMBAI

A Thesis in

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A B S T R A C T

All cities have some form of informal spaces within them and these spaces grow along with the city. This growth in informal spaces is perceived as disorganized and chaotic. The traditional role of city planners is to eliminate or curtail this disorganization. In an attempt to organize the growing city structure, planners are still looking at conventional approaches, and, as a result, they end up designing static spaces. But this disorganized structure, when looked closely, is a self-organizing system. The planners need to understand the self-organization of informal spaces and need to take it into account while designing them.

John Holland's framework of complexity theory explains the self-organization and emergence of a system. This thesis hypothesizes that Holland's framework is the best approach to understand and design informal spaces. The conventional approach, taken by the authorities, is evaluated using Holland's framework with the aim to develop a better analysis strategy for the design of these spaces. For this purpose, this thesis looks at the case of Mumbai's informal railway markets as an example of complex systems. Three cases of informal railway markets and a market built by the authority to replace the informal markets were selected for this study. The markets were studied during a field visit, and were analyzed and compared to understand their pattern and how they work as system. Issues of congestion, messy image, safety, and security were studied to understand the problems of the informal markets. The solutions proposed by authorities and counter proposals were then evaluated using Holland's framework to arrive at a more effective solution for the markets.

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A C K N O W L E D G E M E N T S

I take this opportunity to thank Professor Peter Aeschbacher for guiding me through my struggle and supporting me in this research, for showing me various points of view, and always challenging me to think beyond the obvious. I would also like to thank Professor Deryck Holdsworth, Professor Alexandra Staub, and Professor Jawaid Haider for being patient with me and sharing their knowledge and time. I also want to thank all professors from whom I have learnt during the course of my program. Above all I feel grateful to my family for all their love and motivation.

1. INTRODUCTION

Everyday, cities undergo new additions and new patterns emerge within their boundaries. Many of these new additions evolve informally or in an unplanned manner. The city authorities regard these unplanned informal spaces as disorganized and try to eliminate them. Urban planners are still relying on conventional planning systems. But this disorganized layout, if examined closely, is actually a self-organized growth of the city. Networks of self-organized systems, within the city, aggregate and emerge into a bigger system. When approaching such spaces urban planners and designers fail to take into account the self-organization of the systems. This study seeks to show that taking self-organization into account, better informs planning and design of spaces.

Self-organization is a "phenomenon by which a system self organizes its internal structure independent of external causes (and it) is a fundamental property of complex systems, be it cities or individuals that form their sub systems".[1] The self-organized systems or the subsystems within a city grow in a symbiotic relationship with the planned spaces. Self-organized components of the city have grown interacting with the planned spaces, forming a network to help in the 'emergence' of the city. Emergence is a process when new spatial pattern evolves out of self-organization.[2] Juval Portugali in his book '*Self-organization and the city*' discusses the phenomenon of emergence in cities as a self-organized complex system:

> The city as a complex system exchanges with its environment not only matter and energy but also human population. These individuals act and interact intentionally, perceive, and interpret the urban scene in their own specific way. The movement of these free agents, between and within cities, creates interregional migration, which forms the interactive links between a city and its environment, and intraregional migration, which

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1 Juval Portugali, Self-organization and the city (Berlin: Springer – Verlag, 2000), 49.

2 Michael Batty, *Cities and Complexities: Understanding cities with cellular automata, agent-based models, and fractals* (Cambridge MA: MIT Press. 2005).

> plays an important role in the internal dynamics of cities. Immigrants are indeed free human agents, but their activities take place on an infrastructure which is a cell space of houses, parcels of land, network of streets and so on.[3]

Portugali also points out that self-organization, as a paradigm, has "the potential to provide a common integrative ground to the various cities…and thus to reconcile their seemingly irreconcilable."[4]

Complexity theory describes complex systems as emerging through self-organization. A complex system involves "the interaction among constituents of the system, and the interaction between the system and its environment, such that the system as a whole cannot be fully understood simply by analyzing its components".[5] This means that a complex organized system cannot be merely understood by studying the components but also needs an understanding of the relationship between these components. Any dynamic complex system tends to organize itself so as to optimize energy flow. Self-organization is due to the interaction between the system's components. It results in the emergence of the system.

This thesis utilizes the theory of complexity to understand the development of informal spaces in a city, and to evaluate a design intervention seeking to solve the problems of these spaces. Three cases of informal railway markets, which form a subsystem within the city of Mumbai, are studied. These informal markets are examples of a self-organized complex system.

This thesis adopts John Holland's framework of analysis within complexity theory. Complexity theory has been used by a few researchers to make predictive models of changes in the city pattern. The aim of this thesis is not to develop such

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3 Juval Portugali, Self-organization and the city, 86.

4 Ibid, 47.

5 David O'Sullivan, Steven M Manson, Joseph P Messina and Thomas W Crawford, "Space, place, and complexity science," *Environment and Planning A* 38 (2006): 611.

predictive models but to better understand the working of the systems within a city. This understanding will improve the effectiveness of any design intervention in urban spaces.

2. OVERVIEW

2A. PROBLEM STATEMENT

Many urban designers and planners fail to recognize the nature of informal[6] spaces in a city. They treat them as static objects. This is because most of "our existing theories are so inadequate… they base their explanations on a static world, a world in equilibrium in which spatial structures, (and) not dynamics"[7] are given importance. As a result planners and designers try to remove the informal systems from a city and replace them with more formal, static structures. But these informal spaces are kinetic entities, constantly growing and evolving. They are thriving with vibrant energy and readapt to changes. Additionally, they provide economic benefits at the grassroots level. In order to preserve these informal spaces, it is important to treat them as a self-organizing system.

2B. OBJECTIVE AND HYPOTHESIS

This thesis seeks to develop a better strategy to approach informal spaces and to address their problems using complexity theory. The thesis proposes that Holland's framework in the field of complexity theory serves as a better basis for describing urban design strategies because it is better suited to understand and analyze the emergent characteristics of self-organizing informal systems. The informal railway markets of Mumbai are used as case study.

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6 'Formal' means systems and spaces that are according to the norms and customs made by the society and 'informal' means something which is not 'formal'. However 'informal' is distinct from 'anti-formal'. The informal system need not always be against the prescribed custom but many a times lies on the blurred line between the formal and the anti-formal, between the legal and the illegal. Informal systems are central, interstitial or sometimes peripheral to the formal system. This is defined by Michel Laguerre in his book, The Informal City.

7 Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals,* 7.

2C. RESEARCH QUESTION

Does the application of Holland's framework of complexity theory as an analysis tool yield results that are better suited to addressing the problems of informal urban systems, while still maintaining their positive qualities?

2D. RESEARCH DESIGN

This thesis tests the application of Holland's framework of complexity theory as an analytical and evaluative tool for application in urban design. For this purpose, cases of informal markets of Mumbai were studied, analyzed, and evaluated using complexity theory.

2D.i. Case study

Three cases of informal markets around the suburban railway stations of *Santacruz, Vile Parle* and *Dadar*, and one case of a market built by the authorities - *Hawker's Plaza* - were investigated. They were used as units of analysis. *Field studies, interviews,* and *archival data* for the four cases were analyzed to find commonalities and to identify issues of *location, economy, dynamism, openness,* and *perceived image*.

1. Field study

The four markets were observed and documented in the following manner:

a) The location of the formal and informal markets around the railway stations was mapped.
b) Photographs were taken to establish the relationship of the informal space with the formal space.
c) Recording activity and identifying patterns at various times of the day, and the interaction of people with the informal spaces, helped in establishing the importance of the markets in the lives of the citizens of the city.

2. Interviews

a) Interviews were conducted with officials from the Municipal Corporation of Greater Mumbai (MCGM) to get their feedback on matters of legality of informal markets.

b) Before the site visit, interviews with railway authorities and officials were planned to establish their perception about the issue of safety in relation to the informal railway market, but after discussions with MCGM officials it was discovered that the railway officials have no authority over the issues related to informal railway markets.

c) Interviews with the vendors were conducted to hear the other side of the story - their opinion on the present state.

d) Interviews were arranged with customers to get the end-user's perspective.

3. Archival research

a) Present condition of informal markets – Data on the present condition of the markets was collected from newspapers, books, and articles which included:

- Articles about 'illegal occupancy by the vendors' and articles and books related to the informal market place.
- Articles related to crimes, bomb blasts, and other safety concerns related to the informal space.

b) Current planning efforts for informal railway markets – Current planning data was collected from official documents, and development/existing plans.

This involved collecting 'development plans' of the city and the market areas which helped in indicating the formal spaces and the allocation of spaces by the planning department of Mumbai. Also official documents indicating future proposals for the informal markets were collected from the officials at MCGM.

c) History of development - Studying the historical development of the informal markets in Mumbai helped in the understanding of the circumstances in which these spaces grew in the city and their growing importance over a period of time.

2D.ii. Application of complexity theory for analysis

This thesis adopted John Holland's framework in complexity theory to understand how the informal markets of Mumbai are examples of complex adaptive systems. The basic concepts of a complex adaptive system, given by Holland, are applied to all four cases in order to analyze the workings of markets as a system.

2D.iii. Application of complexity theory for evaluation

Using complexity theory, this thesis then evaluated the solutions proposed by authorities and city planners based on conventional approach and other counter-proposals to address the limitations of the conventional solutions while testing the hypothesis of this thesis. An analysis strategy using complexity theory that is applicable for similar systems is then derived.

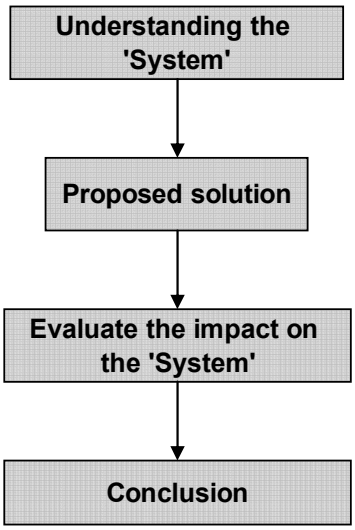

Figure 2-1 Steps involved in analysis and evaluation of informal markets

2E. RELEVANCE

This research intends to help develop a better understanding of the workings of systems and subsystems of a city, thereby, providing a better understanding of the evolution of megacities. Considering the increase in the number of megacities in the future, this study hopes to enable urban planners and designers to be in better position to tackle the problems that these cities may face. Since there is a continuous growth of urban population worldwide, mostly due to migration, many cities probably will face similar issues related to informal spaces. This thesis also seeks to reiterate the value of informal spaces, using the informal markets of Mumbai as a model and work out a solution towards their sustenance. This study seeks a strategy to understand and deal with the problems associated with these spaces. This will help retain and create a lively landscape in the public spaces of Mumbai and other mega cities.

2F. LIMITATIONS

Time was a limitation during the field study and the research period. This study only focused on informal markets around railway stations and the structure of other informal markets and informal spaces around the city may be different. This research was also not able to consider all characteristics, issues and problems related to these markets, for example the socio-cultural issues involving the informal railway markets. All solutions that have been proposed to solve the problems of the markets may not have been explored in the study. It must be noted that while collecting data for the proposed solution of Hawker's Plaza, the authorities were not cooperative. Hence all the data regarding this case is limited to reports from local newspapers.

3. COMPLEXITY THEORY

3A. NEED FOR COMPLEXITY THEORY

"Informal spaces have been perceived as unplannable".[8] They seem to lie outside the realm of control[9] and are mostly unrecognized by the local authorities. Government officials, social services providers, and some economists conceptualized informality as a "parasitic system"[10] since informal transactions do not contribute directly to tax revenue. The informal system is seen as taking undue advantage of the formal system. The rejection in recognition of informal spaces sometimes leads to the decline in the quality and the nature of the urban landscape of a city.

The conventional city planning process generally uses a top-down approach to bring spatial order. Conventional planning "is constituted through models and…practices (based on) utopias… (which) are unable to consider" the informal spaces in planning.[11] It tries to suppress informality in the planning process even though it forms a vital component in the urban structure. It is based on rigid sets of planning principles which do not allow any flexibility.

Architects like Rem Koolhaas have voiced the need for flexible space. Regarding flexible space, he says, "flexibility is not the exhaustive anticipation of all possible changes….flexibility is the creation of margin excess capacity that enables different and even opposite interpretations and uses". [12] To achieve this flexibility, people appropriated informal spaces within the formal rigid space according to their daily needs. These informal spaces become everyday spaces. Everyday space "is the physical domain of

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8 Ananya Roy, "Urban Informality: Towards an epistemology of planning," *Journal of American Planning Association* 71 – 2 (Spring 2005): 148.

9 Ibid, 150.

10 Michel S Laguerre, *The informal city* (New York: St. Martin's Press, 1994), 5.

11 Ananya Roy, "Urban Informality: Towards an epistemology of planning," 155.

12 Adrian Forty, *Words and buildings: a vocabulary of modern architecture* (New York: Thames & Hudson Inc., 2000), 144.

everyday public activity that exists between the defined and the identifiable realms of the home, the institution, and the workplace. As the physical domain of everyday public activity, it is the connective tissue that binds the daily lives together. This makes it a public space".[13] These everyday spaces have social, spatial and aesthetic meanings, and provide a zone of social transition.[14] All citizens irrespective of their social and economic inequalities have equal rights to public space and the city.[15] Right to the city means right to the resources of urban life. According to Lefebvre, it is important to realize and understand the daily life of the underprivileged to work towards the equal right to the city.[16]

The theory of everyday urbanism, acknowledges the richness and vitality of daily life and its ordinary reality. It takes into account the equal participation of the entire citizen. "It is grassroots and populist….It is seen as a community-based, race savvy, bottom-up, unpretentious and democratic."[17] Everyday urbanism takes root in the informal settings within a city. It takes into account the everyday spaces in their design. The principles of everyday urbanism are based on Lefebvre's writing on everyday spaces in which he argues that urban design proposals should not be limited to the morphology of time and space but they should also consider how people live in a city.[18] Everyday urbanism's perspective seeks hidden meanings in the ordinary aspects of everyday life.

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13 Rahul Mehrotra, *Everyday Urbanism – Michigan debates on Urbanism* (Ann Arbor: University of Michigan, 2005), 18.

14 Ibid.

15 Nancy Fraser. "Rethinking the public sphere: a contribution to the critique of actually existing democracy," in, *Postmodernism and the re-reading of modernity*, ed. Francis Baker, Peter Hulme, and Margaret Iverson (Manchester and New York: Manchester University Press, 1992).

16 Henri Lefebvre, "The Right to the City," in *Writings on City,* trans. Eleonore Kofman and Elizabeth Lebas (Oxford: Blackwell Publishers,1996).

17 Rahul Mehrotra, *Everyday Urbanism – Michigan debates on Urbanism*, 8.

18 Henri Lefebvre, "The Right to the City".

However, everyday urbanism has been criticized as just a commentator and interpreter of the city that does not bring any major transformation to the shape of city.[19] In other words, everyday urbanism is successful in describing the everyday spaces of a city but it does not translate into action. In spite of the criticism, everyday urbanism provides an understanding of the importance of the grassroots levels of the urban system by explaining everyday spaces.

To bridge this gap between the theory of everyday spaces and the urban design process, complexity theory and Holland's framework for understanding complex systems are used.

3B. COMPLEXITY THEORY AND ITS EVOLUTION

A complex system is formed of several small components which interact with each other. Due to the nature of these interactions, the property of the whole system is more than the mere summation of the properties of the individual components.[20] The study of these complex systems is known as 'complexity theory'. It deals with the study of the evolution of these systems, their structure, and their behavior. Complexity theory demonstrates that most of the networks in nature as well as in society are composed of elements which are strongly connected and clustered at smaller scales but also have several links with each other at the global scale. Complexity theory seeks to understand how systems evolve and emerge. It has led to the development of universal principles which can be applied to biology, computer science, economics, and urban design. These principles describe the intrinsic structure of complex systems, which is the key to the coherence of the system.

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19 Rahul Mehrotra, *Everyday Urbanism – Michigan debates on Urbanism.*

20 Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals*, 2.

In 1948, Weaver classified all problems concerning systems into three categories: problems of simplicity, problems of disorganized complexity, and problems of organized complexity.[21] He categorized problems of simplicity as those involving just two variables and not a complex whole. Problems of disorganized complexity involve large number of variables behaving "individually erratic… (but) the system as a whole possesses certain orderly and analyzable average properties."[22] In practice, he argued, it is relatively simple to solve problems of disorganized complexity using statistical mechanics.

Between the region of simple problems and the region of disorganized complexity problems lies the region of organized complexity problems. The problem of organized complexity does not depend on the number of variables nor can be solved using only statistical methods. They are problems "which involve dealing simultaneously with a sizable number of factors which are interrelated into an organic whole."[23] This problem cannot be explained like disorganized complexity, where it is possible to average out the behavior. Thus organized complex system (also addressed as complex system) is a system involving interaction between several of its components. The property of the system that emerges because of the interaction of the components is much more than the properties of the individual components. These systems cannot be explained fully by breaking them down to the level of its components but the components need to be studied in relation to each other.

Another property of the organized complex system is that it exhibits self-organization, that is, they exhibit organization without the presence of an external authority. Organized complex systems are also known as '*complex adaptive systems'*.

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[21] Warren Weaver, "Science and Complexity," *American Scientist* 36 (1948): 536.
[22] Ibid, 538.
[23] Ibid, 539.

'*Chaos theory*' is another field of science which is concerned with complex systems. According to chaos theory, complex systems have a balance of order and chaos. [24] These systems lie in the region known as the 'edge of chaos'. The edge of chaos is the thin region between chaos and order, where

> the most interesting dynamical systems which are adaptive, self-organizing, far-from-equilibrium (yet sustainable) systems, such as living things, ant colonies and societies…systems that are not only self-organizing, but self-sustaining, systems that persist through significant amounts of time are found. It is in this region that we also find innovation, systems that effectively solve by exploiting their existing 'knowledge' and structure while retaining the flexibility to explore new configurations and 'solutions'. [25]

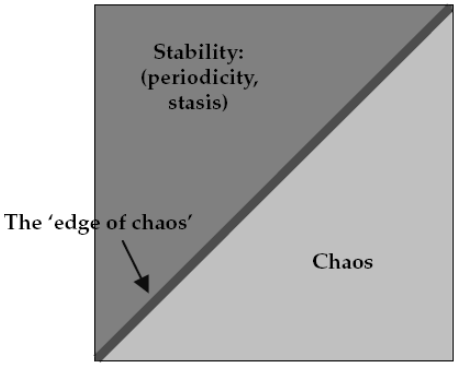

Figure 3-1 Edge of chaos diagram
(Source: Mark Randell. "Constructing participation spaces," *Community Development Journal* 39-2 (2004):145.)

Figure 3-1 illustrates the 'edge of chaos' as the balance between the stable and chaos regions. There is a clear equivalence between Weaver's concept of systems and chaos theory. The 'simple system' and the 'disorganized system' described by Weaver lie in the chaos theory's region of stability and chaos, respectively. The organized complex system or the complex adaptive system lies on the 'edge of chaos'.

In 1984, the Santa Fe Institute was established to facilitate the study of complex systems within various fields like economics, physics, administration, biology and

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[24] M. Mitchell Waldrop, *Complexity – The emerging science at the edge of order and chaos* (New York: Simon & Schuster,1992)

[25] Mark Randell, "Constructing participation spaces*," Community Development Journal* 39-2 (2004):145.

mathematics.[26] Researchers across disciplines apply complexity theory to issues ranging from economic development to earthquake prediction.[27] Chris Langton, a biologist at the Santa Fe Institute, describes the three levels of systems as: order, complexity, and chaos, which are analogous to the three classes of life, namely, too static, life/intelligence, and too noisy.[28]

In biological systems there are many examples of intelligent complex systems. The human brain is an example of such a system. It shows emergent properties at a higher level which depends on the simple chemical interaction between the neurons at the lower level.[29] The human immune system and blood circulatory system are also examples of complex systems. Other examples are the biosphere, an ecosystem, ant colonies, slime mould[30], flock of birds, and even human communities based on social interactions. In case of ecosystems and human communities, the organisms "don't just evolve but coevolve."[31] None of them display any central force controlling them; they exhibit the properties of self-organization and emergence. The interaction between the components of a complex system gives rise to emergence of a higher order. This relationship, shown in Figure 3-2, was illustrated by Langton[32] to show how emergence occurs in complex systems.

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[26] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos.*

[27] Steven Manson and David O'Sullivan, "Complexity theory in the study of space and place," *Environment and Planning A* 38 (2006): 677.

[28] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos,* 234.

[29] Roger Lewin, *Complexity-Life at the edge of chaos* (Chicago: University of Chicago Press, 1992).

[30] Steven Johnson, *Emergence: the connected lives of ants, brains, cities and software* (New York: Scribner, 2001).

[31] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos*, 259.

[32] This is an adaptation of Chris Langton's depiction, illustrated in Roger Lewin, *Complexity-Life at the edge of chaos* (Chicago: University of Chicago press, 1992), 13; as well as in Charles Jencks, *The Architecture of the jumping universe* (London: Academy Edition, 1997), 61.

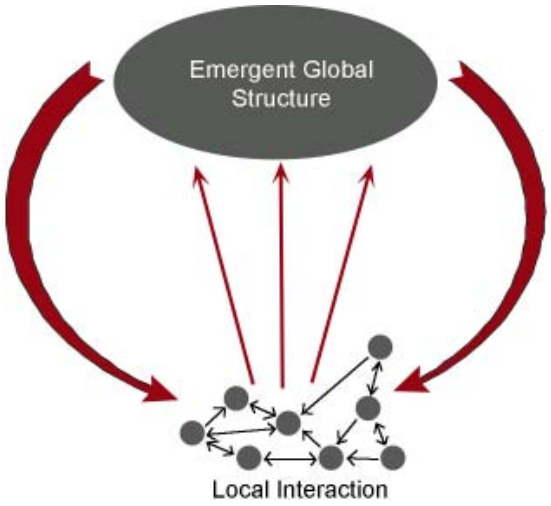

Figure 3-2 Langton's view of emergence in complex systems

3C. COMPLEXITY THEORY IN URBAN DESIGN AND PLANNING

Since the nineteenth century, the haphazardly growing city was seen as disorganized, and this attitude has dominated "our approach to cities and their planning to this day, (where) cities are still seen as manifesting a disorder and chaos requiring control through the imposition of idealized geometric plans".[33] Planners and designers have long perceived cities as disorganized complex systems lying in the region of chaos.[34] This is illustrated in Figure 3-3.

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[33] Michael Batty et al., "The Size, Scale, and Shape of Cities," *Science* 319 (2008): 769.
[34] Ibid.

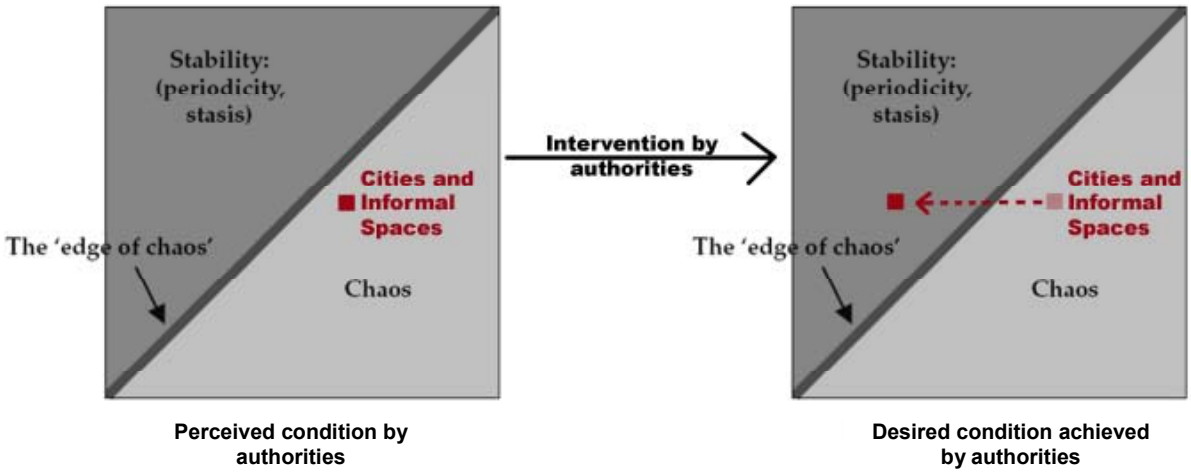

Figure 3-3 Illustration of the planners' treatment of cities as complex systems

Conventional planning theories are ineffective as they are based on the principles of a static world, where equilibrium is given importance.[35] Hence their implementation results in a static space, while failing to give due importance and consideration to the dynamics of a city. On the contrary, complexity theory gives importance to the dynamics as much as to the spatial form, both of which are significant while designing a space. Jane Jacobs was among the first few people to say that cities need to be treated as a problem of organized complex systems.[36] Christopher Alexander argues "we must overcome our ignorance and learn to understand the city as a product of a huge network of processes, and learn just what features might make the cooperation of these processes produce a whole. We must therefore learn to understand the laws which produce wholeness in the city."[37] Batty reiterates that cities are "emergent structures" which are governed by the web of interaction between the components and need a bottom up approach.[38] Cities are complex systems lying at the edge of chaos (Figure 3-4). Here they are very creative and are constantly evolving. They are able to exhibit resiliency, responding and adapting

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35 Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals*, 7.

36 Ibid, 3.

37 Ibid, 457.

38 Ibid, 457.

to any type of changes. Complexity theory provides the necessary explanation of systems in this region. It understands that when approaching the city, dynamism is as important as the morphology. Complexity theory also contributes significantly in the study of place and space.

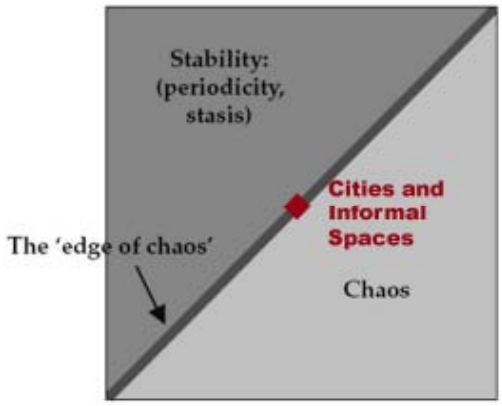

Figure 3-4 Conceptual illustration of the state of megacities

However, complexity theory does not intend to provide only a prediction of urban growth patterns. Its importance lies in its ability to expose the basic mechanisms that govern the process of city growth.[39] Waldrop shares the view that predictions are not always important. An explanation of the fundamental mechanisms is the essence of science.[40] According to Michael Batty, complexity theory also reinforces "the idea that naturally growing cities are in fact more workable, more efficient and more equitable, indeed more democratic, (and this idea) has gained credence as we have begun to probe the complexity which compasses the way cities evolve and function."[41]

Complexity theory is different from the conventional urban design theory in its basic approach. Testa describes the conventional approach of considering space as the fundamental entity and time as a secondary entity with little effect on space. Whereas,

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[39] Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals*, 109.

[40] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos*, 39

[41] Michael Batty and Paul Longley, *Fractal Cities: A Geometry of Form and Function* (London: Academic Press Ltd, 1994), 9.

emergent design looks at the process through which the space evolves and changes in time.[42] Michael Batty also points out that "as architects and planners and urban theorists, we approach the city in terms of its morphology which is not enough. Complexity theory studies cities on multiple related themes: relationships between people and environment, spatial variability, processes at multiple and interlocking scales, and combined spatial and temporal analysis of system."[43] In other words, complexity theory looks at the heterogeneity of a system and the interactive process of the elements within the system.

The city, like an organism, is a large scale entity composed of several hierarchical subunits at smaller scales. These subscale units are usually of different forms, perform a variety of functions, and exhibit a strong interaction with each other. These properties of the subunits sustain the coherence of the whole. A city can be revived by repaving the paths of interaction between the subunits, by reconnecting their geometry. This is where the design principles of complexity theory differ radically from the conventional principles.[44] Complexity theory has the potential to enhance the current approaches to city planning and "replace traditional top-down strategies with realistic city plans that benefit all city dwellers".[45] It can build on an existing urban design theory or a combination of theories such that "city planners can develop operational tools grounded in extensive empirical data."[46]

There have been some approaches similar to complexity theory in the practice of urban design, including systems approach and simulation models.

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42 Peter Testa et al., "Emergent Design: a crosscutting research program and design curriculum integrating architecture and artificial intelligence." *Environment and Planning B: Planning and Design* 28 (2001):481.

43 Michael Batty, "Less is more, more is different: complexity, morphology, cities, and emergence," *Environment and Planning B: Planning and Design* 27 (2000):168.

44 Nikos A. Salingaros, "Complexity and Urban Coherence," *Journal of Urban Design* 5(2000):291.

45 Michael Batty et al., "The Size, Scale, and Shape of Cities".

46 Ibid, 771.

3C.i. *Systems approach*

Systems approach is a framework for understanding complex systems where one looks at "how elements of a problem relate to each other and with what significance"[47] to explain the whole system. It is viewed by many as a logical and robust method of solving problems.[48] But this approach has also been criticized by many who feel that it is very dry and does not require any imagination or intuition.[49] "In the extreme, (this method) is also denounced as a crutch for the untalented since there is no 'art' in it."[50] But the essence remains that city is a system of interrelated parts which form a complex whole, and the systems approach has the capacity to be used as a planning tool to deal with such complex systems.

3C.ii. Simulation models

Simulation models include cellular automata models, agent based models, fractal models, etc. They are tools to better understand the dynamics of a system. For example, a model is initialized by fixing the number of elements of a system and then gradually increasing the number of interactions between these elements to study how emergence occurs and how the elements act as one whole system.[51] Modeling tools like 'cellular automata' have become popular for simulating "spatially distributed processes"[52]. "These applications are promising and have shown realistic results in cities on different continents."[53] They are also capable of representing a realistic future of cities in the developing countries. The computer models are also used to "simulate interactive

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47 Francis Ferguson, *Architecture, cities and the systems approach* (New York: George Braziller, 1975), 5.
48 Ibid, 5.
49 Ibid, 3.
50 Ibid, 3.
51 Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals*, 481.
52 Jose I Barredo et al. "Modeling future urban scenarios in developing countries: an application case study in Lagos, Nigeria," *Environment and Planning B: Planning and Design* 32 (2004): 66.
53 Ibid, 66.

systems as traffic flows, employment, and land-use pattern."[54] They are also used to study the urban morphology. Other software tools, like Emergent Design, that describe emergent process are also used. These software packages are developed from disciplines like computer science and artificial intelligence. The Emergent Design software focuses on "morphology, emphasizing the emergent and adaptive properties of architectural form and complex organizations"[55]. This software was also used in a MIT School of Architecture graduate design studio to study emergence of organizations. It "differs from traditional design approaches that emphasize things in space as fundamental and time as something that happens to them".[56] Other examples of models to understand the morphology of space are: the space-syntax model and shape grammars. Space-syntax models are used to investigate the relation between the function and structure of a city. Shape grammars generate emergent shapes, that is, shapes which are not "predefined in a grammar".[57]

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54 David Grahame Shane, *Recombinant urbanism: conceptual modeling in architecture, urban design, and city theory* (Hoboken NJ: Wiley, 2005), 28.

55 Peter Testa et al., "Emergent Design: a crosscutting research program and design curriculum integrating architecture and artificial intelligence," Environment *and Planning B: Planning and Design* 28 (2001): 481.

56 Ibid, 482.

57 Terry Knight, "Computing with emergence," *Environment and Planning B: Planning and Design* 30(2003):125.

4. HOLLAND'S FRAMEWORK OF COMPLEXITY THEORY

Complexity theory describes a complex system as a system where actors interact and self-organize to emerge as a whole novel system. John Holland, one of the pioneers in the field of complexity, further argued that in a complex system, actors "revise and rearrange their blocks as they gain experience".[58] He argues that the agents in a system adapt and improve their interaction to strengthen their organization for better efficiency. He named these complex systems as '*complex adaptive systems'*. "Every complex adaptive system constantly (makes) predictions based on its various internal models … (based on) assumptions about the way things are out there."[59] He argues that these complex adaptive systems are never in equilibrium but in a state of transition, constantly trying to improve. Hence, to understand complex adaptive systems (for simplicity addressed as complex systems, henceforth) it is important to understand the interactions between the agents in a system.

Holland's framework for understanding the working of complex systems is similar to the systems approach, and can be generalized in any field of life sciences, computer science, and urban systems. These general principles help in "synthesizing complex behaviors from simple laws".[60] According to Holland, the basic concepts[61] needed to understand the emergent behavior of a complex system are: State of a system, Agent, and Mechanism of a system.

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[58] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos*,146.
[59] Ibid, 146.
[60] John H. Holland, *Emergence- From Chaos to Order* (Reading MA: Addison-Wesley,1998), 40.
[61] John H. Holland, *Hidden order: how adaptation builds complexity* (Reading MA: Addison-Wesley,1995).

4A. STATE OF A SYSTEM

The state of a system is its general setting which acts as an apparatus to study the emergence of a system. The state of a system "subsumes all aspects of past history that are relevant to future possibilities".[62] This means that the state is the summary of the present condition of a complex organized system from which we can determine the future possibilities. One example given by Holland is the state of pressurized gas in a container. The state of gas is recorded in terms of its pressure, temperature, and volume. If the can is punctured, the initial state will dictate what will happen next.[63]

4B. AGENTS OF A SYSTEM

"A system is a network of many agents acting in parallel."[64] Agents interact with each other to produce a new emergent environment. They are players within a system who influence its emergence. In our neural system, the brain cells are the agents, whereas, within the cell the nucleus, the mitochondria, etc. are the agents. In a colony of ants, each ant is an agent. In a complex organized system, there is no 'master agent' giving orders to other agents or organizing the system. It is through cooperation and self-organization that the agents develop a novel emergent system from the bottom-up.

4C. MECHANISM OF A SYSTEM

Mechanism is the rules by which the system interacts. All complex systems exhibit the following mechanisms[65]:

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62 Ibid, 123.
63 Ibid, 34.
64 John. H. Holland quoted in M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos*, 145.
65 John H. Holland. *Hidden order: how adaptation builds complexity*.

i. **Tagging** – This mechanism facilitates the formation of an aggregate through selective interaction. With selective interaction, information between agents is filtered to form a relation of cooperation and self-organization. This also leads to the formation of hierarchical organization of agents and meta-agents. Thus, this mechanism contributes directly to the phenomenon of emergence, which centers on the interactions of the agents, and is more than the sum of the activities of the agents.

ii. **Internal Model** – The structure of a system is its internal model. In this mechanism, the agent receives an input pattern and converts its internal structure according to the pattern. The internal model of the system allows the agents to predict possible changes and adapt to the changes becoming resilient.

iii. **Building blocks** – This mechanism uses combinations of repetitive components, that is, aggregation of similar or different agents, to form large number of novel systems. Hierarchical organization is observed in building blocks. That is, an aggregate of agents forming a building block can aggregate with other agents to emerge as a meta-agent, or a higher level of building block. The system is also able to adapt to changes by "revising and recombining" [66] the building blocks.

Due to these mechanisms, the emergence of the following properties within the system is observed[67]:

i. **Aggregation** – Aggregation is where agents interact with each other to form an aggregate. Aggregation is a collection of agents with similar characteristics. This becomes a building block for the model of a system. It is the primary property in the mechanism of tagging, that is, the selective process of tagging is aggregation of similar agents, or, simply said, tagging is a mechanism of aggregation. This

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[66] M. Mitchell Waldrop, *Complexity: the emerging science at the edge of order and chaos.*

[67] John H. Holland, *Hidden order: how adaptation builds complexity*.

aggregate interacts with other aggregates to form a larger aggregate or a meta-agent, where the aggregate becomes a base unit, thus forming a hierarchical organization. Complex large scale behavior emerges from the aggregate interaction of agents. This interaction can be defined using the relationships between the aggregate properties. For example, when studying the human blood circulation system, the relationship between the heart and the lungs is not defined at the cellular level, but at the level of the organs which act as meta-agents.

ii. **Non linearity** – The system is non linear because the properties of the aggregate are greater and different than the sum of the properties of the agents. The non linear interaction of the system makes the behavior of the aggregate more complex. The character of the aggregate 'emerges' from the interaction of the agents. For example, in the human blood circulation system, the interaction of the meta-agents in this system is not a simple linear process, such that the heart supplies blood to lungs and lungs supply the deoxygenated blood to a third organ. But this complex system works as a non-linear process, where there is back and forth interaction between the heart and the lungs. The overall result is more than just the summation of the properties of the heart and lung. Thus a complex system emerges out of this non-linear interaction.

iii. **Flows** - Flows indicate the pattern of the system. They are the patterns of the network which connects the agents or the nodes. They are an important factor in any dynamical system as they indicate the state of the system. Tagging largely defines the flow or the pattern of the system. In an organized complex system, "neither the flows nor the networks are fixed in time. They are patterns that reflect changing adaptations as time elapses." [68]

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[68] Ibid, 23.

iv. **Diversity** – Diversity represents the dynamism of the system. It is because of the diverse agents and their diverse properties that the system can reassert and sustain itself by adapting progressively to any changes.

Figure 4-1 summarizes the properties and mechanism within a complex organized system, showing how they are related to each other. Figure 4-2 illustrates how a complex system emerges from basic agents and building blocks.

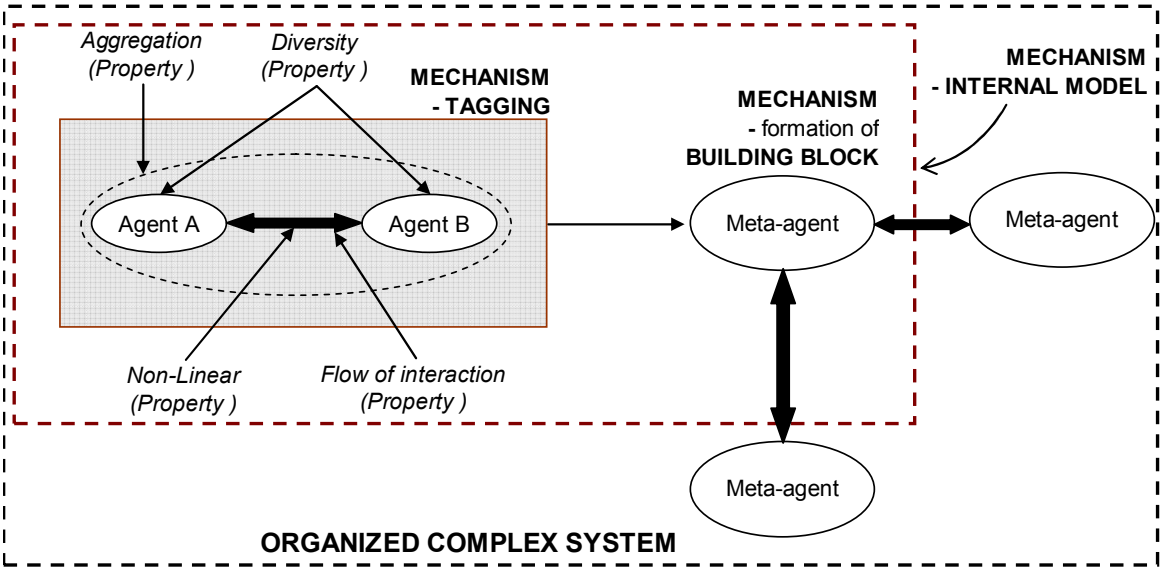

Figure 4-1 Illustration of the properties and Mechanism in a Complex System

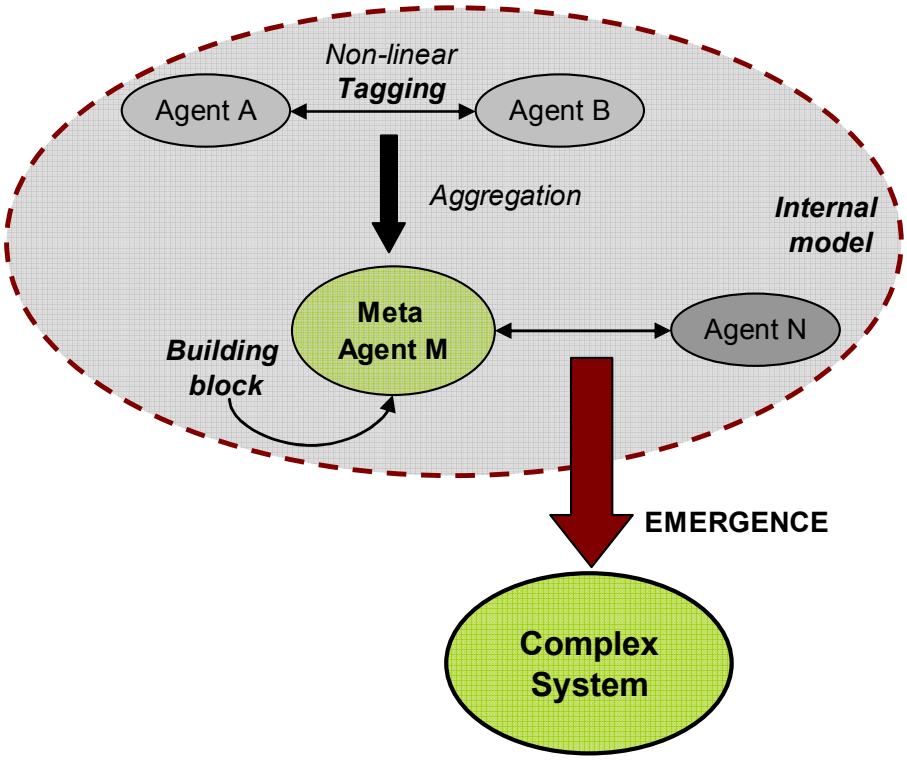

Figure 4-2 Illustration showing Emergence of Complex system

5. MUMBAI AND ITS RAILWAY MARKETS

The image of Mumbai (formerly known as Bombay) as a 'dual city' has existed from the time it evolved from a colonial city to an industrial city, to its present form as a global city or megacity. In their insightful book, 'Bombay, the cities within', Sharda Dwivedi and Rahul Mehrotra have aptly described the duality of Mumbai:

> In contemporary Bombay, the phenomenon of the existence of parallel cities is striking. Until a few decades ago, the many worlds in the city occupied different spaces, but have now coalesced into a singular but multi-faceted image. This image comprises strange yet familiar juxtapositions – fishing villages and slums at the foot of luxury apartments and bazaars in Victorian arcades. Today, the city clearly comprises different worlds that have different social as well as physical manifestations, but are united by their sheer presence in a single space, Bombay.[69]

Mumbai, as a city, did not grow out of any formal planning[70]; rather it is mostly a product of self-organization of systems. This chapter describes Mumbai's growth and how informal markets also simultaneously grew within the city. The case of the railway markets will be discussed with respect to its characteristics and the issues involved.

5A. HISTORY OF MUMBAI

Mumbai started off as seven islands (shown in Figure 5-1) inhabited only by fishermen. In the sixteenth century, the Portuguese settled in Mumbai. They named its islands 'Bom Bahia' or the Good Bay. The true development of Bom Bahia started after the British acquired these islands through a marriage treaty and subsequently named them Bombay. They established a major port in Bombay, which also served as a trading factory. Bombay grew slowly as settlement after settlement was added to its core town.

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[69] Sharda Dwivedi and Rahul Mehrotra, *Bombay, the cities within* (Mumbai: Eminence Designs Pvt. Ltd., 2001), 320.

[70] Ibid.

Migrants came to Bombay in search of lucrative employment. Land was reclaimed to accommodate the growing settlement and the islands were eventually joined. The small walled town grew into a megacity over the century.

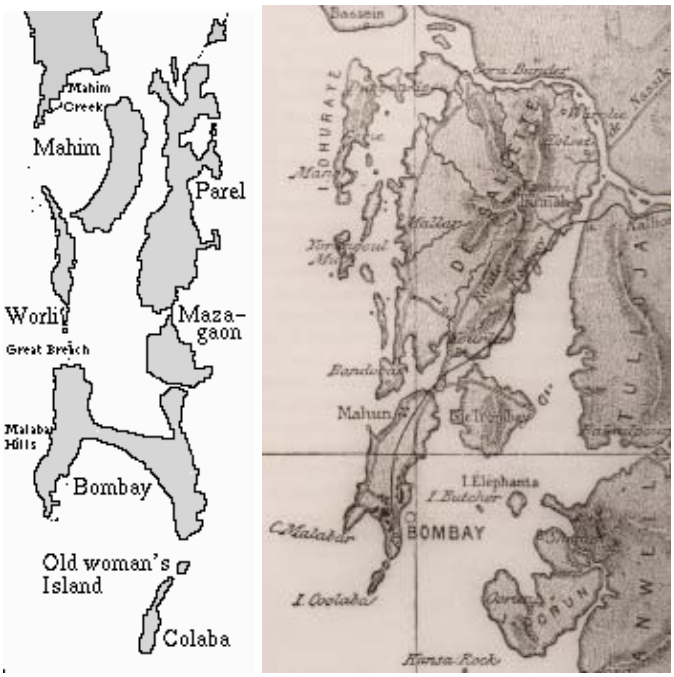

Figure 5-1 Seven Islands of Mumbai and its expansion (Sources a. http://theory.tifr.res.in/bombay/physical/geo.html; b. *Bombay: The Cities Within*)

While the British were establishing Bombay as a port city, they required middlemen, that is, Indian merchants, to carry out trade with the mainland. They started giving incentives to the Indian traders. This resulted in diverse communities settling outside the fort walls, forming the 'native town'. This was morphologically different from the walled city, which had a low density. The native town comprised of a 'mixed use' with shops on the ground floors and residences on the upper floors, "with entire town doubling as a market place."[71] The urbanization of Bombay started this way.

Exports, especially of cotton, from Bombay became a major part of the colonial economy. The Great Indian Peninsular Railway (built in 1853), and the Bombay Baroda

[71] Roy Turner, *India's urban future* (Berkeley and Los Angeles: University of California Press, 1962), 60.

and Central Indian Railway Company (built in 1855) facilitated trade and travel within India. This network of infrastructure helped in the growth of Bombay. The port was further developed during this period, and the cotton exported from the hinterland facilitated the industrialization of Bombay.

Industrialization of Bombay started in 1854 when the first cotton mill was built. Bombay then shifted from a trading town to an industrial and manufacturing center. This opened up new job opportunities and brought a steady stream of migrants, especially from the drought affected interior regions, to the city.[72] Bombay was never planned, even though it underwent an increase in population and size. Bombay grew "precinct by precinct, becoming a collage, not only of varying architectural styles and different urban forms, but more importantly, of the many ethnic and social groups that colonized its growing localities."[73] Bombay showed a striking blend and contrast between the indigenous and the anglicized world. It functioned as a dual entity and continues to do so even after independence. Local bazaars, informal markets for daily provisions, grew in and around densely populated indigenous localities. They gave these localities a vibrant look. By the end of the 1850s, Bombay had a mixed cultural settlement and was acquiring a cosmopolitan identity, which was different than any other colonial or traditional urban settlement in India.

After the end of World War I, the city went through many changes in its physical as well as social structures. More industries were being established which attracted more migrants. To accommodate these people the city started developing and expanding towards its north, resulting in the sprouting of more and more suburbs. But unlike other cities, the settlement of the wealthier class concentrated towards the south

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[72] Rupali Gupte, "The Setting, A Brief History of Mumbai," Collective Research Initiative Trust Mumbai, http://www.crit.org.in/members/rupali/2-TACTICAL%20CITY-%20Brief%20History%20of%20Mumbai-Bombay.pdf.

[73] Sharda Dwivedi and Rahul Mehrotra, *Bombay, the cities within*, 11.

of Bombay, nearer to the older city boundaries, and the middle class and the working class settled in the suburbs.

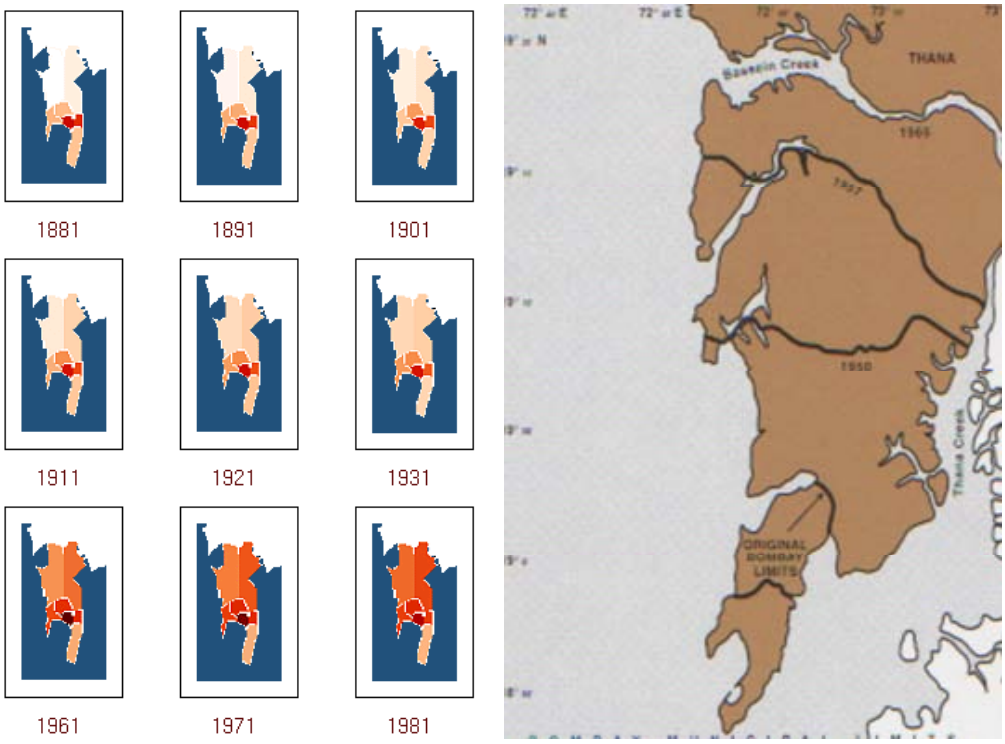

Figure 5-2 Growth of Mumbai over the century
(Sources a. http://theory.tifr.res.in/bombay/stats/pop_stat/density.html;
b. Bombay, The Cities Within)

The shift towards the northern suburbs was facilitated by improvement in the infrastructure and the establishment of the suburban railway system as a 'mass rapid transport'. The northern suburbs had started growing since the early 1930s and by the 1940s, Bombay and its suburbs together formed Greater Bombay. The city grew from the 'portal of transfer of wealth' to the 'financial heart of the country' and now as a 'global city'.[74]

[74] Ibid, 289.

5B. THE RAILWAY MARKETS OF MUMBAI

Mumbai has various strata of settlements – with people from different classes and castes. It has become the melting pot of different cultures. Its cosmopolitan status and lucrative job opportunities have drawn heavy migration in the twentieth century. These migrants, from the rural areas of India, have brought their social values and culture with them. They have been changing the social structure of the city and defining a parallel Mumbai. They also brought the bazaar to the city. They have defined an informal world in an already existing formal establishment. The contemporary megacity of Mumbai has a very striking image of the formal and the informal cities within a single space, even though they are different in their social and physical expression.

One example of this dual existence is the informal market[75] – the bazaar, which has sprawled along the suburban railway lines, its stations, and any undefined interstitial spaces. As Mumbai grew, new suburbs were formed along the newly laid railway system. Soon, locations with mixed use activity started to develop around the suburban railway stations. The buildings had shops at the street level and residences above. As the suburbs grew, residences started growing beyond this area with the former remaining as the market zone. The growing population and the heavy usage of the suburban railway system meant that a large crowd moved in and out of the station through the market. This became a conducive initial condition for the informal vendors to start up their businesses in these areas.

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[75] Informal Market is defined in this research as an economy which is unremunerative and underground. This is a definition by Jonathan Gershuny - Professor of Sociology, used in the article "Informal Spaces - The Geography of Informal Economic Activities in Brussels," *International Journal of Urban and Regional Research* (1999). Market Buildings and open air markets which are a part of municipal market are considered formal market. Another definition can be that informal economy comprises "income-earning activities unregulated by the state in contexts where similar activities are so regulated and is a sector operating between underground and legality. Typically, informal economic activities are 'small scale and characterized by low capital endowments, simple technologies, unremunerated family labor and flexible work sites.' Rosemary D.F. Bromley, "Informal Commerce Expansion and Exclusion in the Historic Centre of the Latin American City," *International Journal of Urban and Regional Research* (1998): 245

Bazaars have long been a part of Indian culture, and most people use them on a daily basis. The typical bazaar in an Indian city appears to be a chaotic and a highly disordered place. This chaos is due to the free and unrestricted interaction of the buyer and the seller in the market. But above all, the chaos represents the underlying optimism and energy in the masses of the city. Every community can easily associate itself to this informal market. The commercial activity of the entire city of Mumbai is like a farmer's market where the excitement is intriguing.[76] These bazaars form the case study for this thesis as examples of informal spaces, which should be treated as complex systems.

Figure 5-3 Typical Informal Market of Mumbai
(Sources a. Bombay: The Cities Within; b. Public places – Bombay)

[76] Rahul Mehrotra, *Everyday Urbanism – Michigan debates on Urbanism, Vol.1: Margaret Crawford vs. Michael Speaks* (Ann Arbor: University of Michigan, 2005).

5C. ISSUES OF INFORMAL MARKETS

Anjaria, in the social sciences journal Economic and Political Weekly, points out that vibrancy, chaos, crowd, affordable, convenient are some of the images that come to mind when talking about the bazaars or the informal markets of Mumbai.[77] For the purpose of this research, *location, economy, dynamism, openness,* and *perceived image* are the characteristics of the markets which are considered in detail.

5C.i. Location

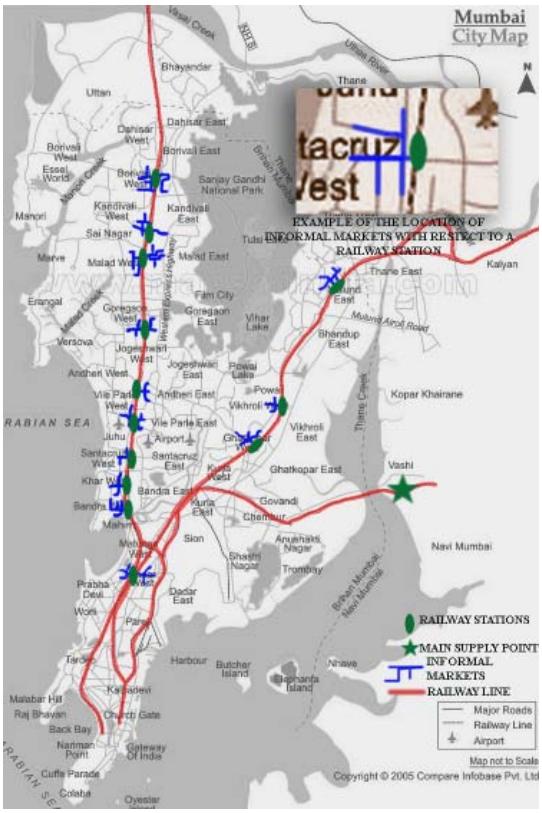

Figure 5-4 Location of Informal markets with respect to the railway stations and supply points

The informal railway markets are located conveniently for the daily rail commuters as well as the vendors around the railway stations, which is the main mode of transportation

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[77] Jonathan Shapiro Anjaria, "Street Hawkers and Public Space in Mumbai," *Economic and Political Weekly* (May 27, 2006):2140.

in Mumbai. Figure 5-4 shows the location of the suburban railway routes and the major railway markets along the railway route, near the railway stations.

5C.ii. Economy

The bazaars of Mumbai form a major part of the micro-commerce sector of Mumbai, contributing to the city's economy. They provide goods at a low price, which is important considering the various income groups living in the city.

5C.iii. Dynamism

Bazaars form a 'kinetic' space, giving the space a dynamic feel and a vibrant look. People feel safe to some extent in the presence of a dynamic crowd as compared to being alone on the street.

On the other hand, a large crowd also leads to congestion, lower pedestrian safety, and a overall chaotic condition. This raises security concerns, like pick pocketing, in these areas.

5C.iv. Openness

The informal markets are situated in open spaces, which make them naturally ventilated, and hence have no additional cost of operating mechanical ventilation. The open layout arrangement also adds to the safety of the crowd since it provides many escape points in case of an emergency.

However these escape routes can also be used by criminals to escape easily, thus making it difficult to enforce law and order in the market.

5C.v. Perceived Image

Other characteristics that are associated with the informal railway markets are 'unhygienic' and 'disorganized', which is due to the lack of infrastructure in these

markets. This disorganized nature is perceived as unsafe as it is difficult to monitor all activities.

These issues related to informal markets around railway stations have their positive as well as negative effects. The positive features establish the importance of these informal markets in the city system.

5D. CURRENT PLANNING AND DESIGN EFFORTS

The aspects of dynamism, image and openness of the market also have negative issues of congestion, safety and security, disorganization and hygiene Based on the negative issues, the informal vendors are deemed illegal by the authorities. Recent actions proposed by authorities are to remove the vendors completely, or relocate them in a formal setting within a building or replace them with malls.[78]

The hawker's problem in Mumbai was first targeted in 1985 when the Supreme Court of India passed a law which did not allow anyone to carry their trade in a public place which could cause inconvenience to others. . The Court asked the MCGM to frame a final scheme which was passed in 2004. The Supreme Court of India has allocated hawking zones in the city where the vendors will be allocated areas for vending, for which they will have to pay some amount of rent.

The final law passed by the Supreme Court has the following main points[79]:

- Vendors or hawkers are not allowed to occupy both sides of the road in areas where they are allowed to carry out their business

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[78] British Broadcasting Corporation, "India's sensory assault course," http://news.bbc.co.uk/2/hi/programmes/from_our_own_correspondent/7330355.stm. Article dated April 5 2008.

[79] Civil appeal no. 4156-4157 of 2002 given by an officer of Municipal Corporation of Greater Mumbai during field visit.

- Hawkers must not erect stalls or place any tables, stands, or erect any type of structure. They also should not use handcarts. However they may protect their goods from the sun, rain or wind.
- There should be no hawking within 100 meters from any place of worship, educational institutions and hospitals or within 150 meters from any municipal or other markets or from any railway station. There should be no hawking on foot-bridges and over-bridges.
- Hawking is allowed only between 7:00 am and 10:00 pm.
- No hawking is allowed in areas which are exclusively residential and where trading and commercial activity is prohibited. Thus hawking cannot be permitted on roads and pavements, which do not have other shops.
- Hawkers have to pay a fee to the municipality to carry out their business and get a licence if permitted.

The Municipal Corporation of Greater Mumbai (MCGM) carried out surprise checks in order to remove the hawkers from unauthorized areas. If they caught any hawker, they would confiscate his or her goods and carts and fine them a penalty of Rs. 10,000 to 13,000. But taking away the materials and asking the vendors to pay the fine is not effective because the fines are expensive and the vendors in turn buy new carts and goods instead of paying their fines. MCGM has proposed more markets like Hawker's Plaza, where all the vendors will be relocated. These markets will also have small service providers like cobblers, carpenters, etc. Provisions to accommodate this informal service sector will give secured job opportunity to this marginal section. Almost every suburb of Mumbai will have these markets located near the railway station. These markets will also provide basic infrastructure like toilets, and water supply to the vendors. These markets will also have a big municipal retail store as the anchor store, to make them financially feasible. MCGM also pointed out that although some shopkeepers

complain about vendors, there are some who themselves put up vending stalls to give away their materials on sale.

However, the removal and relocation of the vendors in a building results in the elimination of the positive factors of the market. The vendors around the railway station form a large portion of informal market in Mumbai. Removing them would mean pushing them out of the city to their villages, as they would be jobless. [80] This would result in more poverty in the rural areas and concentration of money in the urban areas, which means there would be an increased class polarization in the Indian population. Besides, there are health aspects to farm produce vending. Since the hawkers don't have the infrastructure or money to store their goods, they get a fresh supply of goods everyday. Hence the customers are ensured of buying fresh vegetables and fruits unlike the processed, frozen vegetables from supermarkets.[81]

The authorities' attempts to relocate or remove the vendors are met by oppositions from the vendors associations. A BBC article reported that many vendors also opposed the establishment of malls in the city, as it takes away their daily livelihood.[82] Even if the opposition is quashed, the attempt to relocate the informal vendors has been a failure. This is because such planning fails to consider the dynamics of the market system. The approach taken by the authorities is either an attempt to adapt to the regulatory policies of western cities or an adoption of conventional planning approach.

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80 Jonathan Shapiro Anjaria, "Street Hawkers and Public Space in Mumbai".

81 Sharit K Bhowmik, "National Policy for Street Vendors," *Economic and Political Weekly* (April 19, 2003): 1543.

82 British Broadcasting Corporation, "India's sensory assault course," http://news.bbc.co.uk/2/hi/programmes/from_our_own_correspondent/7330355.stm. Article dated April 5 2008.

6. ANALYSIS OF INFORMAL MARKETS AS COMPLEX SYSTEMS

An organized complex system is a group of elements that show a self-organizing property and emergence of a novel system.[83] In a complex system, the interaction of the agents in a system is more important than the agents themselves.[84] Similarly in Mumbai, the formal shops, informal vendors, and the suburban railway system, together with their interactions, have emerged as a "market zone". The informal vendors and the formal markets are building blocks, which, with their interactions, have emerged as a complex adaptive system, that is, the railway market system. The complex system of the suburban railway markets is illustrated in Figure 6-1 which shows the building blocks and the flow of interaction between them.

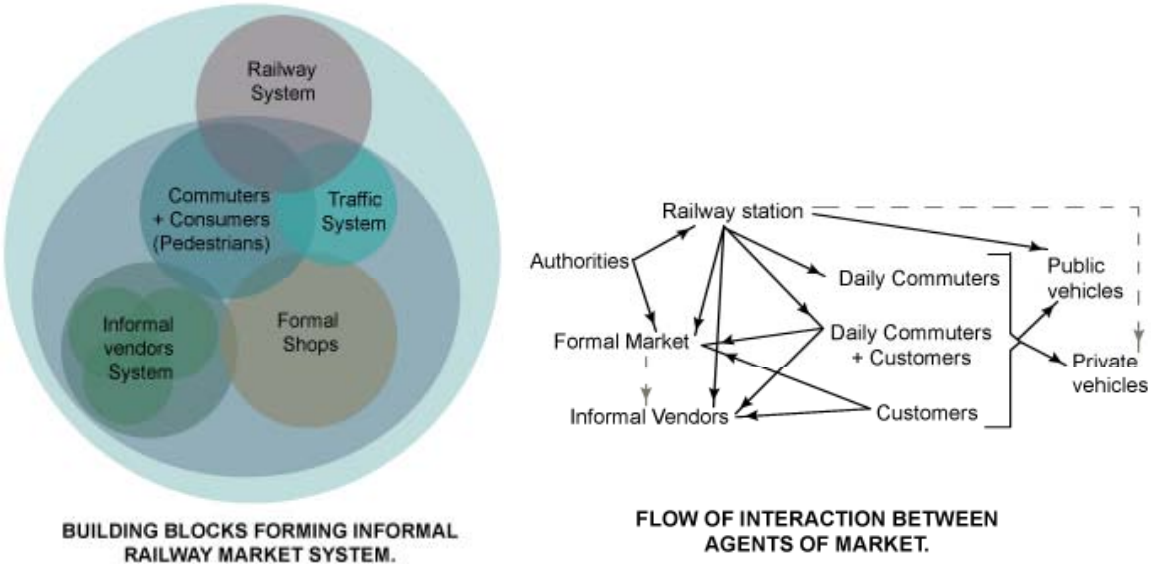

Figure 6-1 Illustration of the Market System

After understanding how markets can be explained as complex systems, the data collected from the field study for the four cases of railway markets is analyzed using

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[83] John H. Holland, *Hidden order: how adaptation builds complexity*.
[84] Ibid.

Holland's framework of complexity theory. This analysis is aimed at understanding the structure of the markets as a complex system.

6A. STATE OF THE INFORMAL MARKET

The state of a system is the basic feature which provides an understanding the emergence of a system. In the case of the informal markets, it is the condition of the market, its characteristics, and their influence on the surrounding area and the city, which gives a better understanding of the 'state' of the informal markets. The issues of the informal markets, which have been mentioned in Chapter 4, represent the state of the markets. The five issues identified for all four cases are: location, economy, dynamism, openness, and perceived image.

6A.i. Location

Positive features:

The informal railway markets are located conveniently for the daily rail commuters around the railway stations. More than half of Mumbai's residents commute daily on the Mumbai Suburban Railway network. This number does not include the railway travelers outside the suburban network.[85] The commuters shop from these vendors on their way home, and do not need to go out of their way. This is not only convenient, but also saves them considerable time and money.

Most of the railway stations have a formal market located in the immediate vicinity, and the informal vendors locate themselves outside these formal shops. Hence, to their advantage, they also serve the customers of the formal shops. They are

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[85] "The Mumbai Suburban Railway network caters to 6.3 million commuters everyday. It has the highest passenger density in the world. Almost half of the total daily passengers using the entire Indian Railway System are from Mumbai Suburban Railway system alone." Official website of *Mumbai Railway Vikas Corporation Ltd*., www.mrvc.indianrail.gov.in/intr.htm (Accessed July 12, 2007).

conveniently located for both the commuters, as well as the customers who are not commuters.

Establishing themselves around railway stations is also convenient for the vendors. They are connected to their 'supply point' via the railway network. They also save on their traveling time and money due to the proximity to the cheapest mode of transportation in Mumbai. Figure 5-4 shows the location of the railway routes and the major railway markets on the Western railway route.

6A.ii. Economy

Positive features:

The bazaars of Mumbai help the migrants in their transition into the urban setting by acting as an easy source of employment and providing a familiar social setting. Bhowmik, in the journal 'Economic and Political Weekly', estimates that this set up provides direct employment to over three hundred thousand people in addition to indirectly employing hundreds of thousands more.[86] For many households this is the only source of income.[87] The two worlds of Mumbai, formal and informal, are economically interlinked. Architect and urban planner, Charles Correa, an expert on informal spaces points out,

> there is a limit to the number of jobs which can be generated in industry. The vast majority of migrants to the cities will have to find work in tertiary and bazaar activities. Any intervention we make on the urban scene, therefore, should aim to increase economic activity in these areas. To achieve this, the physical form of the city can be of importance. [88]

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[86] Sharit K Bhowmik, "National Policy for Street Vendors".

[87] Ibid.

[88] Charles Correa, *The New Landscape: Urbanization in the third World* (Stoneham MA: Mimar Book/ Butterworth Architecture, 1989), 21.

Vending in bazaars represents micro-commerce; vendors are independent business owners acting as a point of sale for manufactured goods, farm produce, and services, and, in some cases, self-produced products. People who lack any particular skills, training or significant amount of capital can start off their own vending business without much difficulty.

Hawkers and vendors also serve the city by providing its residents with a variety of goods at a low price. The food vendors cater to the city's outdoor life and they flourish because they service the demand not met by regular commercial establishment.[89] Thus, vendors create a diverse economic market within the city. Jane Jacobs, writing about American cities, argues that everyday diversity is valuable because it allows people to successfully support their neighborhoods.[90]

6A.iii. Dynamism

Positive features:

The informal market forms the interstitial spaces of the city. These interstitial spaces give Mumbai its identity, and it is the activities that occur in these spaces that shape the form of the city more than the formal plans.[91] They create a continuous transitional space between work and home. Bazaars form a 'kinetic' space in a static city and give it a dynamic feel and a vibrant look. It is the daily activities of the people which wrap a kinetic fabric around these static spaces offering a glimpse of the experience in the city.[92] However, most of the urban design projects create 'permanent static urban

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89 William. H. Whyte, *The Social Life of Small Urban Spaces* (Washington D.C.: The Conservation Foundation, 1980).

90 Jane Jacobs, *The Death and Life of Great American Cities* (New York: Vintage books-Random house, 1961).

91 Rahul Mehrotra, *Everyday Urbanism – Michigan debates on Urbanism.*

92 Ibid.

conditions'. It is in the bazaars that one gets the 'kinetic'[93] glimpse, with a variety of activities, and different people visiting these markets. Along with the aspect of vibrancy, the dynamic crowd of the informal market also reinforces the feeling of safety among people. Safety here is related to comfort a person feels when he or she is in the presence of people.

Negative features:

The presence of crowds brings issues like congestion, pedestrian safety, chaos, and security concerns due to pick-pocketing, etc. But a newspaper article argued that the informal markets become more unsafe with respect to other crimes only after the market closes; prostitution and drug peddling happen only when the crowd recedes. [94]

Informal markets are described as a nuisance and are criticized for causing congestion, blamed for blocking access, and are seen as a private commercial use of public space. Because the informal vendors occupy most of the sidewalks, they cause obstructions for the pedestrians. As a result, the pedestrians overflow on the street, causing crowding on the road which results in traffic congestion and issues of pedestrian safety. Sometimes the vendors themselves spill out on the roads contributing further to congestion.

The repeated bomb blasts in and around the railway stations in Mumbai have also raised security concerns, and have put the informal markets under the authorities' scrutiny. Table 6-1 shows the locations of all the bomb blasts in Mumbai since 1993. The most targeted areas are the markets around the railway stations. Generally, the public places that are usually crowded are attacked. In Mumbai, the trains and the markets are very crowded and are often targeted. Singh, in the journal Strategic Analysis, argues that

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[93] Many people like J. B. Jackson, Edward Soja, Michel DeCerteau, and Marc Auge have written about the positive aspects of kinetic spaces in a city.

[94] Rajiv Sharma, "Not so gay at Andheri station," *The Times of India*, November 11, 2002. http://timesofindia.indiatimes.com/articleshow/27977609.cms

the aim of a terrorist act is to have many victims and witnesses, and the resultant chaos and panic is a measurement of the success of their acts.[95]

Table 6-1 Bomb blasts in Mumbai, 1993-2006[96]

Date	*Place*	*Fatalities*	*Injuries*
July 11, 2006	7 blasts at 7 locations in local trains across the city	181	890
August 25, 2003	Gateway of India (Tourist spot), and Zaveri Bazaar(Market)	50	150
July 29, 2003	Ghatkopar Railway station Market	3	34
March 13, 2003	Mulund Railway Station	11	80
January 27, 2003	Vile Parle Railway Market	1	25
December 6, 2002	Mumbai Central railway station	0	25
December 2, 2002	Ghatkopar Railway station Market	3	31
March 12, 1993	13 blasts across the city in public places	257	713

The disorganized characteristic of a market becomes a threat to the security and safety of the public. An article in the newspaper Asia Times reports that these spaces by virtue of their messy nature, offer outsiders, including antisocial elements, easy scope to mingle and get lost in a crowd.[97] This theory has further fueled the drive to remove

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[95] Khurshchev T Singh, "Terror Trends: Mega Cities, Maximum Impact," *Strategic Analysis*, 30(3) (2006). http://www.idsa.in/publications/strategic-analysis/2006/jul-sep06/KruschevCommentary.PDF (Accessed November 11,2007)

[96] South Asia Terrorism Portal, "Bomb blasts in Mumbai, 1993-2006," South Asia Terrorism Portal, http://www.satp.org/satporgtp/countries/india/database/mumbai_blast.htm (Accessed October 15,2007)

[97] Raju Bist, "Mumbai police called to account," *Asia Times,* August 28, 2003, http://www.atimes.com/atimes/South_Asia/EH28Df08.html (Accessed September 23,2007)

these informal bazaars from the urban setting or relocate them into a more formal setting.

6A.iv. Openness

Positive features:

The general layout of the informal market in India has been of an open air market since the beginning of the concept of a bazaar. The vendors arrange themselves on both sides of the street. This helps in achieving better ventilation, without the need to spend on mechanical ventilation if they had been in an enclosed space. Hence this is the most efficient and economic layout for an informal market. This open layout also reduces the claustrophobic feeling in such a crowded space. Besides, the open layout arrangement allows more exits and dispersion points for the people coming to the market. In case of emergencies there are more escape routes for the customers, which adds to the safety of the market.

Negative features:

More number of exit points and escape routes also become a security issue, as the difficulty in controlling all the exit points allows criminals and terrorists to escape easily. This is one reason why the authorities want to relocate the vendors within a formal space like a building.

6A.v. Perceived Image

Negative features:

An issue which arises out of the present condition of the markets is hygiene. Due to lack of infrastructure like water supply, garbage disposal and sanitation, the market remains unhygienic. This also gives an unhealthy image to the food products sold in the market. This is largely due to the failure of the authorities to maintain the cleanliness of the

market. Also the markets seem cluttered and messy even though they are internally self-organized. Anjaria, in Economic and Political Weekly, reports that this allows the authorities to claim the bazaars to be a "menace and an eyesore that prevents the development of Mumbai as a world class city."[98] The upwardly mobile middle class in India are demanding western standards which symbolize their personal status. For them a mall symbolizes world class status. [99] But considering the small percentage of people who can afford to go to a mall, informal markets continue to serve the majority of citizens in India. [100]

The state of the market dictates the change in the structure and the condition of the market when there is an external intervention, which has the potential the model of the railway market. Table A7 (in appendix) presents a summary of the state of the market, its positive and negative impacts, the issues that surface due to the negative impacts, the action the authorities have taken to resolve the issues, and the outcomes of the action. Thus, the state of the market is an important factor in the reaction of the market to future changes. These reactions will be further explored for each case study, with respect to mechanisms of complexity theory.

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[98] Jonathan Shapiro Anjaria, "Street Hawkers and Public Space in Mumbai," 2140

[99] Anthony. D. King, *Spaces of Global Cultures – Architecture, Urbanism, Identity* (London: Routledge, 2004), 134.

[100] Ibid.

6B. AGENTS OF THE INFORMAL MARKET

Agents within a system interact to produce a new emergent environment. Table 6-2 lists the agents acting in the informal railway market system. The agents are categorized into *actors* and *units*. Units are the spatial components which an actor forms within the bigger unit of the informal market. Batty has identified agents as basic elements or atoms of the city, and categorized them in two groups – "cells, which represent the physical and spatial structure of the city, and agents, which represent the human and social units that make the city work."[101] Batty's basic elements, *cells* and *agents*, are respectively equivalent to the terms *units* and *actors*.

In the informal railway markets, three categories of agents are identified: *primary agents, secondary agents,* and *external agents*. The primary agents are directly involved in the emergence of the market system. Secondary agents have an indirect impact in the working of the system. Their presence is solely because of the primary agents. External agents are not part of the market system but can cause a change in the emergence of the system. Their action impacts the working of the system through an intervention or interference in the interactions between the agents within the system.

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[101] Michael Batty, *Cities and Complexities: understanding cities with cellular automata, agent-based models, and fractals*, 6.

Table 6-2 Agents of market system

TYPE OF AGENTS (ACTORS + UNIT) IN AN INFORMAL MARKET SYSTEM		
	Actors	***Units***
Primary Agents	Permanent informal vendors	Vendor stalls - Bamboo supports and plastic sheet roof; wooden planks for partition and plastic sheet roofing.
	Temporary informal vendors	Vendor stalls setup on a day to day basis - Without any overhead structure; with carts
	Moving informal vendors	Carrying baskets or handbags, set-up for short duration (5-10 minutes) when making a sale.
	Shopkeepers	Formal shops
	Customers i. Commuters who are customers ii. Customers who are not commuters	Commuting route
	Commuters	
		Railway station
Secondary Agents	Public Vehicles i. Buses ii. Auto rickshaws	Vehicular route
	Private vehicles like cars and bikes	
		Municipal market
External Agents	Authorities i. City planners ii. Police	

Table A9 (in appendix) analyzes the relations and the interactions among the agents. This helps in understanding the mechanism of an informal market system. It is from these interactions that we can understand the tagging between the agents, the building blocks they form, and the internal model of the whole system.

6C. MECHANISM OF THE INFORMAL MARKET

A mechanism is the set of rules by which a system interacts. According to Holland's framework, all systems exhibit the mechanisms of tagging, building blocks, and internal model. The market system displays these mechanisms in the following manner:

6C.i. Tagging

Tagging is the mechanism which facilitates the formation of aggregate through selective interaction, thereby forming a better relation between the agents. Tagging exists between most of the agents. Tagging can be a direct relation (shaded in blue) or an indirect relation (shaded in yellow). When there is tagging between agents 'A' and 'B', 'A' can have a direct impact on 'B' and at the same time 'B' can have an indirect impact on 'A'. This implies that the property of 'non-linearity' exists in their tagging. This non-linearity establishes the complex relations the actors have developed and have emerged as a higher system. In some instances two agents might have an indirect relationship with each other, thus establishing an 'indirect non-linear tagging' between them. The following tagging relations exist among the agents of the railway market system:

1. Permanent vendor  Other permanent vendors
2. Permanent vendors  Temporary vendors
3. Temporary vendor  Other temporary vendors
4. Permanent vendors  Formal shops  Temporary vendors
5. Formal shops  Moving vendors
6. Formal shops  All customers  All vendors
7. Formal shops  Railway station  All vendors
8. Formal shops  Private + Public vehicles  All vendors
9. All commuters + All customers  Private + Public vehicles
10. All commuters  Railway station  Private + Public vehicles

[ &  indicate a direct relation, and &  indicate an indirect relation]

A hierarchical order is observed, in the tagging mechanism described above.

6C.ii. Building blocks

The mechanism of building blocks uses combinations of repetitive components to form a large number of novel systems. The agents of the market system aggregate to form building blocks, and building blocks aggregate to form the market system. The market system is also a building block - a higher building block or a meta-meta-agent - in the city system. For the railway market system, the following are the building blocks formed by the aggregation of agents due to the mechanism of tagging:

1. Permanent vendor stalls $\longleftrightarrow$ Permanent vendor stalls
2. Permanent vendor stalls $\longleftrightarrow$ Temporary vendor stalls
3. Formal Shops $\longleftrightarrow$ Permanent vendor stalls $\longleftrightarrow$ Temporary vendor stalls
4. Commuting Route $\longleftrightarrow$ Moving vendors $\longleftrightarrow$ Formal shops
5. Commuting Route $\longleftrightarrow$ Formal Shops $\longleftrightarrow$ All Vendor stalls
6. Vehicular Route $\longleftrightarrow$ Commuting route $\longleftrightarrow$ Formal Shops $\longleftrightarrow$ All Vendor units

[$\longleftrightarrow$ indicates non-linear tagging between units]

This sixth building block or sub-system has evolved through the aggregation of the units tags itself with the unit of railway station to emerge as the informal railway market system.

7. Railway market system = [Railway station $\longleftrightarrow$ Vehicular route $\longleftrightarrow$ Commuting Route $\longleftrightarrow$ Formal Shops $\longleftrightarrow$ All Vendor units]

These building blocks also display hierarchical organization in the system. The building blocks illustrated above are arranged in hierarchical order.

6C.iii. Internal Model

The structure of a system is its internal model. It is formed out of the network of tagging between agents and meta-agents. The bigger building block illustrated above is also the internal model, depicting the pattern of interaction, of the railway market system. The internal model allows the agents to predict possible changes, adapt to the changes, and be more resilient. One example of this resiliency is seen in Dadar's railway market. The agents in Dadar market had built their internal model through selective tagging. After interventions from external agents, the primary agents modified their internal pattern, and re-adapted themselves, thus becoming more flexible.

Within the mechanisms of the market system, emergence of properties of a system, like *aggregation, non linearity, flows, diversity,* and *hierarchical order,* is observed.

The problems of the market system that need to be resolved, or the changes that need to be introduced in the system to improve it, can be based within the internal model of the market system. These changes would exclude the relocation of the market system from their current location. This would in turn also prevent any disruption in the working of the city system.

Figure 6-2 presents the internal model of the building blocks of the market system. It provides a better understanding of the market as an organized complex system.

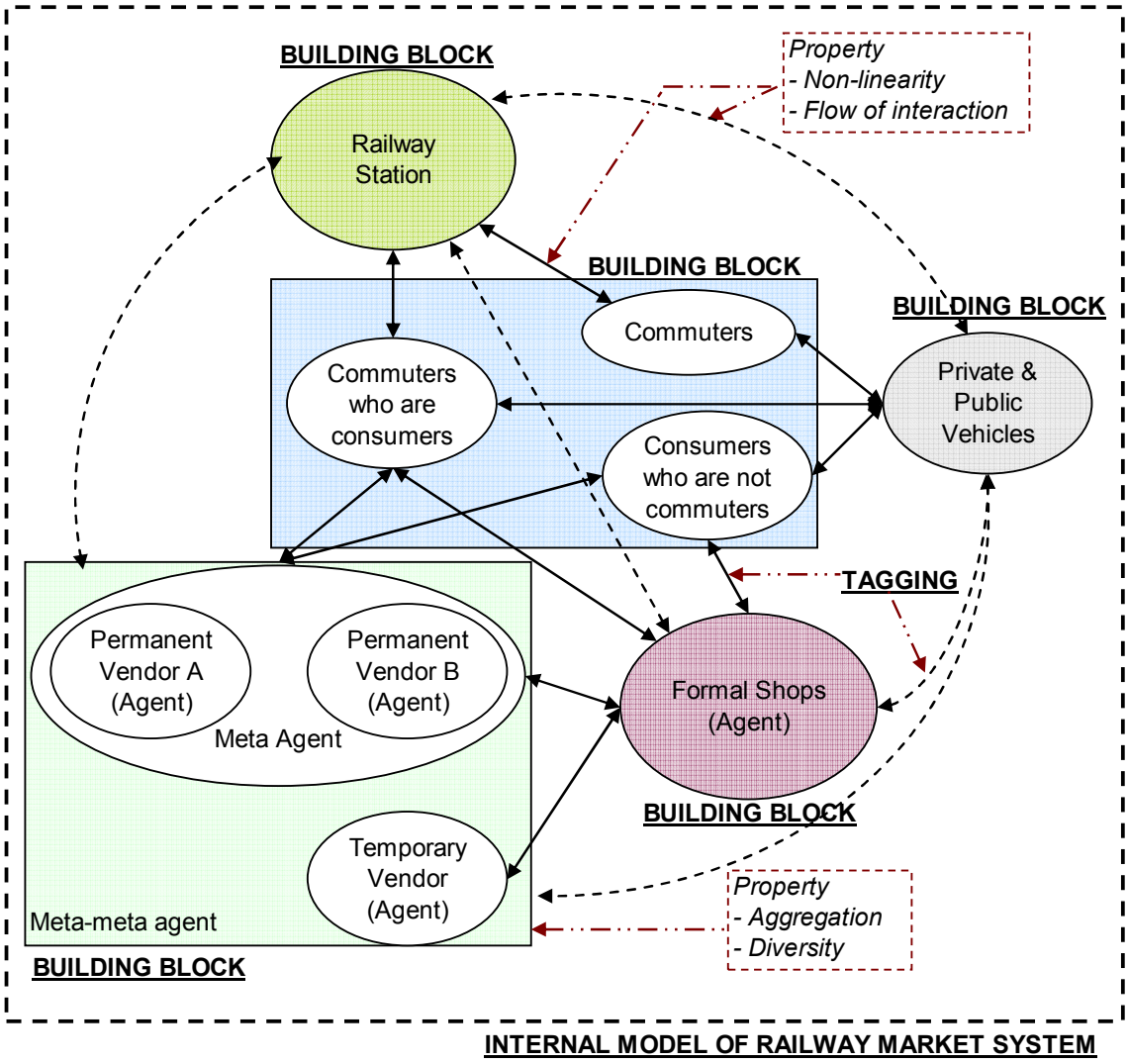


Figure 6-2 Mapping Properties and Mechanism in a Market System

6D. GENERAL ANALYSIS OF THE MARKET CASES

The four cases of Mumbai's railway markets are studied to understand their characteristics, the issues related to informal markets, and how they form a sub-system of a city as a complex organized system.

Three cases of informal railway station markets selected are: *Dadar West*, *Santacruz West*, and *Vile Parle East*. The criteria under which these three cases were selected are:

i) Dadar market – At Dadar market, authorities have already relocated the vendors by building the Hawker's Plaza, a five-storey market for the vendors. This provision is a failure, and most of the vendors are still near the station.

ii) Santacruz market – At Santacruz market, most vendors do not have a license and hence are perceived as illegal. Authorities are taking measures to remove them from the area around the station.

iii) Vile Parle market – Most of the vendors at Vile Parle market hold a license and are considered legal.

These cases are representative of most of the informal railway markets in the city. The Hawker's plaza is included as the fourth case study.

iv) Hawker's Plaza – This building was built for the vendors who were relocated from Dadar railway station. This case will give a comparative overview of how an informal market works as opposed to a planned provision of an informal market. This case is further elaborated in Chapter 7, as an analysis of actions taken by authorities.

Figure 6-3 Location of Case Studies

A comparison of the four market cases is presented in Table A8 (in appendix). The states, the type of agents, and other general and spatial data collected during the field study have been presented and compared. The three railway markets of Dadar, Santacruz, and Vile Parle are similar in most respects. All of them are vibrant, well ventilated and generate a feeling of safety in the customers by providing them with several exit points. However, they are all congested, not very secure, and unsafe for the pedestrians. Access to sidewalks is most difficult at the Santacruz market. They appear to be disorganized, and, except the Santacruz market, none have basic infrastructure.

The conditions in the Hawker's Plaza are very different from the informal markets; it lacks most of their positive features. It lacks the vibrancy of the other markets, it is not large enough to accommodate all the customers, and most importantly, it is relatively farther away from the station. On the other hand, it is secure, organized, and has provision for basic facilities.

CASE STUDIES

6E. SANTACRUZ RAILWAY MARKET

Santacruz, one of the northern suburbs of Mumbai, started developing around the 1930s. Its railway market is located between two main transportation routes, namely, the railway route and a main arterial road, Swami Vivekananda Road, which lies to the west of the railway route. The location and a detailed map of the market are shown in Figures 6-4 and 6-5, respectively.

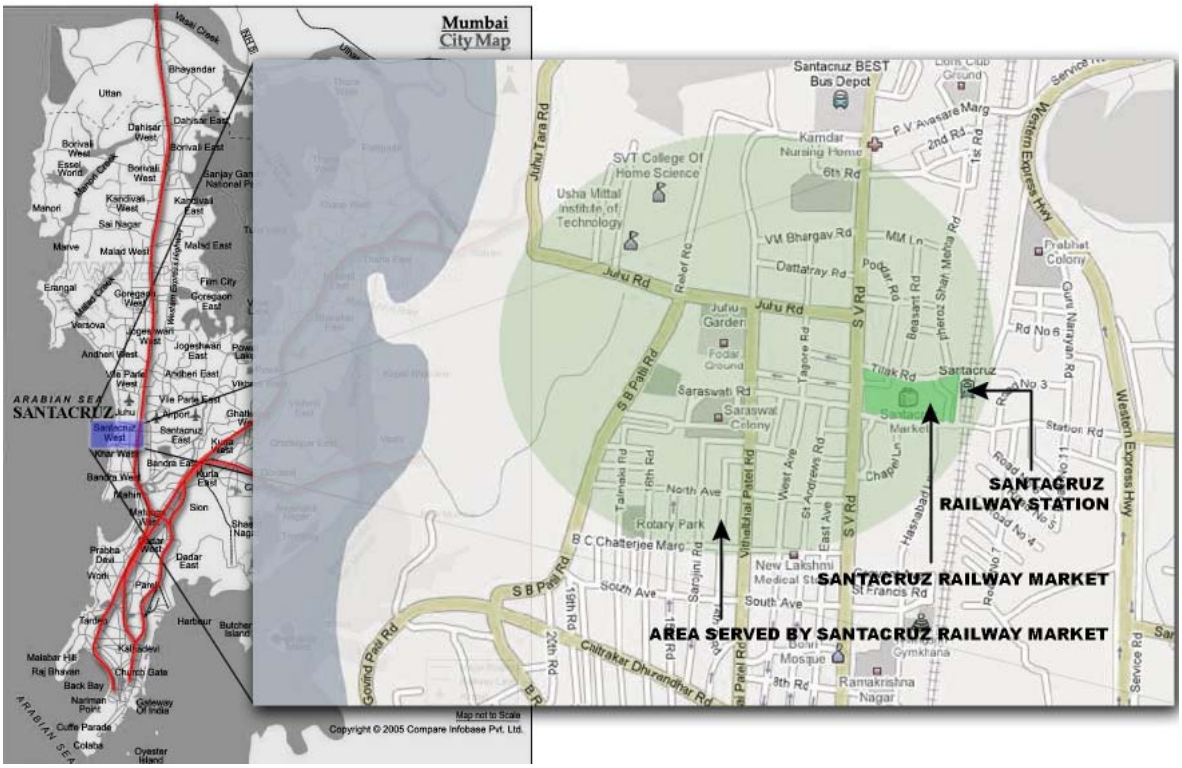


Figure 6-4 Location of Santacruz Railway market

6E.i. State of Santacruz market

The Santacruz railway market is mostly occupied by unlicensed permanent vendors, and very few temporary vendors. There is a municipal market in the vicinity. The vendors of the municipal market sell the same goods as do the informal vendors. Table A2

summarizes the ‘state’ of the Santacruz railway market, issues which arise because of a particular state, the action taken by the authorities, and analysis of the system based on complexity theory. The following is the ‘state’ of the Santacruz market:

Dynamism: The Santacruz market encompasses various activities. It has formal shops as well as informal vendors which attract thousands of people from different economic strata. This leads to congestion, pick-pocketing, unsafe pedestrian paths, obstruction in the movement of customers and vehicles. Authorities conduct regular inspections, confiscate the vendors’ goods, and levy fines. The dynamism of the market arises from the non-linear tagging between the permanent vendors and the formal shops.

Openness: The Santacruz market is well ventilated, has several exit points, and gives a feeling of safety to the customers and commuters. The open layout is an important feature of the bazaar culture, and acts as an internal model of the system.

Perceived image: The Santacruz market is not a planned space and is disorganized and cluttered. It has sanitation facilities in the vicinity, but no potable water supply. This is an indication that this market lies in the region of ‘chaos’. To remove the market from this region, the authorities want to relocate it to a formal, organized space.

Convenient location: The Santacruz market is very close to the railway station, which makes it convenient for both the customers and the vendors. This proximity to the railway station is a very important initial condition for the development of the market.

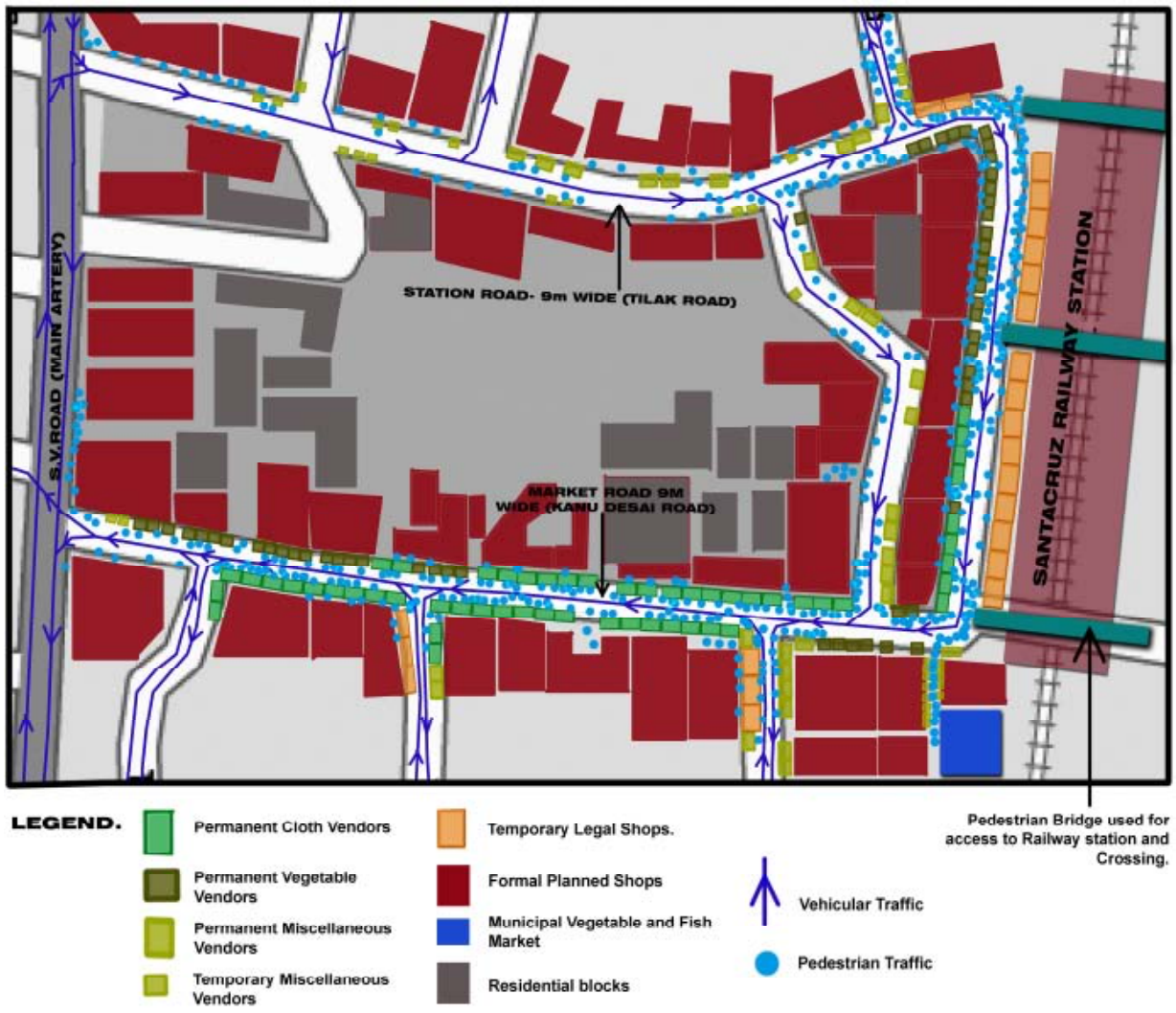


Figure 6-5 Detailed map of Santacruz Railway market

6E.ii. Agents of Santacruz market

Table 6-3 Agents (actors + units) of Santacruz Railway Market.

	Type of Actors	Type of Units
Primary agents	Permanent Informal Vendor - Unlicensed	Stall of Bamboo supports and plastic sheet for roofing and sometimes partition.
	Shopkeepers	Formal planned shops
	Daily commuters	Commuting Route
	Daily commuters who are customers	
	Customers who are not commuters	
		Railway Station
Secondary agents	Private cars	Vehicular Route
	Public vehicles like – buses and auto rickshaws	
		Municipal market
External agents	City Planners	
	Police	

Table 6-3 presents the type of actors and their spatial structure at the Santacruz market. The relation among the actors is presented in the relationship matrix shown in Table A1 (in appendix) which illustrates the mechanism of 'tagging' that the actors have developed with each other. The 'building blocks' and the 'internal model' of the informal market system of Santacruz are also derived from Table A1. The spatial condition of the market is also analyzed by studying the mechanism used by the actors in the system. Using this analysis, important aspects that need to be considered before determining a solution are derived. The measures taken by the authorities are compared with these considerations to assess the reasons behind their failure.

6E.iii. Mechanism of Santacruz market

The following agents tag with each other in Santacruz market:

1. Permanent vendors ⇄ Permanent vendors
2. Permanent vendors ⇄ Formal shops
3. Formal shops ⇄ All customers ⇄ Permanent vendors
4. Formal shops ⇢ Railway station ⇢ Permanent vendors
5. Formal shops ⇢ Private + Public vehicles ⇢ Permanent vendors
6. All commuters + All customers ⇄ Private + Public vehicles
7. All commuters ⇄ Railway station ⇢ Private + Public vehicles

[→ & ⇄ indicate a direct relation, and ⇢ & ⇢ indicate an indirect relation]

These actors form building blocks of the Santacruz market system with their units, using the mechanism of tagging. Following are the building blocks that make up Santacruz market:

1. Permanent vendor stalls ⟷ Permanent vendor stalls
2. Formal Shops ⟷ Permanent vendor stalls
3. Commuting Route ⟷ Formal Shops ⟷ Permanent Vendor stalls
4. Vehicular Route ⟷ Commuting route ⟷ Formal Shops ⟷ All Vendor units
5. Railway station ⟷ Vehicular route ⟷ Commuting Route ⟷ Formal Shops ⟷ All Vendor units

[⟷ indicates non-linear tagging between units]

The final aggregation forms the total building block for the Santacruz market. It also represents the internal model of this market. Figure 6-6 maps the agents and the mechanisms involved in the formation of the Santacruz railway market as an organized complex system; while, in Figure 6-7 the issues faced by the market are mapped.

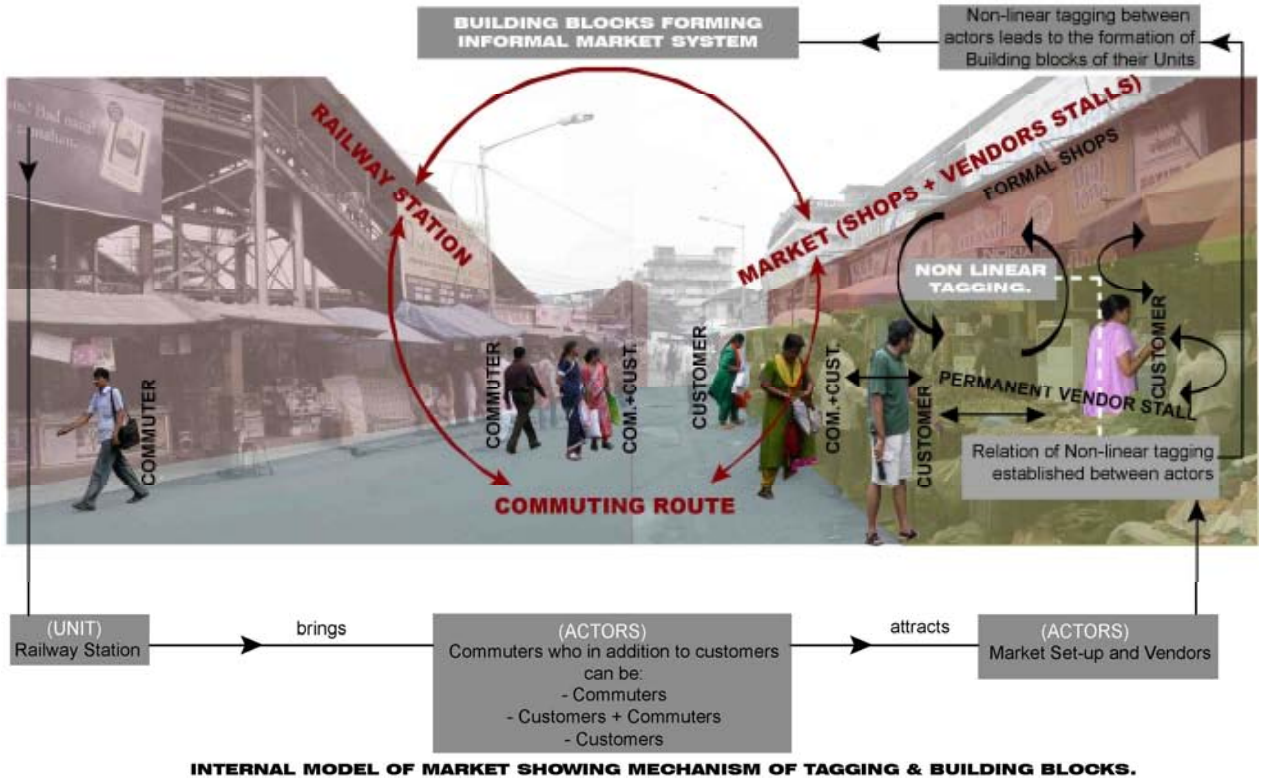


Figure 6-6 Map of Agents and Mechanisms of Santacruz railway market system

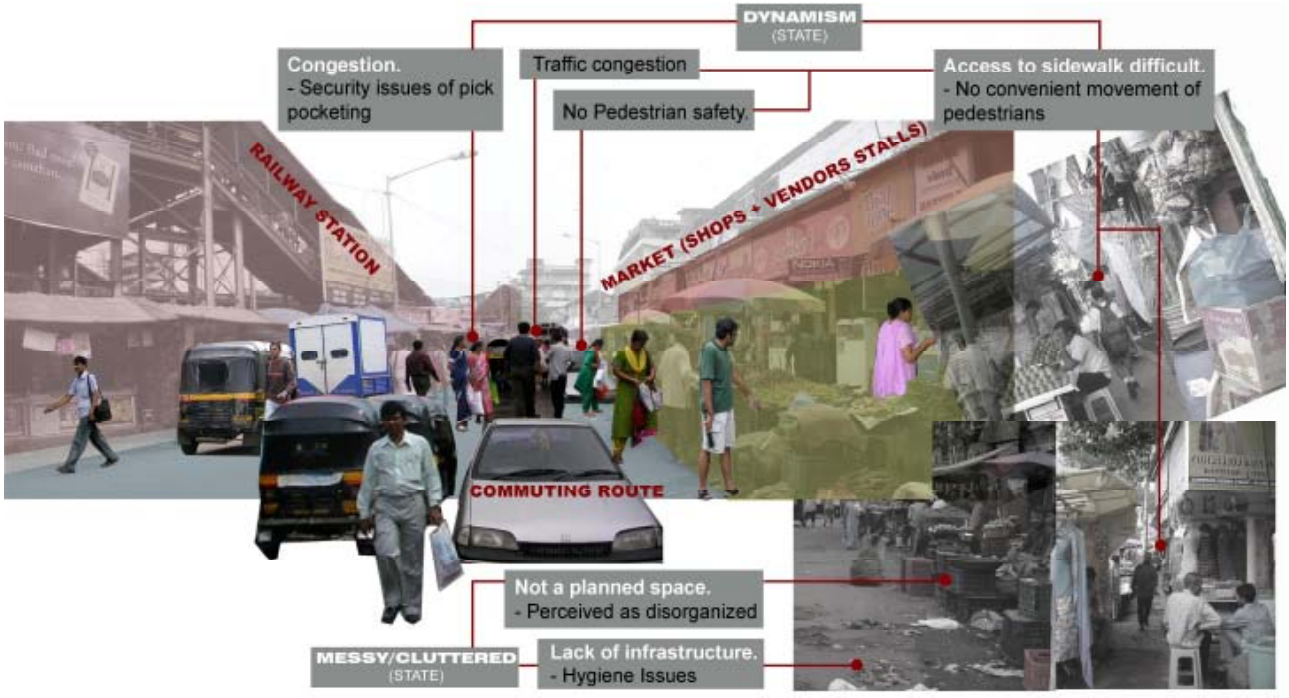


Figure 6-7 Mapping issues in the Santacruz railway market system

6F. VILE PARLE RAILWAY MARKET

Vile Parle is part of the northern suburbs of Mumbai and is located very close to Santacruz. Vile Parle also started developing around the 1930s about the same time as Santacruz. The railway market of Vile Parle is located to the east of the railway station, between the railway route and the Western express highway. It serves mostly the eastern part of the suburb of Vile Parle. The location and a detailed map of the market are shown in Figures 6-8 and 6-9, respectively.

Figure 6-8 Location of Vile Parle Railway market

6F.i. State of Vile Parle market

The Vile Parle market comprises of permanent vendors as well as temporary vendors. Most of the permanent vendors have a license to vend and most of them hold a vending license since 1965. After 1978, the issuance of new licenses was suspended. Thus, the unlicensed vendors, who came after 1978, mostly occupy the market area as temporary

vendors. Only the permanent vendors are considered legal. But despite the legality of permanent vendors they, too, face the risk of relocation after the Supreme Court declared a 150 meter hawking free zone around the railway station. The authorities, on the other hand, want to remove the temporary vendors first. A Municipal market is also located in this market zone. The licensed vendors in the Municipal market and the informal vendors on the street do not sell the same products, and hence the vendors in the Municipal market are less impacted by the presence of the informal vendors.

Table A4 summarizes the 'state' of the Vile Parle railway market which is analyzed using complexity theory, issues which arises because of this state, and the action taken by the authorities. The Vile Parle and Santacruz markets are very similar in their states.

Dynamism: The dynamic nature of the market leads to congestion, pick-pocketing, unsafe pedestrian paths, and constricted access to the formal shops. Authorities conduct regular inspections, but primarily target the temporary, unlicensed vendors. The dynamism of Vile Parle market arises from the non-linear tagging between the permanent vendors, temporary vendors, and the formal shops.

Openness: Similar to Santacruz, the Vile Parle market is well ventilated, and has several exit points that give a feeling of safety to the customers and commuters. The open layout is an internal model of the system.

Perceived image: The Vile Parle market, too, lacks basic sanitation and water supply. However, in comparison to Santacruz, it appears more organized.

Convenient location: Proximity to the railway station is an essential condition for the presence of Vile Parle market.

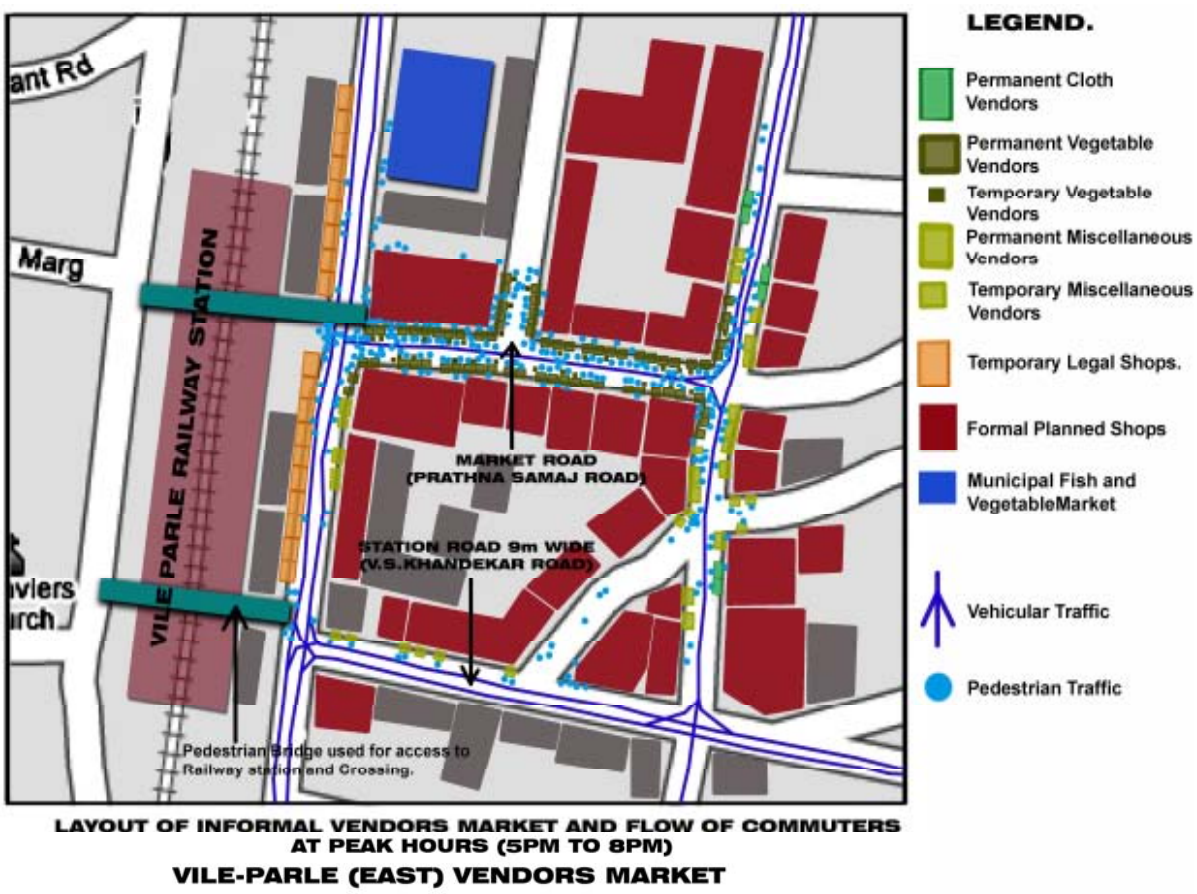


Figure 6-9 Detailed map of Vile Parle Railway market

6F.ii. Agents of Vile Parle Market

Table 6-4 Agents (actors + units) of Vile Parle Railway Market

	Type of Actors	Type of Units
Primary agents	Permanent Informal Vendor - Licensed	Stall of Bamboo supports and plastic sheet for roofing and sometimes partition.
	Temporary Informal Vendor - Unlicensed	Without any overhead structure.
	Shopkeepers	Formal planned shops
	Daily commuters	Commuting Route
	Daily commuters who are customers	
	Customers who are not commuters	
		Railway Station
Secondary agents	Private cars	Vehicular Route
	Public vehicles like – auto rickshaws	
		Municipal market
External agents	City Planners	
	Police	

Table 6-4 lists the type of actors and their spatial structure in the Vile Parle market. Similar to the relationship matrix of the Santacruz market, the relation of the actors with each other in the Vile Parle market is presented in the relationship matrix shown in Table A3. This helps in understanding the mechanism of 'tagging' and deriving the 'building blocks' and the 'internal model' of the informal market system of Vile Parle.

6F.iii. Mechanism of Vile Parle market

Following are the agents of Vile Parle market who have established tagging between them:

1. Permanent vendor ⇄ Another permanent vendor
2. Permanent vendors ⇄ Temporary vendors
3. Permanent vendors ⇄ Formal shops ⇄ Temporary vendors
4. Formal shops ⇄ All customers ⇄ All vendors
5. Formal shops ⇢ Railway station ⇢ All vendors
6. Formal shops ⇢ Private + Public vehicles ⇢ All vendors
7. All commuters + All customers ⇄ Private + Public vehicles
8. All commuters ⇄ Railway station ⇢ Private + Public vehicles

[→ & ⇝ indicate a direct relation, and ⇢ & ⇝ indicate an indirect relation]

These actors form the following building blocks of Vile Parle railway market:

1. Permanent vendor stalls ⟷ Permanent vendor stalls
2. Permanent vendor stalls ⟷ Temporary vendor stalls
3. Formal Shops ⟷ Permanent vendor stalls ⟷ Temporary vendor stalls
4. Commuting Route ⟷ Formal Shops ⟷ All Vendor stalls
5. Vehicular Route ⟷ Commuting route ⟷ Formal Shops ⟷ All Vendor stalls
6. Railway station ⟷ Vehicular route ⟷ Commuting Route ⟷ Formal Shops ⟷ All Vendor units

[⟷ indicates non-linear tagging between units]

The final building block is the aggregate building block of the Vile Parle railway market, which also indicates the internal model of the market system. Figure 6-10 maps the

agents and mechanism of Vile Parle market, while Figure 6-11 illustrates the issues which are due to the negative aspects of the state of the market.

The key issue in Vile Parle railway market is the difficulty in accessing the formal shops, although some of the formal shop owners have used their political muscle to disperse vendors from their shop fronts. Another important problem is the lack of adequate infrastructure. Even though the vendors hold licenses, there seems to be no action by the authorities towards improving the working conditions. Another issue in this market is the unauthorized vending by the temporary vendors, whom the authorities want to completely remove. The other restriction is the 150 meter non-hawking zone around the railway stations declared by the Supreme Court.

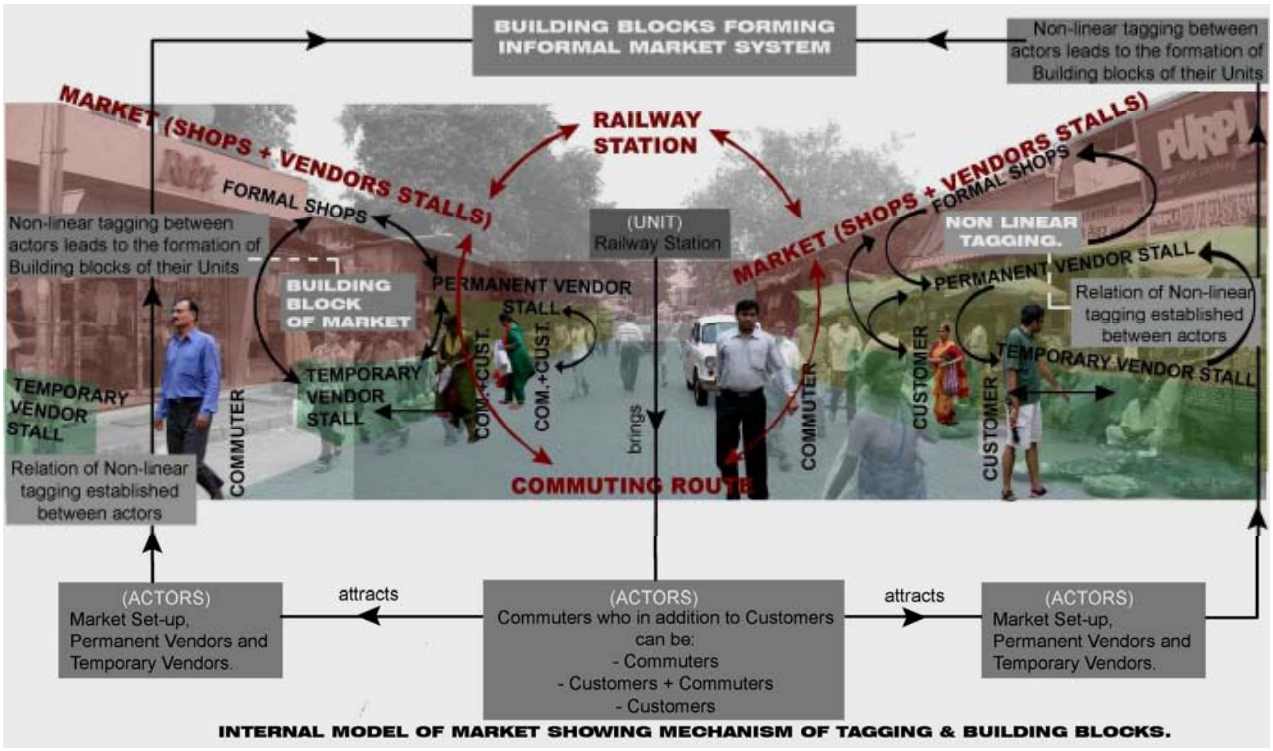


Figure 6-10 Map of Agents and Mechanisms of Vile Parle railway market system

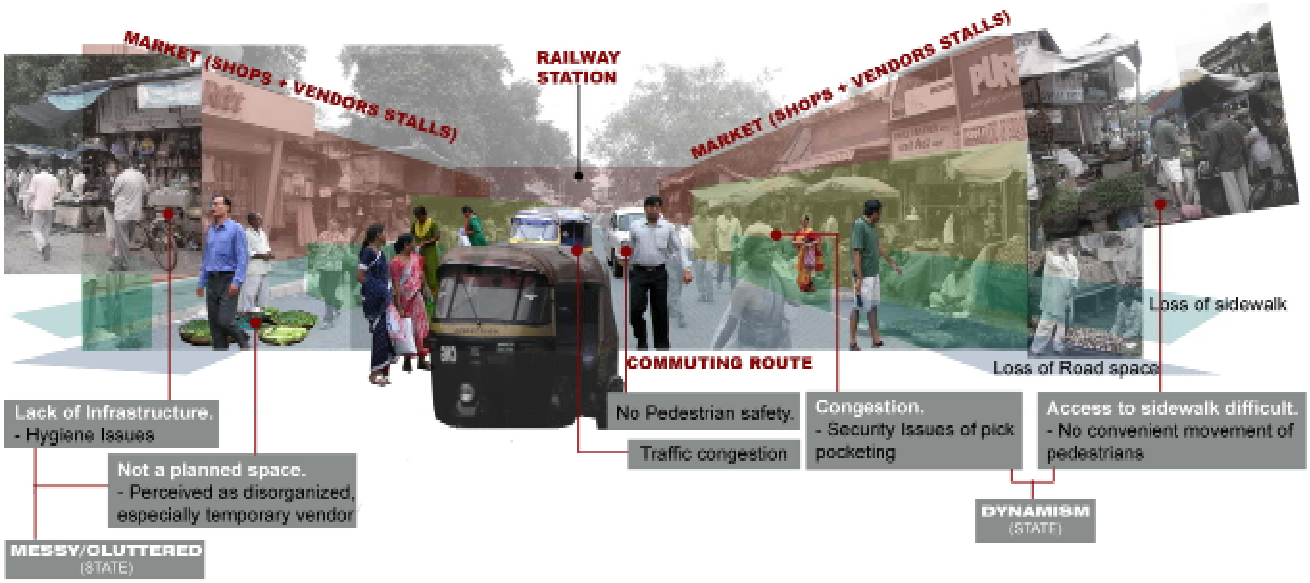


Figure 6-11 Mapping issues in Vile Parle railway market system

6G. DADAR RAILWAY MARKET

The suburb of Dadar started developing in the year 1899. It is a suburb in the southern part of Mumbai and has the only railway station connecting the western and the central railway routes (the main arterial railway routes) of the city. As a result it has become an important node of the city. Dadar is the best example where relocation of vendors from this market was implemented. Most of the vendors in Dadar market were relocated to Hawker's Plaza, farther away from the station. The present condition of Dadar gives an indication of how few agents have readapted to this change. The locations of Dadar railway market and the Hawker's Plaza are shown in Figure 6-12. Figure 6-13 is a detailed map of Dadar railway market.

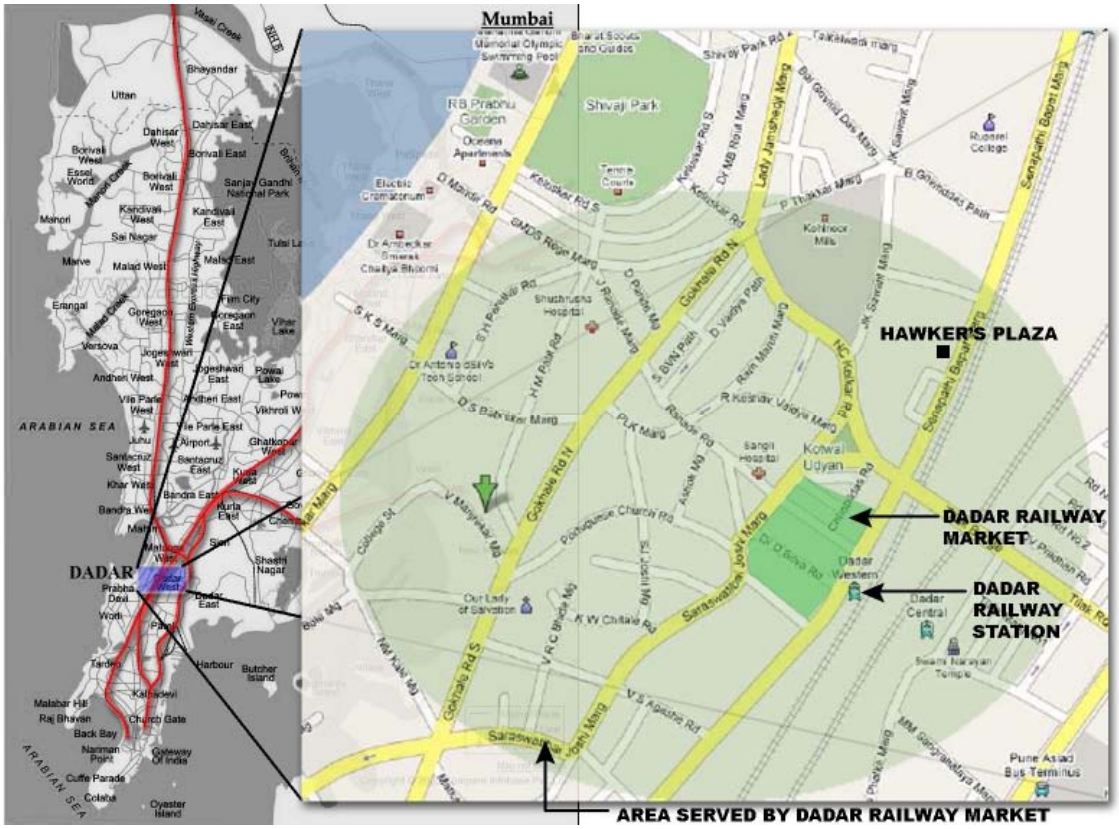


Figure 6-12 Location of Dadar Railway market and Hawker's Plaza

6G.i. State of Dadar market

In May 2001, Hawker's Plaza (See Chapter 7 for details on the Hawker's Plaza) was completed and all licensed vendors, except flower vendors, from Dadar railway market were ordered to move to Hawker's plaza. The unlicensed vendors were ordered to vacate the railway market. A permanent vendor's stall is illegal in Dadar railway market. Most vendors did not want to relocate to the Hawker's Plaza as they feared a loss of business, which is because the Hawker's Plaza does not function as a successful market system. Despite the new rule, many vendors still occupy the streets of Dadar railway market. Most vendors have been frequenting the station area to carry out their business as a temporary or a moving setup. These agents have changed their internal model to adapt to the stimulus of the external agents, namely, the authorities and the police. When the police conduct surprise inspections, the vendors can easily move and escape with their flexible, movable units.

Table A6 summarizes the 'state' of Dadar railway market, its analysis using complexity theory, issues which arises because of this state, and the action taken by the authorities. The state of Dadar market is similar to the states of Vile Parle and Santacruz markets.

Dynamism: The authorities have ordered the licensed vendors to relocate to Hawker's Plaza and prohibited the unlicensed vendors from vending near the railway stations. However, all vendors do not comply and continue with their business near the railway station as moving vendors. The dynamism of Dadar market arises from the non-linear tagging between the temporary vendors, moving vendors, and the formal shops.

Openness: Similar to other markets, Dadar market is well ventilated, has several exit points, and gives a feeling of safety to the customers and commuters. The open layout is an internal model of the system.

Perceived image: The authorities do not provide basic sanitation and water supply in the Dadar market. They have relocated the vendors to the Hawker's Plaza where they are provided with these facilities.

Convenient location: Proximity to the railway station is the reason the vendors have been returning to the Dadar market despite the relocation.

6G.ii. Agents of Dadar market

Table 6-5 Agents (actors + units) of Dadar Railway Market.

	Type of Actors	Type of Units
Primary agents	Temporary Informal Vendor - Unlicensed	Without any overhead structure.
	Moving Informal Vendor - Unlicensed	Carrying baskets or handbags, set-up for short duration (5-10 minutes) when making a sale.
	Shopkeepers	Formal planned shops
	Daily commuters	Commuting Route
	Daily commuters who are customers	
	Customers who are not commuters	
		Railway Station
Secondary agents	Private cars	Vehicular Route
	Public vehicles like – auto rickshaws	
		Municipal market
External agents	Police	
	City Planners	

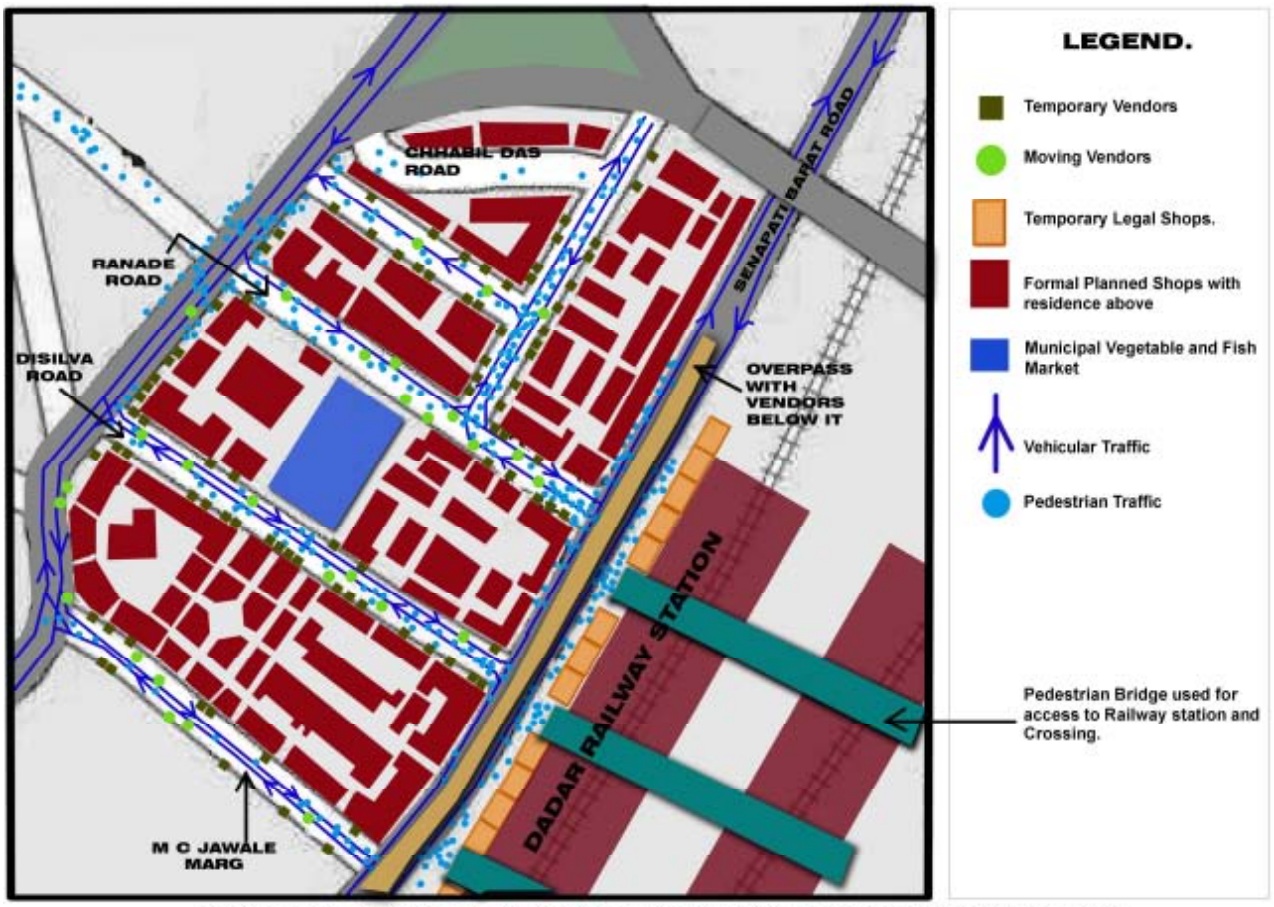


Figure 6-13 Detailed map of Dadar Railway market

6G.iii. Mechanism of Dadar market

From the relationship matrix Table A5 in the appendix, following are the agents who have established tagging among them in Dadar railway market:

1. Temporary vendor ⇄ Other temporary vendors
2. Temporary vendors ⇄ Formal shops
3. Formal Shops ⇢⇠ Moving vendors
4. Formal shops ⇄ All customers ⇄ All vendors
5. Formal shops ⇢⇠ Railway station ⇢⇠ All vendors
6. Formal shops ⇢⇠ Private + Public vehicles ⇢⇠ All vendors
7. All commuters + All customers ⇄ Private + Public vehicles
8. All commuters ⇄ Railway station ⇢⇠ Private + Public vehicles

[→ & ← indicate a direct relation, and ⇢ & ⇠ indicate an indirect relation]

These actors form the following building blocks of Dadar railway market:

1. Temporary vendor stalls ⟷ Temporary vendor stalls
2. Formal Shops ⟷ Temporary vendor stalls
3. Commuting Route ⟷ Moving vendors ⟷ Formal shops
4. Commuting Route ⟷ Formal Shops ⟷ All Vendor stalls
5. Vehicular Route ⟷ Commuting route ⟷ Moving vendors ⟷ Formal Shops ⟷ Temporary Vendor stalls
6. Railway station ⟷ Vehicular route ⟷ Commuting Route ⟷ Moving vendors ⟷ Formal Shops ⟷ Temporary Vendor stalls

[⟷ indicates non-linear tagging between units]

The final building block or sub-system has evolved through the aggregation of all units to emerge into the informal railway market system of Dadar.

Besides the failure of Hawker's Plaza and the reluctance of the vendors to move to the building, there is another impact on the railway market system of Dadar. The old internal model of this market was

Railway station $\longleftrightarrow$ Vehicular route $\longleftrightarrow$ Commuting Route $\longleftrightarrow$ Formal Shops $\longleftrightarrow$ Permanent Vendor stalls

When the authorities banned vendors from the area and ordered the removal of all permanent vendor stalls, the system changed its internal model. The agents which were affected by the intervention of external agents changed their internal model or structure. In other words, the old agent was replaced by a new agent. To adapt to the stimulus of external agents, few of the old vendors shifted their model from a permanent one to either temporary or moving. The other old vendors were replaced by new temporary or moving vendors. Thus the new internal model of the market is

Railway station $\longleftrightarrow$ Vehicular route $\longleftrightarrow$ Commuting Route $\longleftrightarrow$ Moving vendors $\longleftrightarrow$ Formal Shops $\longleftrightarrow$ Temporary Vendor stalls

The railway market system, with its ability to adapt, continued working while the authorities were trying to remove the vendors from this area. Table A6 indicates that despite the change in the mechanism of the market system, there is no change in the state of the market. The positive aspects of the market are still preserved but the negative issues are not resolved because of the change in the internal model of the system.

Figure 6-14 Map of Agents and Mechanisms of Dadar railway market system

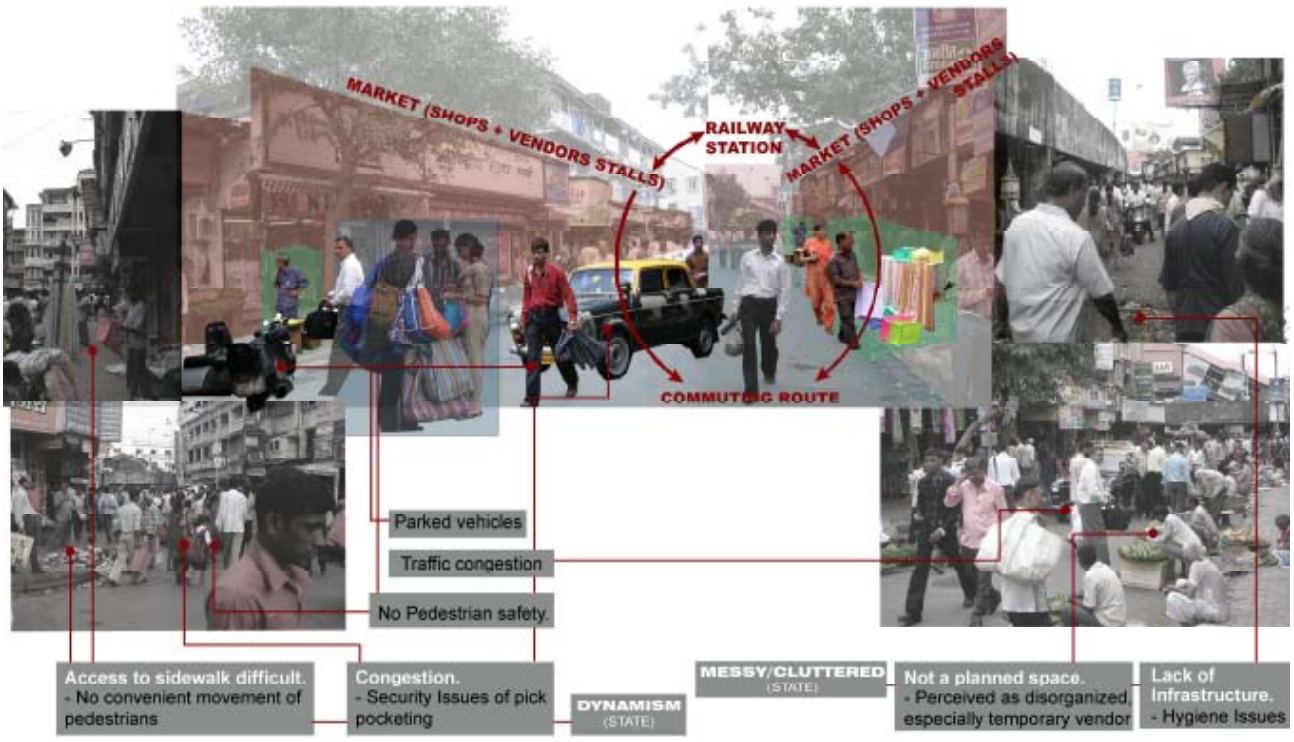


Figure 6-15 Mapping issues in Dadar railway market system

7. HOLLAND'S FRAMEWORK AS AN EVALUATION TOOL

In Chapter 6, Holland's framework was used as an analysis tool to understand the working of informal railway markets of Mumbai as a complex system. In this chapter, Holland's framework will be used as a tool to evaluate the proposals by the authorities and counter proposals. This evaluation process will help in determining the best strategy.

7A. EVALUATION OF CURRENT PLANNING EFFORTS

In accordance to the law passed by the Supreme Court, the planning division of MCGM made two proposals, which are: i) *removal and relocation of vendors,* and ii) *building a new market space* in the area. The solutions proposed by the authorities are evaluated for each market case studied for this thesis.

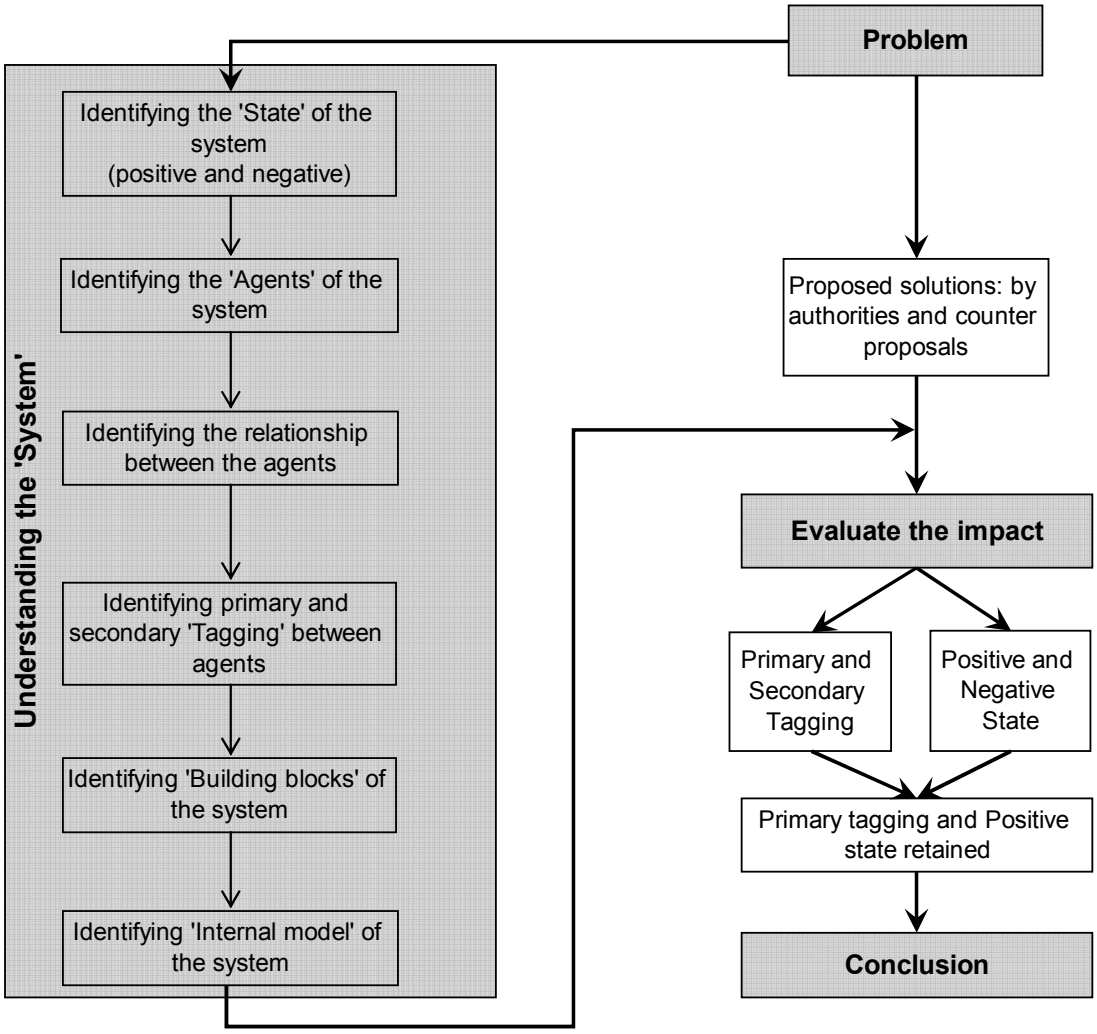


Figure 7-1 Illustration of the steps for analyzing proposed solutions

The steps involved in analyzing the cases are illustrated in Figure 7-1. After an understanding of each market case as a system, the impact of the solutions proposed by the authorities on the complex system of the market is evaluated. Based on the impact on the market system, a conclusion on the reasons behind the failure of the proposed solutions is derived.

Two solutions proposed by the authorities to resolve the problems of the railway markets are analyzed using Holland's framework of complexity theory. These are:

7A.i. Removal and relocation of vendors

To resolve the issues which arise due to the state of the market, a solution proposed by the authorities is to relocate one of the primary agents, that is, the vendors from this area. The Supreme Court of India passed a law prohibiting vendors within a 150 meters radius around a railway station. It granted permission to vendors to occupy less crowded areas where they will not be an obstacle.[102] This solution has an impact on the structure of the complex system of the market, which has a further impact on the other systems of the city. This solution is analyzed for each market case.

a) Santacruz railway market

For the Santacruz market, Table 7-1 shows the effects of removal of relocation of vendors on the inter-relationship between the agents. This table illustrates that the tagging between the vendors is completely broken when they are removed from that area. This solution resolves the problem of congestion faced by cars and public buses, and the commuters since the impact of the vendors on these actors is completely removed. The municipal market will also gain from this action to some extent, due to the absence of vendors and as a result they would get more customers. But this solution proposed by the authorities will also result in severing of the tagging between vendors and commuters, customers, and the railway station completely. The convenience that vendors provided to the commuters who are customers and the other customers would be eliminated. As a result fewer customers would prefer to use this market. The tagging which the shops and the vendors had established with each other is also affected. Although some shops may gain more store display and easy access due to the absence

[102] Information obtained from MCGM officials during field visit

of vendors, they might experience loss of customers. The same negative effect will be seen on public buses and the railway system, as they would, too, lose commuters who were customers of the informal vendors. This has a large impact on the mechanism of the complex system of the market, which is seen in Table 7-1.

The impact of failure of the mechanisms because of the solution proposed by the authorities will be felt on the state of the market. The solution resolves the issue of congestion and difficult access to sidewalks, which arise from the state of dynamism. However, the positive aspects of the state of the market are also lost. The vibrancy and feeling of safety, and convenience of location that the vendors bring as an agent to the market system, are lost.

b) Vile Parle railway market

The Vile Parle market exhibits an impact very similar to that seen at the Santacruz market. The affected tagging mechanisms are illustrated in Table 7-2. Both, the workings of the market as a system and the state of the market are negatively affected. A lesser effect is also experienced when the authorities want to resolve the issue of unauthorized vending by removing the temporary vendors. Although the impact is lesser, the positive aspects of the state of the market are lost to some extent.

Table 7-1 Illustration of impact of *removal and relocation of vendors* from railway market, on the interrelationship of the agents of the Santacruz market system.

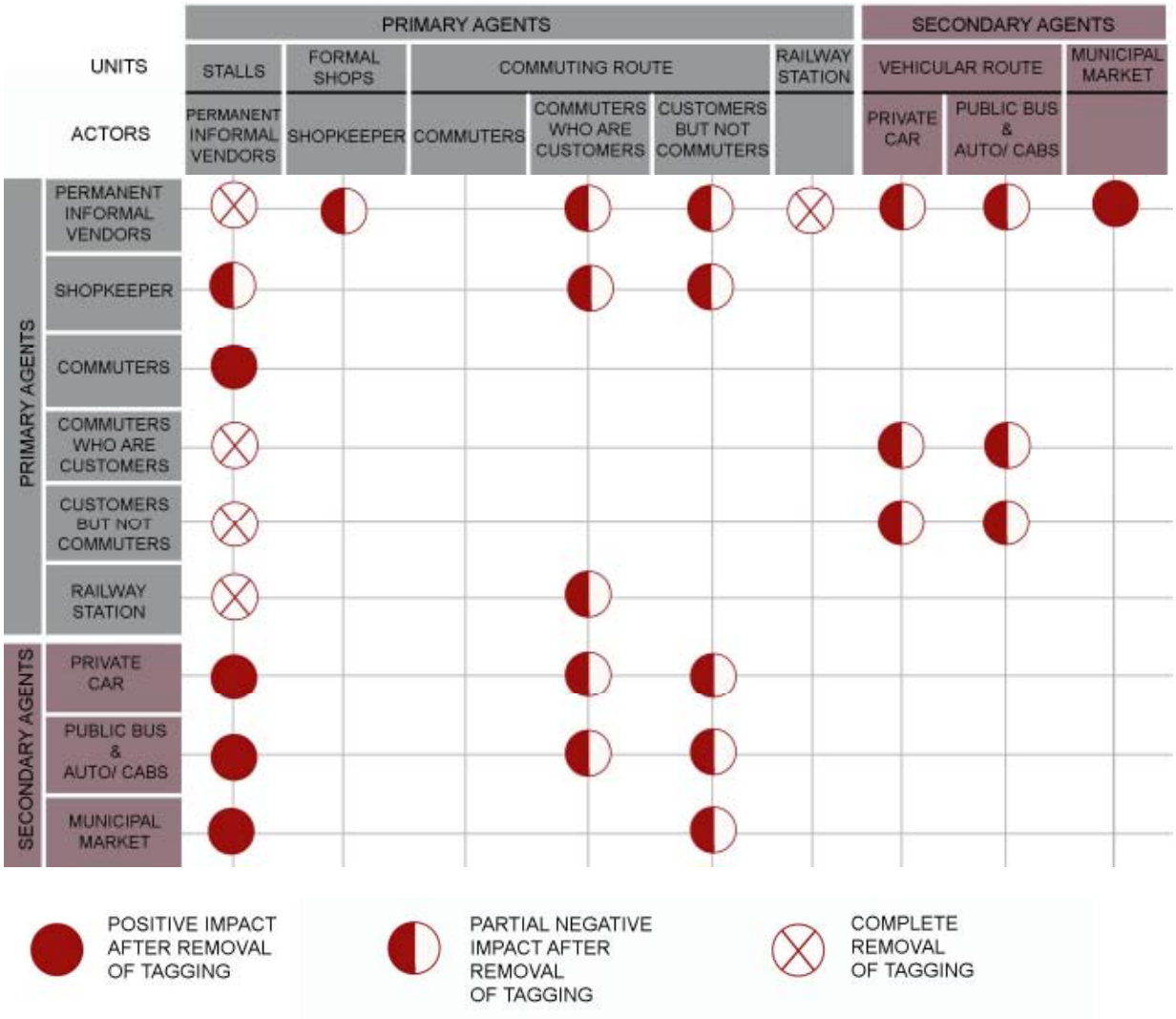
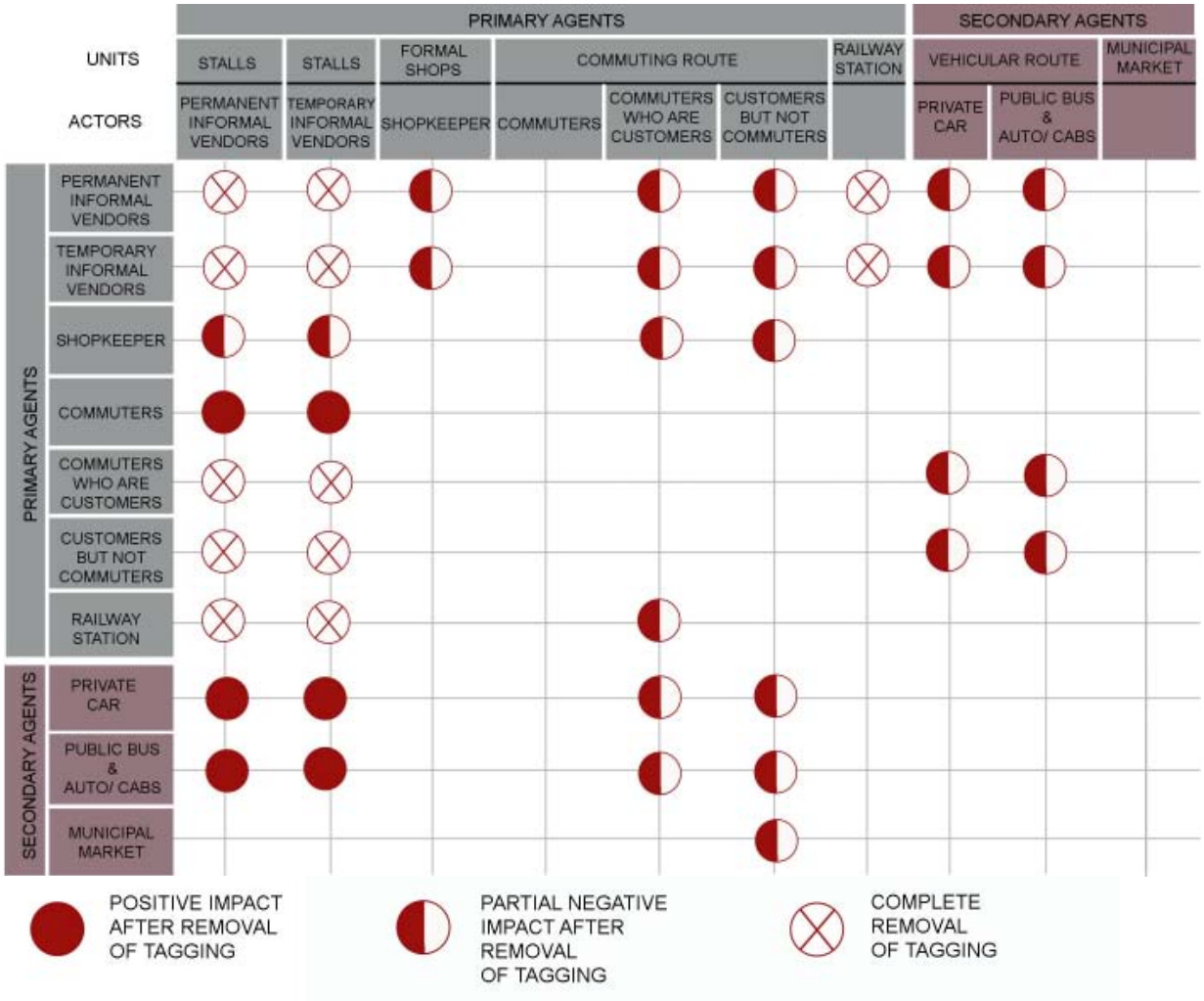


Table 7-2 Illustration of impact of *removal and relocation of vendors* from railway market, on the interrelationship of the agents of the Vile Parle market system.



c) Dadar railway market

In the case of Dadar market, the authorities have already executed the proposal of removing and relocating the vendors to the Hawker's Plaza. The urban designers provided an enclosed space – a five storey building named the Hawker's Plaza – to accommodate the licensed vendors around Dadar station. The Hawker's Plaza, completed in 2001, is designed to accommodate 1448 vendors. But by the end of 2002, only 76 vendors occupied this building on the ground floor. A reason for the low occupancy was that the authorities were asking Rs. 100,000 (approximately 2,600 US dollars) as annual rent for space within the building. The vendors could not afford to pay the rent amount, but were willing to negotiate up to a rent of Rs. 25,000. Hawker's Plaza provides an illustration of the consequence of relocation of the vendors. It physically illustrates the results of relocating vendors from the station market, as opposed to the hypothetical analysis in the previous two cases.

Table 7-3 Agents (actors + units) in Hawker's plaza.

	Type of Actors	Type of Units
Primary agents	Licensed vendors	Partitioned cubicles in the building
	Customers	
External agents	City Planners	
	Police	

In contrast to the tagging mechanism and the internal model of Dadar market, the two agents of Hawker's Plaza, listed in Table 7-3, have a linear relation, where the vendors are dependent only on the customers for their business.

Customers $\longrightarrow$ Licensed vendors (permanent)

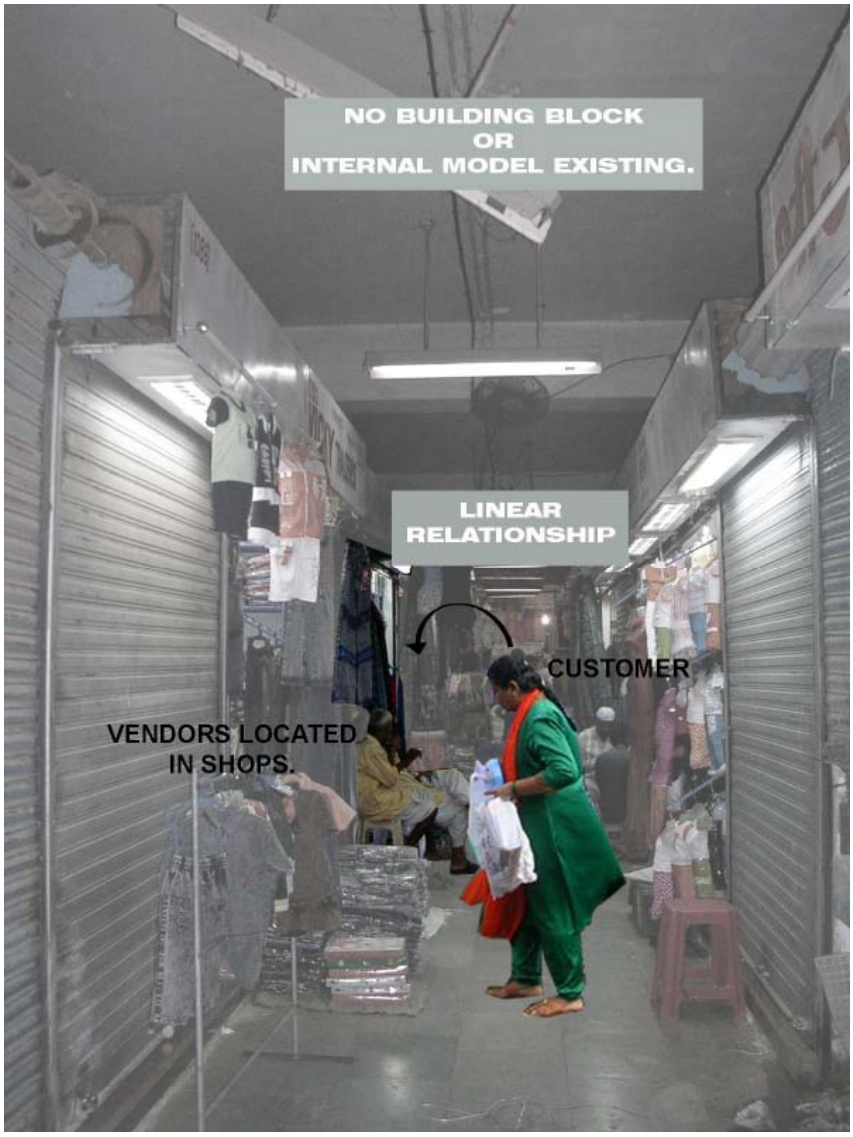


Figure 7-2 Hawker's Plaza

Since the vendors are located detached from other agents, the customers have no incentives to travel to Hawker's Plaza other than to shop from the vendors. These two agents form a simple object. A complex organized system succeeds in its working compared to a simple object because the basic property of a complex system encourages diversity of agents, and forms a system through the aggregation of these diverse agents. Because of the diversity of agents, when "one kind of agent (is removed) from the system, creating a 'hole', the system typically responds with a cascade of

adaptations resulting in a new agent that 'fills the hole'. The new agent typically occupies the same niche as the deleted agent and provides most of the missing interactions."[103] This rich diverse interaction is absent in simple objects. This is a reason for the failure of Hawker's Plaza. The other reason for its failure is the failure of the authorities to understand the importance of the initial conditions for the formation of vendor markets. They failed to pay attention to the influence of location of railway market or the importance of the commuters' flow, both of which influenced the location of the vendors. In short, the authorities failed to understand that these vendors work as a complex organized system, and, hence, they tried to remove them from their system and treat them as simple objects. The idea behind treating them as simple objects was to have a simplified organization for effective control.

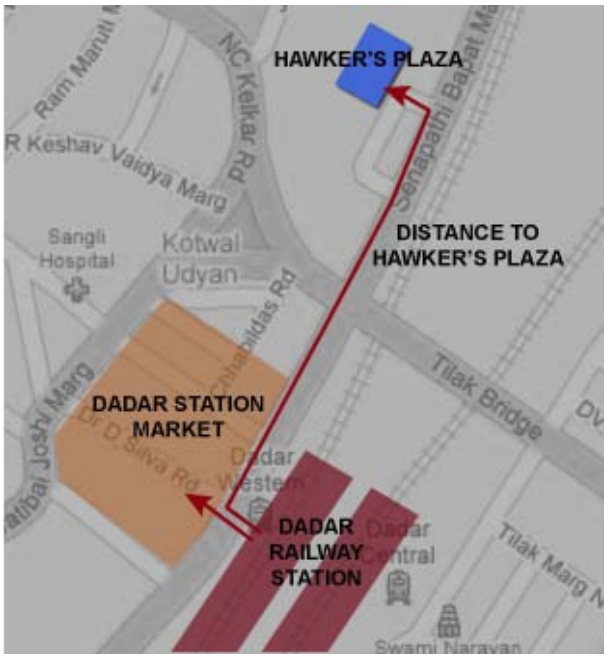


Figure 7-3 Illustration showing the distance of Hawker's plaza

[103] John H. Holland, *Hidden order: how adaptation builds complexity*, 27.

The Hawker's Plaza resulted in the elimination of the positive aspects of the old railway market. This is illustrated in Table 7-4, where it is seen that the state of the market is completely altered, eliminating all the positive aspects.

Table 7-4 Analysis of State of Hawker's Plaza.

Spatial Character	State of Market	Issues	Analysis using complexity theory
1. No Density	No Dynamism		There is no relationship of the vendors with the surrounding.
2. Not an open space	No Openness	Less ventilation	
		Less exit points	
		Less feeling of safety	
3.Image	Very crammed	No convenient movement of customers.	
4.Location	Not Convenient as it is away from the railway station		This system failed as the initial condition and essential environment i.e. the proximity to the railway market was ignored while developing this market.
	5.Economy	Failed to be a working market.	

7A.ii. Building a new market space in the area

Another architectural solution proposed by the authorities is to build a market for the informal vendors within the infrastructure of a railway station. This solution will maintain most of the positive aspects of the market and retain the mechanism of the market system. However, this proposal will reduce the dynamism of the market, that is, the duality of informal and formal spaces juxtaposed with each other will be removed. Also this proposal is economically not feasible as it would become difficult to provide the

required space at an affordable rate to the vendors. It would increase their cost of business, and the price of their goods. The economic convenience that the vendors bring would be lost. Thus, even though the mechanisms of this market are not disturbed, this solution does not satisfy all the states of the market.

7B. EVALUATION OF COUNTER PROPOSALS

Two solutions or counterproposals to the ones made by the local authorities are now analyzed using Holland's framework. The two solutions are: i) *Removal of all vehicles*, and ii) *Removal of only private vehicles*. These two solutions have the potential to maintain the most positive aspects of the state of the market and its primary tagging. They also recognize and give importance to the informal markets. The impact of these solutions on tagging and the state of the market is evaluated in order to arrive at a better strategy to address the issues of the markets.

7B.i. Removal of all vehicles

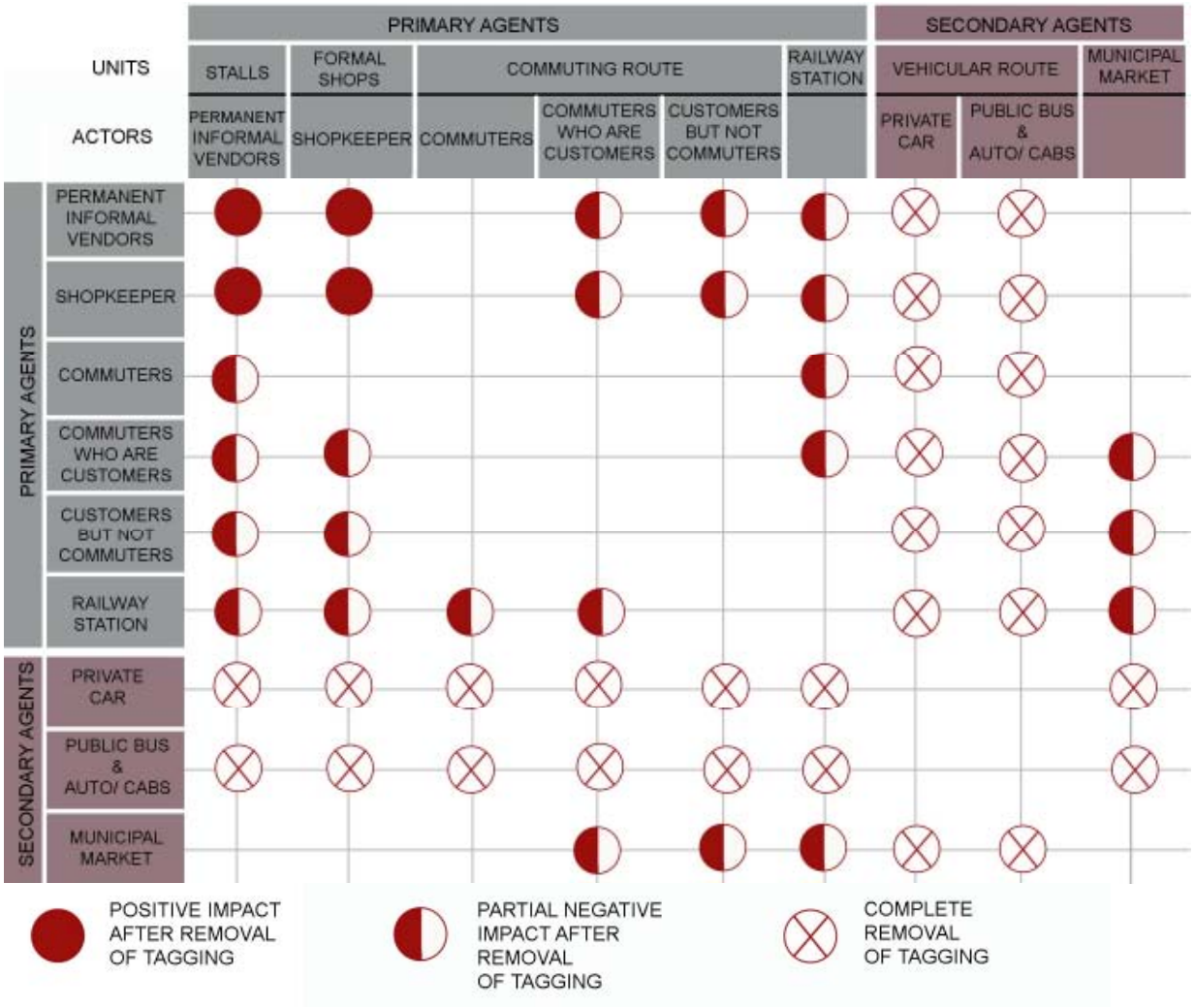
After understanding the markets as a complex system, and determining the primary and secondary agents along with tagging, one apparent solution that can resolve the congestion issues is the elimination of a secondary agent - the vehicular route - from the market zone. But this solution has greater negative impacts on the working of the market as an organized system as compared to the positive impacts in solving the issues.

The impact of this solution is first analyzed with regards to the of Santacruz railway market. This is illustrated in Table 7-5, where the tagging between the vehicular route and other agents is eliminated. Although the tagging between the primary agents, the vendors, and other actors is retained, there is a negative impact because of the elimination of secondary agents. First, the customers, who tag themselves with the vehicular route, will be affected. They will stop using this market zone, due to which the

tagging between the customers and the vendors will be affected. Secondly, the commuters who are also customers will be affected in the same way, and the tagging between these commuters and vendors will be affected. The tagging of the shopkeepers with the customers and the commuters who are also customers will also be affected. Thirdly, the commuters who are dependent on the vehicular route will reduce in number. This whole effect will negatively impact the railway system. Thus, this solution will result in the failure of the market system as well as the railway system. This, in turn, will have a cascading impact on the entire city system.

In the cases of Vile Parle and Dadar, too, complete removal of vehicular traffic does not work for the same reasons. The effects on the mechanism are similar to those in Santacruz. Removing all vehicles from the market may reduce the number of commuters and customers coming to the railway station and markets, which in turn, results in a loss of business for the vendors and an adverse effect on the railway system.

Table 7-5 Illustration of impact of *removal of all vehicles* from railway market, on the interrelationship of the agents of the Santacruz market system



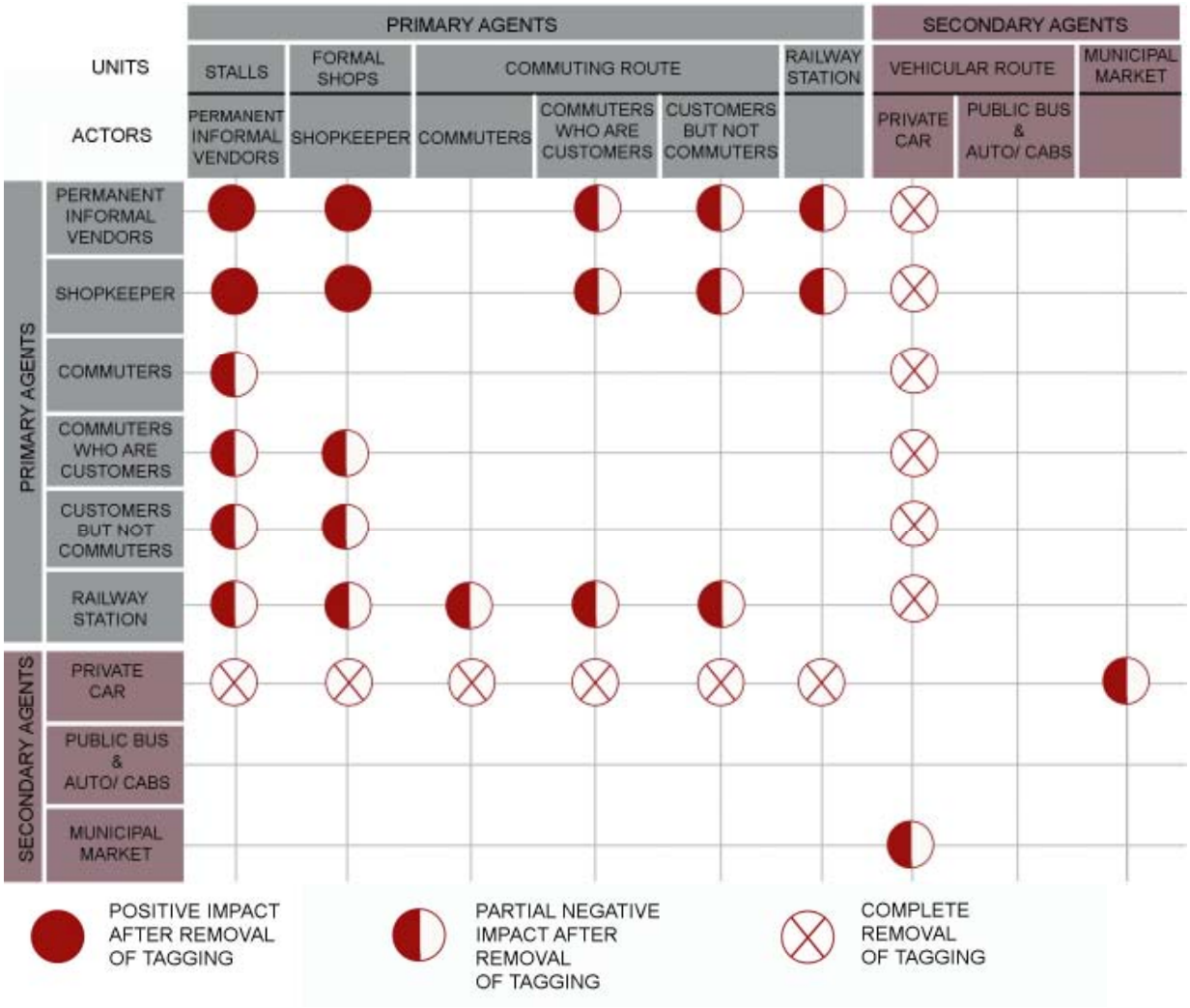
7B.ii. Removal of only private vehicles:

The previous solution had taken a step towards resolving the negative aspects of the market by removing all vehicles but leaving alone the positive factors of the state of the market, but it fails to reach a better mechanism. This solution also proposes to remove one of the secondary agents, private vehicles.

a) Santacruz railway market

The impact of the solution on the inter-relationship of the agents of Santacruz market is illustrated in Table 7-6. Although the effect is similar to the previous solution, the negative impact is lesser. There are fewer commuters and customers who are affected due to removal of private vehicles from the market zone. Similarly, the railway system is also not greatly affected by the absence of private vehicles. With this solution, the issue of congestion due to traffic is also partially resolved. The widening of sidewalks will facilitate access to pedestrians. Even though this would mean a reduction in the width of the road, but with the elimination of private vehicles from this zone, a reduced road width would be sufficient for the lower vehicular traffic. All this will, eventually, resolve the issues of security, like pick-pocketing. The issue of a messy and cluttered image can be resolved by the authorities when they provide proper infrastructure. This solution is illustrated in Figure 7-4. This solution is more effective in resolving the problems of the market compared to the previous solutions, as there are fewer disturbances to the mechanism of the market system while the positive issues of market are retained. However, this solution is not a perfect solution. A part of the internal model of the market system is compromised in order to resolve the issues arising from the negative aspects of the state of market.

Table 7-6 Illustration of impact of *removal of only private vehicles* from railway market, on the interrelationship of the agents of the Santacruz market system



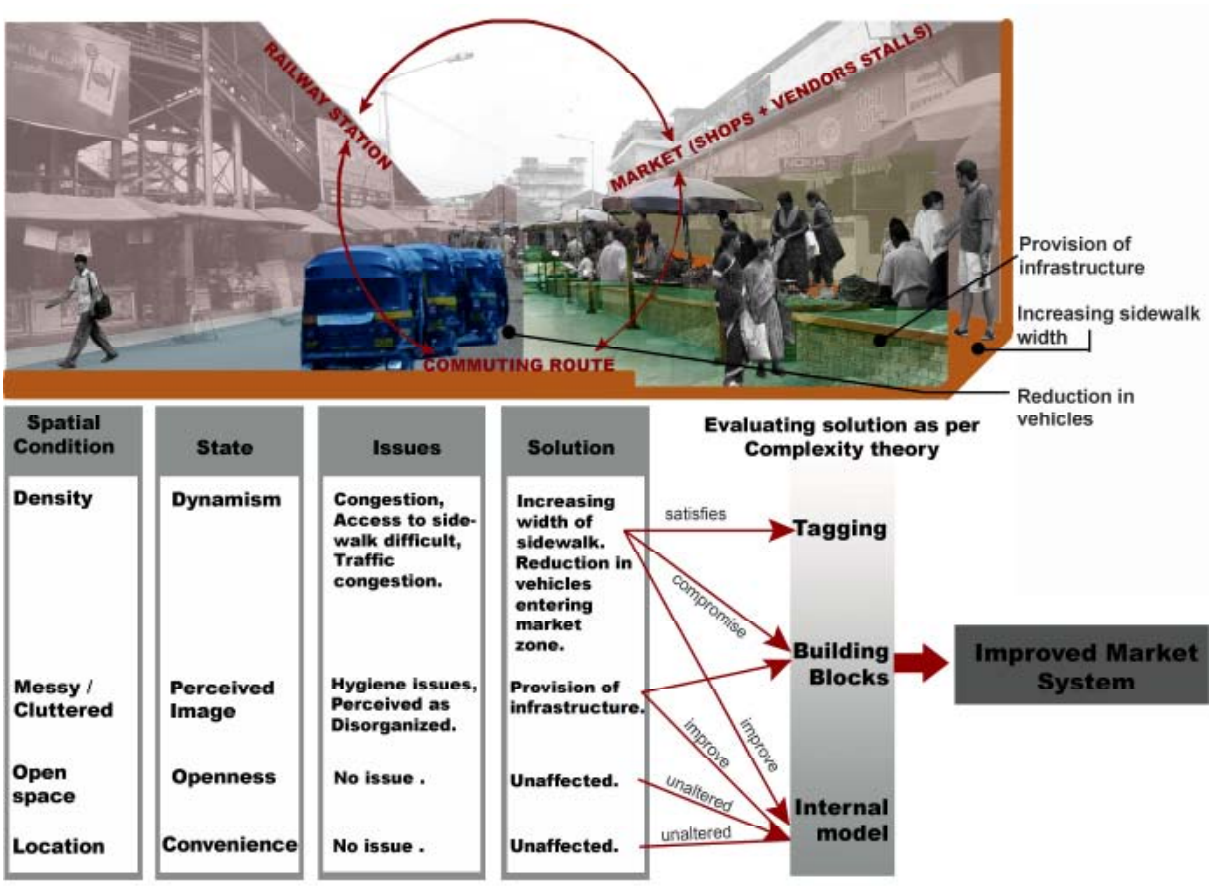
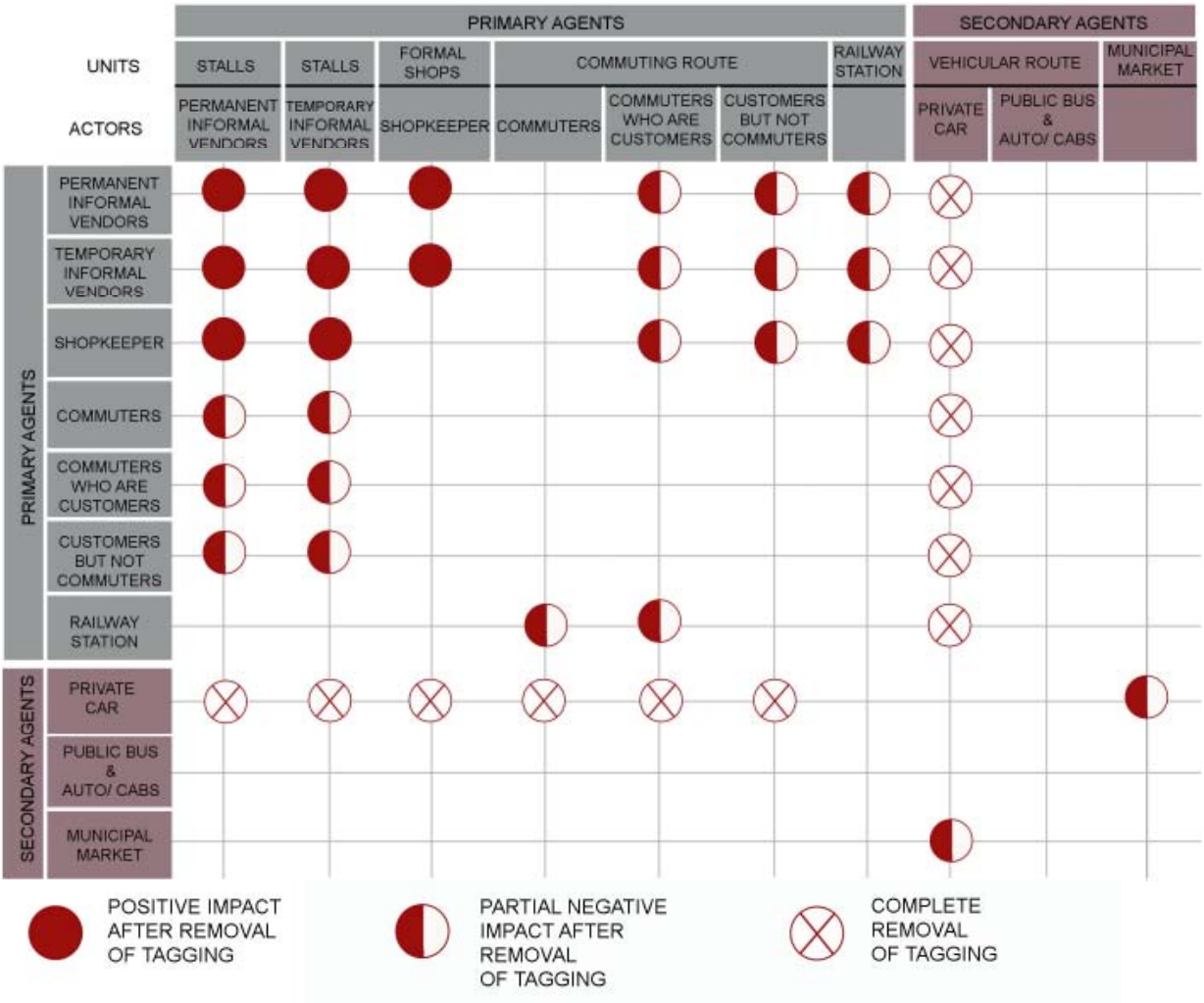


Figure 7-4 Illustration of removal of private vehicles in Santacruz market.

b) Vile Parle railway market

For the case of the Vile Parle railway market the effects on the mechanism are presented in Table 7-7, while Figure 7-5 illustrates the solution. In Vile Parle, too, the positive aspects of the state of the market are retained. Although, some of the mechanisms related to secondary agents are affected in the same way as the previous case of Santacruz, the working of the whole system is relatively less disturbed. This solution resolves the issue of congestion and traffic with more effectiveness than the previously discussed solutions. For resolving the issue of a messy image, the authorities would have to pay more attention to the infrastructure. A few suggestions to achieve this are illustrated in Figure 7-5.

Table 7-7 Illustration of impact of *removal of only private vehicles* from railway market, on the interrelationship of the agents of the Vile Parle market system



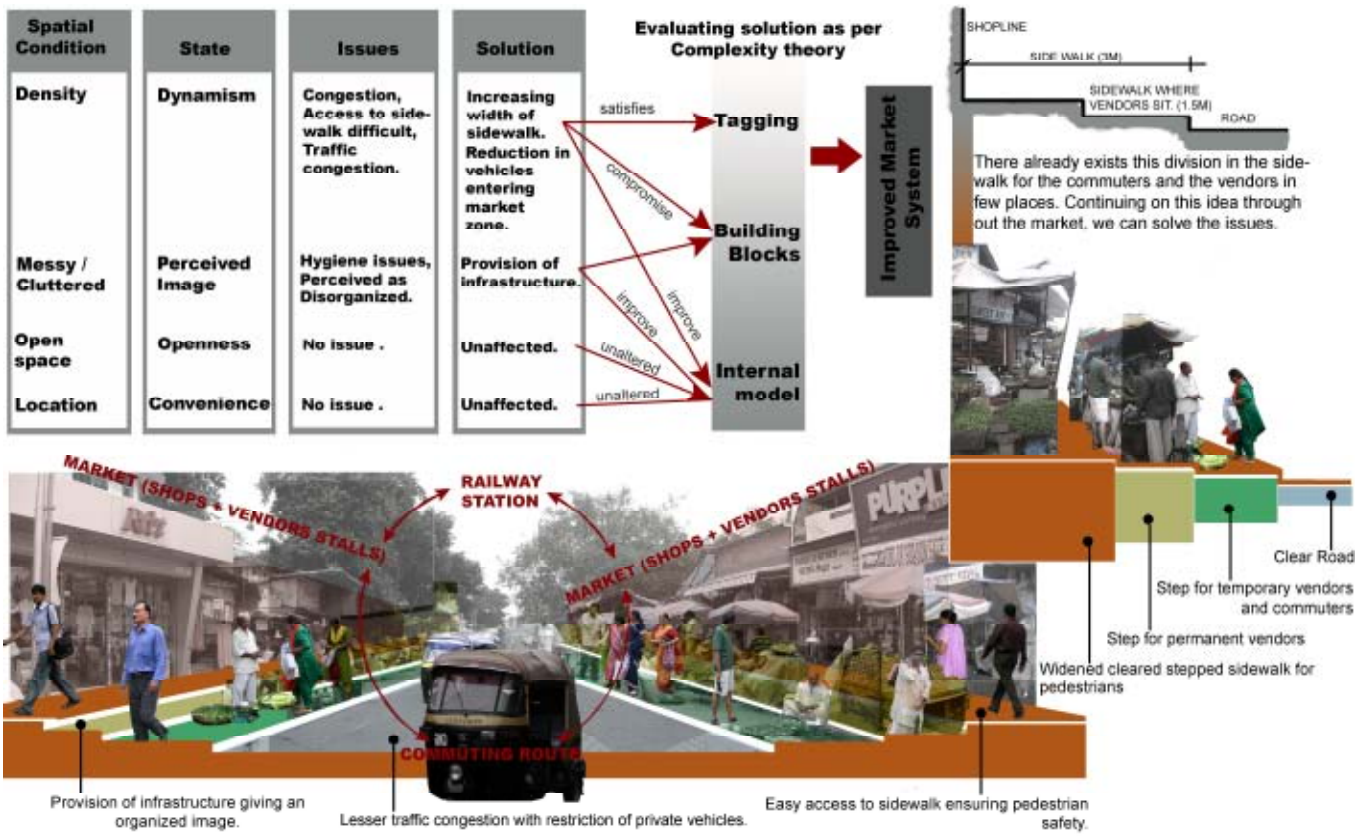


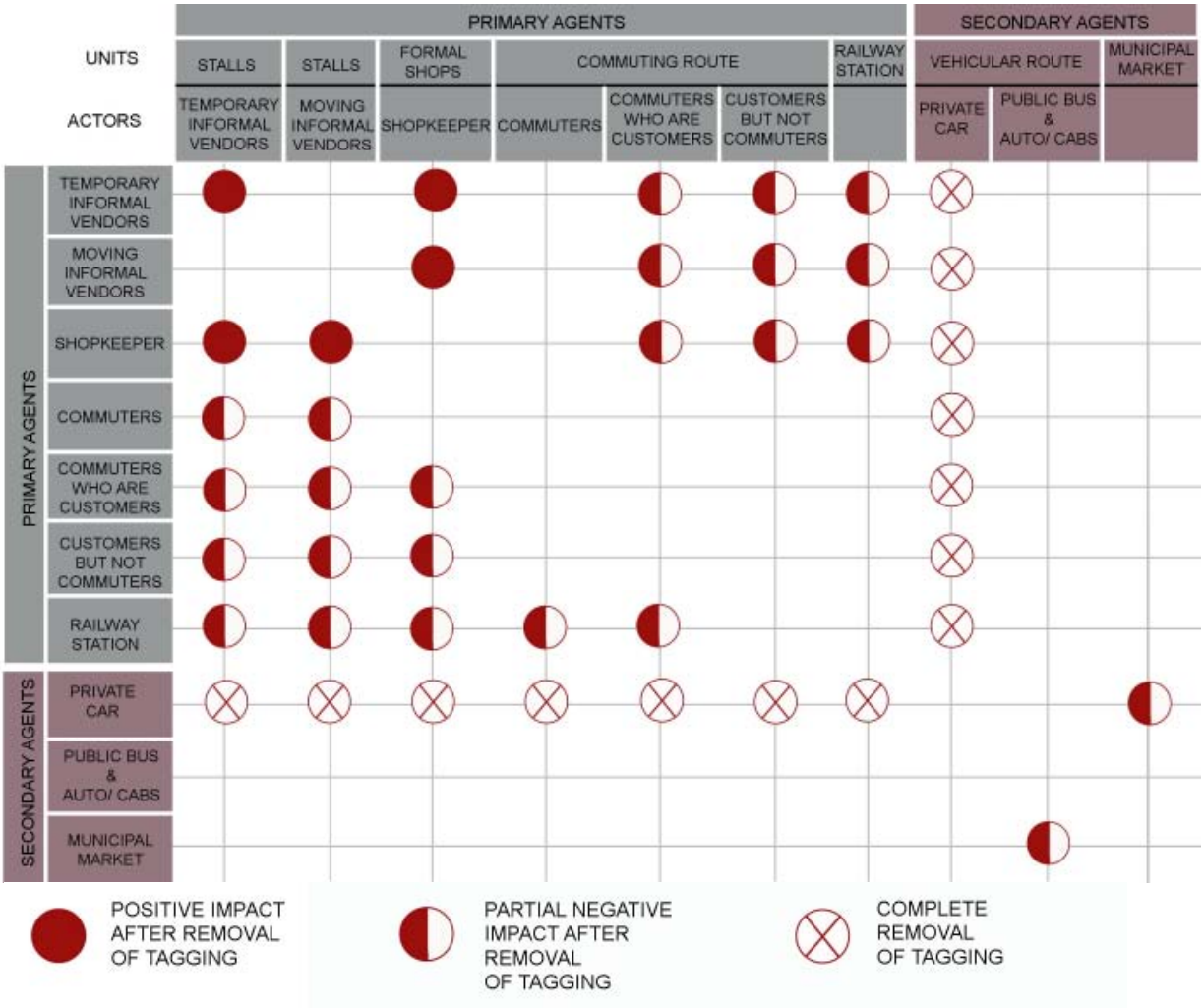
Figure 7-5 Illustration showing removal of private vehicles in Vile Parle market.

c) Dadar railway market

A study conducted in Dadar market by the Research and Design Cell at Kamla Raheja Vidyanidhi Institute for Architecture (KRVIA)[104] concluded that parked private vehicles were a bigger cause of congestion than the vendors. Hence restricting private vehicles will also ensure release of the parking spaces. The impact of this solution on the mechanism of the market is summarized in Table 7-8, while Figure 7-6 illustrates the solution. Like the other cases of the Santacruz and the Vile Parle markets, this solution retains the positive aspects of the state of the market. The working of the whole system is not affected except for an effect on some mechanisms of the secondary agents. This solution resolves the issues of congestion and traffic effectively. The problem of a messy image can be resolved by initiatives of the authorities for providing infrastructure to the vendors and keeping a hygienic environment. A few suggestions for resolving these issues and achieving the necessary results are illustrated in Figure 7-6.

[104] Interview with Prof. Aneerudha Paul (Director, KRVIA) on August 23, 2007.

Table 7-8 Illustration of impact of *removal of only private vehicles* from railway market, on the interrelationship of the agents of the Dadar market system



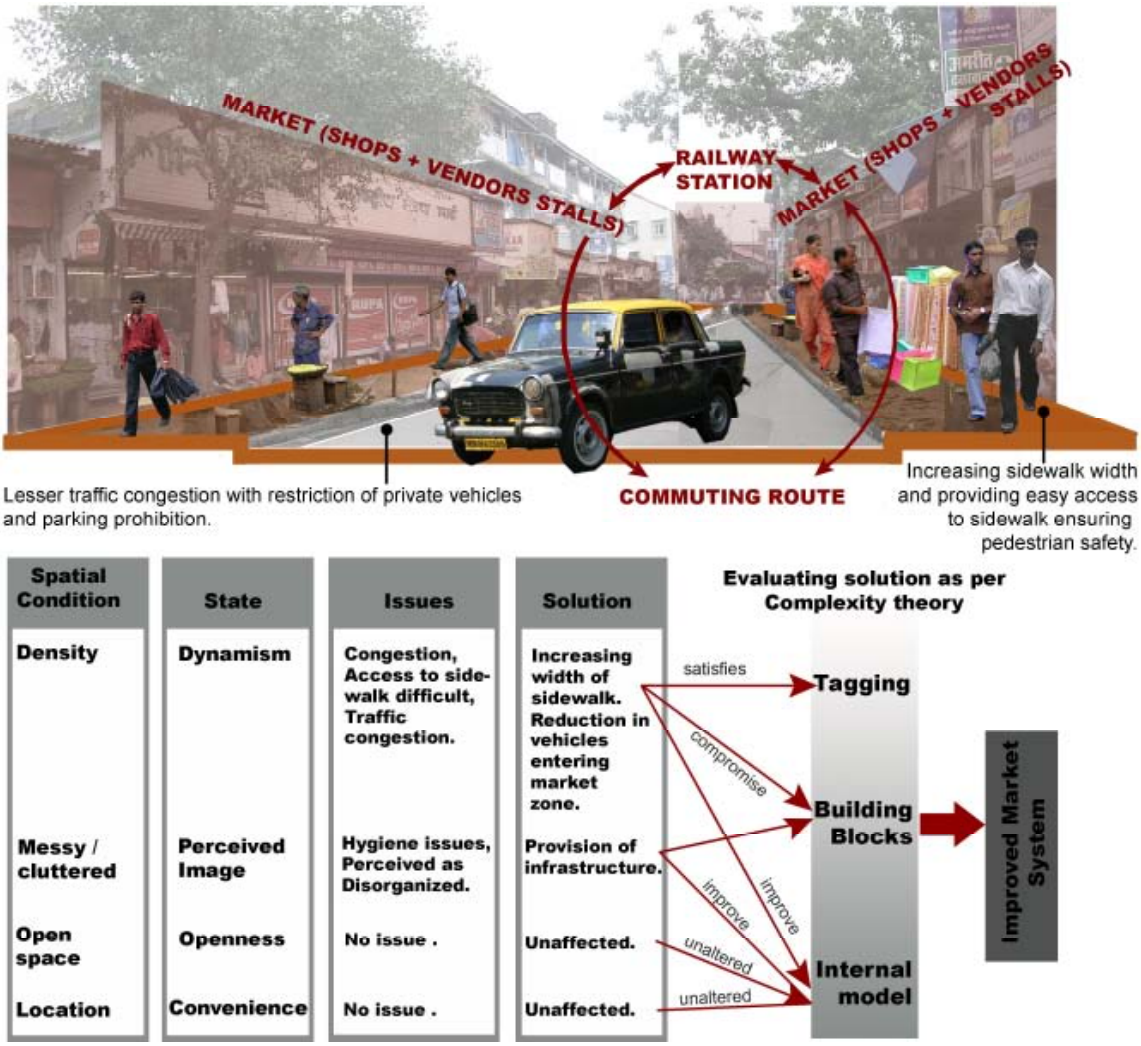


Figure 7-6 Illustration of removal of private vehicles in Dadar market.

7C. CONCLUSION

On looking at all the solutions and analyzing them using the basics of Holland's framework, one understands that there is no perfect solution to the issues of Santacruz market. But the solution of removal of only private vehicles satisfies most of the conditions for the market to function better as an organized complex system. By applying Holland's framework of complexity theory to this research, the underlying mechanisms of the market system are better understood which in turn enables us to arrive at a better solution. It is essential for any solution to maintain the primary actors and the primary tagging identified in the analysis. This enables the retention of the positive features of the state of the market while solving the issues. This was achieved in the final solution of restricting private vehicles in the market area. Holland's framework becomes a good analysis tool for making decisions during design of the space. This enriches the conventional approach taken by local authorities and planners, making it a more successful design intervention.

8. CONCLUSION

This thesis discusses the problems associated with informal systems within a city and the drawbacks of the conventional methods used by the local authorities to deal with those problems. The issues associated with one such subsystem were analyzed using Holland's framework of complexity theory along with a critical analysis of the key areas where the authorities have failed to address the associated problems. A better strategy for tackling the problems within the subsystem was derived by using the same theory of complexity.

For understanding the application of complexity theory on systems within a city, this study examined the subsystem of informal railway markets of Mumbai. As the first step, this research established the importance of an informal space within the system of a city. These informal spaces are the everyday spaces in a city that add vibrancy and life to the city system. They also contribute to the economic development of the city. But in addition to these positive features, these spaces also have some major problems associated with them, namely, congestion, disorganization, safety and security concerns. In an effort to solve these problems, the local authorities generally, inadvertently eliminate the positive features of these spaces. They tend to use a more conventional approach where they disregard the importance of these spaces and try to remove them or relocate them in a more planned space. These actions remove the very positive features that make these informal spaces an important system of a city.

This research has focused on complex systems at the local scale of the market. However, the market itself is a part of the network of a larger complex system: the city. Due to time constraints, this study was unable to include the system at the larger scale and the factors within the larger system that may influence the state and the mechanism of the agents in the market system.

The conclusions of this research can be categorized into three sections: analysis using Holland's framework, evaluation using Holland's framework, and the importance of the framework in urban design.

8A. ANALYSIS USING HOLLAND'S FRAMEWORK

Having established the importance of informal spaces in the city system, this study examined 'complexity theory', which focuses on emergent, self-organized systems. Jane Jacobs, Michael Batty, John Holland, and others have argued that cities are examples of complex systems.

The informal markets of Mumbai are composed of formal shops, informal vendors who are permanent, temporary or moving, the customers, commuters, the railway station, and public and private vehicles. Their functioning is not governed by any higher authority, although they are subject to regulations imposed by the city authorities. Despite their apparent disorganization, they have successfully catered to the needs of people of various economic strata since the establishment of Mumbai. They act as transition zones for migrants to the city and provide employment to thousands.

The bazaar's success is based on its characteristics of emergence, self-organization, and spontaneity. The emergence of the bazaar system is not solely a result of its components, but primarily due to the interaction of each component with the others. For example, the formal shops and the informal vendors are dependent on each other for attracting customers. If placed individually, they lose access to each other's customers, which are a source of considerable business. In other words, the success of the market is due to the emergent property resulting from the symbiosis between its components.

An analysis of the informal markets using Holland's framework shows that the informal markets function as a complex system. Like other complex systems, they are

chaotic, self-organized, and exhibit an emergent property. The components of the markets are the agents of the complex system. The interaction between the agents gives rise to the emergence of the system. The agents in the railway markets of Mumbai were categorized into primary and secondary based on their impacts on the markets. The third type of agent, the external agent, though not part of the market, has a significant impact on the system. The city authorities and police are the external agents considered.

The state of a complex system is the set of the system's present conditions which dictates its future possibilities. The five aspects of informal markets, namely, location, economy, dynamism, openness, and perceived image, together form the market's state. Most aspects have positive and negative features. The aim of any design intervention is to change the state of the market so as to eliminate the negative features. The agents in the informal markets selectively tag with other agents to form aggregates. For example, the formal shops, the railway station, and the vendors, tag with each other to form an aggregate. These aggregates form the building blocks of the market system which provide it with a structure and an internal model. The aggregation of the railway station, vehicular route, commuting route, formal shops, and vendor units forms the internal model of a market system. Such an analysis of a system using Holland's framework, involves identifying the agents, states, and mechanisms of a complex system. The understanding gained by studying a system within Holland's framework is successful in explaining the self-organization and emergence of the informal spaces.

However, this research is unable to take into account all the states, mechanisms, or agents of the market system. For example, the local economy near the markets, the income and demographic distribution of the local population, and proximity to other informal markets are other important states which influence the working of the markets. Similarly, the economy of the city acts as an influential external agent to the markets. The success of the market depends on the city's economy. It is not easy to predict

whether a rising economy will increase the number of customers to the market, or whether it will drive more customers towards shopping centers and malls. The city economy is not an agent per se, but a building block of the city system formed from the various economic activities in the city. A future study of the analysis of informal markets could include the economic and social agents and focus on the impacts that they have on the workings of the markets.

The data collected during the field study was also limited due to time limitations. The category of actors could have been broken down further instead of an umbrella category for all permanent informal vendors. For example the category of permanent vendors could have been categorized according to the type of goods they sell, which would also influence the number of customers a particular vendor would attract. Similarly, the customers and commuters can be divided according to age and other demography. All these factors could have brought into light other states of the market system. The informal markets around the railway station also have different features compared to informal markets located around other commercial areas or residential areas. An interesting future study could see how well the framework applies to the other markets in Mumbai.

A relationship matrix to understand the inter relationship of the actors was developed. According to Holland's framework it is important to gain an understanding of the interrelationship between the agents. The relationship matrix formed the foundation for further analysis. Based on the relationship matrix, diagrams mapping the mechanism of the informal market were developed. This diagram showed a cross-section of a single space at a single point in time. The analysis derived out of this diagram is limited considering the possibility of varying cross-sections at various spatial and temporal points.

Besides, for an analysis of a larger complex system, the relationship matrix can be tedious and confusing. The number of diagrams plotted for a larger scale will increase temporally as well as spatially. But, since the current analysis was performed for a space at the local scale, a single temporal and spatial point could be used. Similarly, the evaluation table developed for each proposal can be valid for only this particular scale. The assessment of the number of primary tagging and positive aspects retained is, again, valid only for only this case. Since this research considered only five states of the market, the data to be examined was limited and easy. Therefore, a better and efficient analysis process needs to be developed for a bigger system.

The theory of everyday urbanism demonstrates the importance of informal spaces in a city. It sheds light on the meaning of such everyday spaces in the lives of the city's residents. It gives an urban designer the reason to take into account these spaces during the design process. However, everyday urbanism is criticized for failing to provide solutions to the problems of informal spaces. In conjunction with complexity theory, it becomes an effective tool to recognize and solve the problems of informal spaces. Besides, Holland's framework, in isolation, cannot explain the importance of the informal spaces. It is not a tool to study the daily life of the city's underprivileged citizens and realize the significance of the informal spaces in their lives. However, it is able to show the relation of the informal spaces to the workings of other systems of the city. This thesis relies on everyday urbanism to establish the need for a design intervention that considers the importance of informal systems. Holland's framework is used to analyze the informal spaces as complex systems, and to evaluate the effects of potential solutions on the positive aspects of the informal spaces.

Since complexity theory studies kinetic systems, it is well suited to analyze informal spaces. Complexity theory explains informal systems as being on the edge of chaos, where they exhibit dynamism, resiliency, and spontaneity. Conventional design

approaches seek to achieve a static equilibrium, where everything is predictable and controllable. In trying to solve the problems of informal spaces, they convert them to static spaces which are ineffective. Complexity theory, on the other hand, helps in preserving the dynamism of informal spaces in the city rather than converting them to static spaces.

8B. EVALUATION USING HOLLAND'S FRAMEWORK

The solution of preserving the informal markets and restricting private vehicles in the market zone derived using Holland's framework is a better solution than the ones proposed by the planners and local authorities because it is based on a rigorous analysis of the actual existing system. It takes into consideration the spatial factors involved in the market system. This solution does not involve biases towards any actors involved in the system; instead it takes an objective view towards a better working of the market and thereby a better working city.

An important point to be noted is that an analysis using Holland's framework should include all the important agents, states, and mechanisms. A failure to consider all the important aspects of the system limits the reliability of the derived solutions. For example, if the analysis for the informal markets failed to consider the tagging between the formal shops and informal vendors, the solution of removal of informal vendors would have a smaller negative impact, and could be viewed as a suitable solution. A different solution could emerge as a better solution if other aspects are also included. In other words, the states, mechanisms, and agents considered for an analysis of a system have a significant influence on the derived solution. Since this thesis focuses more on the spatial aspects of the market system, it does not include all the relevant aspects of the market. Thus restricting private vehicles should not be treated as a definitive solution

to the problems of informal markets. This research is to be viewed as providing a methodology for analysis and evaluation of informal spaces using Holland's framework.

The dependence of the solution on the considered aspects can be used to justify any particular solution, and therefore is an important drawback. An illustration of this is when the state of the market is described only in terms of the economic aspects, without considering the spatial aspects. An analysis like this could be used by the city authorities as a basis to advocate the removal of vendors as the best solution. Future research on this subject could focus on tools to assess the comprehensiveness of an analysis and the validity of the derived solution.

Generally, the local authorities and planners, in their conventional or traditional approach, refer to a framework or a model to solve the problems of the city. But these models generally do not apply to informal spaces in a megacity because the models are based on the western model of a city. Complexity theory understands self-organized system and hence the solution proposed using this theory does not use any external model or framework, instead the solution is derived from within the system itself. Since the solution is based on the smallest units and their interactions, it is an example of a bottom-up approach. This makes it a better solution, especially, for informal markets. Since informal markets do not derive their organization from any central force, a bottom-up solution which targets each actor in relation to the system is the most effective.

In the process of understanding the markets as a complex organized system, this study also determined the strategy that can be used to understand how the complex system of markets work. This strategy can be used as a framework for evaluation of design interventions in other informal spaces. The steps involved in the strategy are illustrated in Figure 7-1.

This strategy of understanding the system was then implemented and expanded to evaluate, analyze and arrive at a better design proposal for the market system.

Having identified the problems with the system within a city or of the city itself, the structure of this complex system and its workings can be understood. For understanding the system, first the 'state' of the system needs to be understood. This process identifies the attributes of the system, and enables the identification of the positive and the negative aspects. This further helps in deciding what issues need to be addressed and what are the positive factors that need to be preserved. Having done this, the actors involved in the system and the relationships these actors have with each other are identified. Identifying the relationships helps in further identifying the mechanism of tagging, both primary and secondary, the building blocks formed by tagging and, finally, the internal model of the system. This whole process helps to understand the working of the system.

This analysis was further developed to evaluate the proposed solution, and arrive at a better design intervention. For the evaluation, the impact of the solution on the mechanism of tagging is first verified. The best solution is trying to retain the maximum number of primary tagging with a lesser impact on secondary tagging. This is then verified with the impact on the states of the system. In case of the Dadar market, for example, the relocation of permanent vendors to the Hawker's Plaza and the removal of temporary vendors significantly reduced the number of actors in the market system. The tagging mechanism between the formal shops and the vendors, as well the tagging between the vendors and the railway station was disrupted. This resulted in a simple static system with the primary tagging retained only between the vendor and the customer. Along with some of the negative features, the positive aspects of dynamism, openness, economy, and location were also eliminated. The final solution should aim to preserve all the positive aspects of the system, while trying to target a maximum number of negative issues. It would be the most effective urban design intervention for the problems in a city.

8C. IMPORTANCE OF HOLLAND'S FRAMEWORK IN URBAN DESIGN

The strategy for analysis and evaluation of informal spaces and the proposed design interventions is applicable not only to the informal markets but can also be generalized to other informal or formal systems. This generalization can be made because the strategy does not revolve around the actors, but on the relationship these actors have with each other that result in the various mechanisms of a complex organized system.

On the other hand, the conventional approaches used in urban design give more importance to the actors and not their relationships. They fail to recognize the self-organization of the system. They treat actors as mere objects that are static and controllable. This reduces the complex system of informal spaces to nothing more than a collection of objects with very limited interaction amongst themselves. This is seen in the commonly proposed solution of complete removal of vendors from around the railway markets. This solution is based on the assumption that the informal vendors are not an integral part of the railway market. It also fails to consider the resiliency of the complex adaptive system of the railway markets. The removal of vendors would temporarily eliminate some of the negative factors, but the void in the system would be quickly filled by another agent.

An important point to be noted about the solution proposed using complexity theory is that it is not an instantaneous problem-solving strategy, but it takes a longer time to implement. The longer time of implementation stems from the resiliency of the system to any external intervention. The slow implementation ensures that it takes into account all involved factors while going through a change during the implementation phase. For instance, as soon as the private vehicles are removed, the market system may initially experience a loss of customers. However, since the primary tagging is

intact, the system readapts itself to the change, and reaches a new state where the negative aspects due to the private vehicles are absent.

Since dynamism is an inherent quality of an organized complex system, a solution based on complexity theory ensures the retention of this dynamic quality and does not push it into a static zone. This is because the first steps in using complexity theory are to identify the primary tagging mechanisms and the positive features of the system to be retained which give the system its dynamism.

Thus, complexity theory is a better analysis tool for urban design interventions to solve the problems of megacities formed by the emerging informal everyday spaces. Theories like everyday urbanism acknowledge the everyday spaces, but fail in the actual urban design process. Complexity theory bridges this gap between everyday urbanism and urban design processes, as an analytical and evaluative tool by successfully providing a strategy to preserve the positive features of everyday spaces. As indicated earlier, the positive features of the informal space have to be provided by a theory like everyday urbanism. Everyday urbanism answers the 'why' portion of the question of preservation of informal spaces, whereas complexity theory answers the 'how'.

Like systems approach, complexity theory can also be subjected to the criticism that its approach is rigidly formulated, restricting creativity in design. In this research, however, Holland's framework is not used as an urban design tool, since it does not provide a ready solution to the problems faced by the informal systems. It is a tool to test the effectiveness of a proposed solution and derive the best solution strategy. This provides the urban designer room for creativity in design as it does not lay rigid rules for derivation of the solution. It, on the other hand, tests whether the derived solution conforms to the design goals. It balances the need for conformity and flexibility in design. A generic design tool operates primarily in the static zone (refer Figure 3-1), a creative

designer functions in the chaotic zone, but complexity theory provides solutions at the edge of chaos.

This new tool can be used for understanding, analyzing, and synthesizing strategies for various systems at various scales, that is, from a subsystem of a city, to a system of the city, to a metasystem of a megacity or the global network city. Although the number of agents and states of the systems would increase exponentially with increasing scale, the basic mechanisms of tagging, building block and internal models remain the same. The basic strategy to analyze these systems using Holland's framework would not change although more sophisticated tools would be required to manage the large amount of information. Holland's framework enriches the urban design approach to a city, making the intervention more successful and reliable, if not perfect.

Since this tool is better suited for understanding cities, it is very valuable to urban designers and researchers, considering the growing number of cities and megacities. However, it is important to understand the limitation of this method due to the possibility of selecting specific states and agents to arrive at a desired solution.

Another point to be noted is that this tool is better for analysis of the systems, unlike other tools which use predictive generic models. Such predictive models are based on set of general rules and do not treat each system distinctly. Holland's framework requires the identification of the distinct states, agents, and mechanisms of the system considered. However, a detailed analysis of a complex system at the scale of the city could be performed efficiently by using Holland's framework in conjunction with such generic models.

APPENDIX

A. SANTACRUZ RAILWAY STATION:

Figure A1 Informal shops along railway station in Santacruz

Figure A2 Santacruz Station Market as seen from Station

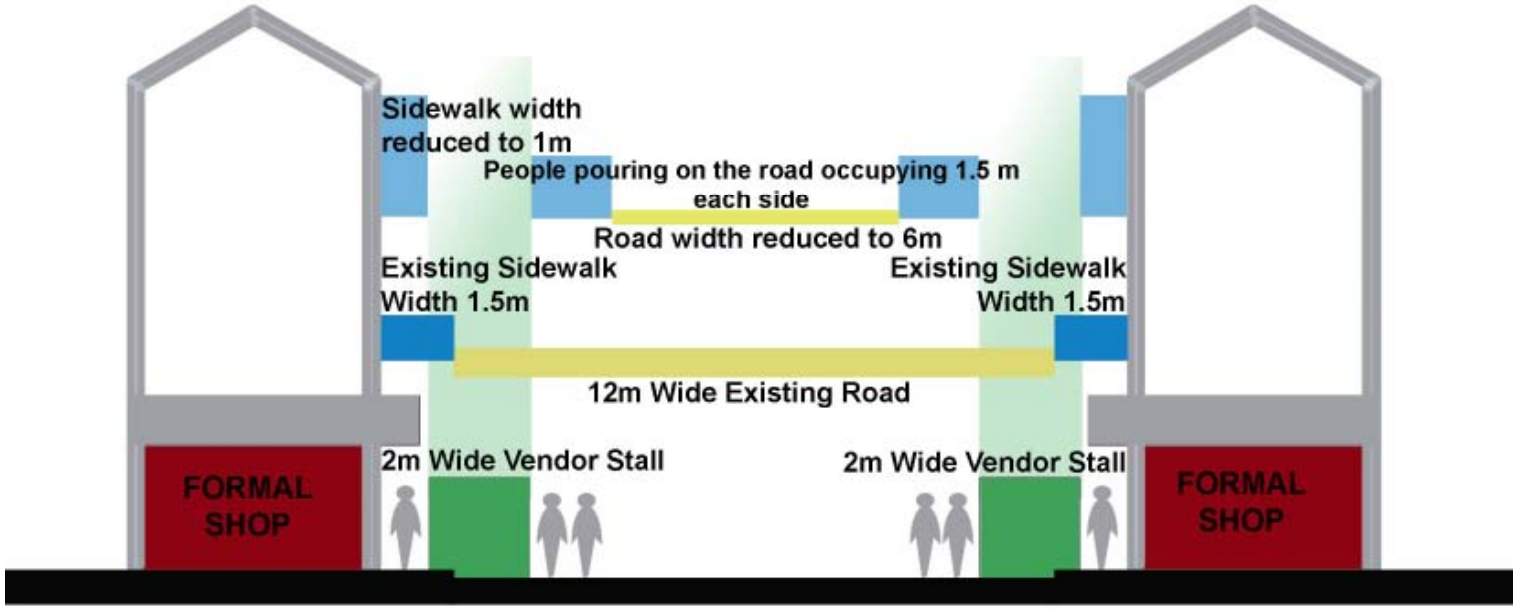


Figure A3 Typical section through Santacruz market

Figure A4 Informal vendors around Santacruz station

Table A1 Interaction of Agents in Santacruz Railway Market.

		PRIMARY AGENTS					
	Units	**Stalls**	**Formal Shops**	**Commuting route**			**Railway Station**
	Actors	**Permanent Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**	
PRIMARY AGENTS	**Permanent Informal Vendors**	They self organize themselves to form an economically viable informal market.	They get customers who also come to buy from the informal vendors and vice versa.	They are not concerned.	They buy goods from them on their way home from the station.	They buy goods just from them or when they come to shop in the formal shops.	It is because of the railway station, the permanent vendors get 50% of their customers.
	Shopkeepers	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.	It is because of the railway station, the shopkeepers get 50% of their customers.
	Commuters	They are sometimes an obstacle in their movement as they occupy the sidewalks.	They are not concerned about the commuters.				Railway Station is the reason for their presence in this market area.

LEGEND		Direct relation		Indirect relation

Table A1 continued

		PRIMARY AGENTS					
	Units	**Stalls**	**Formal Shops**	**Commuting route**			**Railway Station**
	Actors	**Permanent Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**	
PRIMARY AGENTS	**Commuters who are also customers**	They are located conveniently for them.	They provide them goods on their way back home.				Railway Station is the reason for their presence in this market area.
	Customers who are not commuters	They provide goods at a cheaper price.	They provide them goods.				
	Railway Station	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	The commuters use the railway station for daily commuting.	The commuters use the railway station for daily commuting.		
SECONDARY AGENTS	**Private Cars**	They are sometimes an obstacle in their flow.	They are a destination point for some cars.	Some of the commuters travel in private cars to the railway station.	Some of the commuters travel in private cars to the railway station.	Some of the customers travel in private cars to the shopping area.	The railway station is the destination point for the car passengers.

LEGEND		Direct relation		Indirect relation

Table A1 continued

		PRIMARY AGENTS					
	Units	**Stalls**	**Formal Shops**	**Commuting route**			**Railway Station**
	Actors	**Permanent Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**	
SECONDARY AGENTS	**Public buses & autos/cabs**	They are sometimes an obstacle in their flow.	They are a destination point for some autos/cabs.	Most of the commuters travel in public buses/autos to the railway station.	Most of the commuters travel in public buses/autos to the railway station.	Some of the customers travel in public buses/autos to the shopping area.	The railway station is a major hub for the public bus and auto system.
	Municipal Market	They sometimes experience loss of customers because of the convenient location of vendors.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.	It is because of the railway station, the municipal market gets 50% of their customers.
EXTERNAL AGENTS	**City Planners**	They have protested against the city planners' actions to remove them or relocate them and are opposed to their plans to setup more malls.	They ask the city planners to remove or organize the vendors.	They ask the city planners to remove or organize the vendors.	They ask the city planners to organize the vendors and improve the infrastructure.	They ask the city planners to organize the vendors and improve the infrastructure.	The railway station is a dominant planning component for the city planners.
	Police	The unlicensed vendors do not set up their stalls during the inspection days or just pay the fine when they are caught.	They want the police to regulate the vendors.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	The railway station is a major zone of vigilance for the police.

LEGEND		Direct relation		Indirect relation

Table A1 continued

		SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Vehicular route**		**Municipal Market**		
	Actors	**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Permanent Informal Vendors**	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They want to remove vendors to improve Mumbai's image as an organized city and to reduce the congestion caused because of the vendors.	They drive them away by taking away their goods and imposing fines, to avoid crimes like pick pocketing. They come on a weekly inspection to implement rules set up by planners.
	Shopkeepers	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market for their shops.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Commuters	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They are not concerned about the commuters.	They want to reduce the congestion and organize place for the ease of their commuting.	They want to protect them and make a safer environment free from crime and other illegal activity.

LEGEND		Direct relation		Indirect relation

Table A1 continued

		SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Vehicular route**		**Municipal Market**		
	Actors	**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Commuters who are also customers**	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets, ignoring their convenience.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Customers who are not commuters	They bring some of the customers to this market area.	They bring some of the customers to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Railway Station	They bring some of the commuters to the railway station.	They bring most of the commuters to the railway station.	They sometimes influence the number of commuters using that particular railway station.	They want to reduce congestion around the railway stations.	They want to make the stations a safer area.
SECONDARY AGENTS	**Private Cars**			They are a destination point for some cars.	They want to reduce traffic congestion around the railway stations.	They want to ensure traffic safety around the railway stations.

LEGEND		Direct relation		Indirect relation

Table A1 continued

		SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Vehicular route**		**Municipal Market**		
	Actors	**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
SECONDARY AGENTS	**Public buses & autos/cabs**			They are a destination point for some autos/cabs.	They want to reduce traffic congestion and provide efficient transit points.	They want to ensure traffic safety around the railway stations.
	Municipal Market	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market .	They want to protect them and make a safer environment free from crime and other illegal activity.
EXTERNAL AGENTS	**City Planners**	Private cars influence the planners to maintain the roads free from congestion.	Public buses and autos/cabs influence the planners to maintain the roads free from congestion and provide efficient transit.	Municipal markets require the city planners to maintain uncongested and efficient access to them		They act on the city planners' behalf to evacuate the informal vendors to avoid traffic congestion and improve the image of the city.
	Police	Private cars require the police to maintain safe travelling conditions.	Public buses and autos/cabs require the police to maintain safe travelling conditions.	Municipal markets require police to mainatin safety for their customers.	They ask the police to regulate the spaces so that their proposed organized plan can be implemented.	

Table A2 Analysis of State of Santacruz market

Spatial Condition	State of Market	Positive and Negative Features	Issues	Action taken by Authorities	Analysis using complexity theory
1. Density	Dynamism	1a. Congestion	Security issues like pick pocketing etc.	Attempt to remove the vendors from the area; conducting weekly inspections; confiscating their goods & imposing fines	There is a non-linear dynamic relation of 'Tagging' between the permanent vendors and the shopkeeper, i.e. formal shops and the stalls.
		1b. Access to sidewalk – Very difficult to impossible.	No convenient movement of customers.		
			No pedestrian safety.		
			Traffic Congestion.		
2. Open space	Openness	2a. Ventilated			This type of layout has traditionally been part of the culture & hence this is the basic Internal Model of informal market system. Fig 5-5 shows the layout of market.
		2b.Feeling of safety			
		2c.More exit points			
3.Image	Perceived Image	3a. Lack of Infrastructure	Hygiene issues.	Authorities want to organize the vendors in a formal way, for instance inside a building or remove them.	This present condition indicates that the informal market – an organized complex system – lies beyond the 'edge of chaos' within the 'chaos' region.
		3b. Not a planned space	Perceived as Disorganized		
4.Convenient Location	Location	4a.Convenience due to proximity to railway station			Location of Railway station is an essential environment and initial condition for the development of the Informal market.
Other Characteristics					
		High Vehicular movement on the 12m wide road.			

B. VILE PARLE RAILWAY STATION:

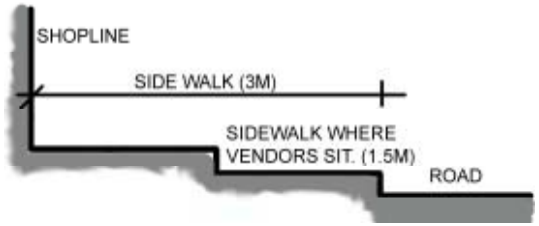


Figure A5 Section through Vile Parle market

Shopkeepers believe this is a provision (Figure A5) made for the vendors, while the vendors claim that MCGM is yet to finish the leveling of the sidewalk. Vendors keep their structure set-up through out the night. Since they do not have a storage space, they keep left-over materials in the shop through out the night. Some vendors do not mind shifting to a proper municipal market which has proper infrastructure, provided that the MCGM is able to keep away other vendors from setting up in this area.

Figure A6 Informal vendors around Vile Parle Station

Figure A7 Typical section through Vile Parle market

Figure A8 Vile Parle Station market as seen from station

Table A3 Relationship of actors in Vile Parle market

		PRIMARY AGENTS			PRIMARY AGENTS		
	Units	**Stalls**	**Stalls**	**Formal Shops**	**Commuting route**		
	Actors	**Permanent Informal Vendors**	**Temporary Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**
PRIMARY AGENTS	**Permanent Informal Vendors**	They self organize themselves to form an economically viable informal market.	They organize themselves around the permanent vendors to increase their visibility. They share customers. They will take the place of permanent vendors if the permanents vendors relocate.	They get customers who also come to buy from the informal vendors and vice versa.	They are not concerned. They generally use Station road for commuting.	They buy goods from them on their way home from the station.	They buy goods just from them or when they come to shop in the formal shops.
	Temporary Informal Vendors	They influence their setup and share customers		If the permanent vendors relocate, shops will influence the setup and location of the temporary vendors.	They are not concerned. They generally use Station road for commuting.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop in the formal shops or from the permanent vendors.
	Shopkeepers	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.
	Commuters	They are not much of a problem because the commuters use the other road.	They are not much of a problem because the commuters use the other road.	They are not concerned about the commuters.			

Table A3 continued

		PRIMARY AGENTS			PRIMARY AGENTS		
	Units	**Stalls**	**Stalls**	**Formal Shops**	**Commuting route**		
	Actors	**Permanent Informal Vendors**	**Temporary Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**
	Commuters who are also customers	They are located conveniently for them.	They are located conveniently for them.	They provide them goods on their way back home.			
	Customers who are not commuters	They provide goods at a cheaper price.	They provide goods at a cheaper price.	They provide them goods.			
	Railway Station	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	The commuters use the railway station for daily commuting.	The commuters use the railway station for daily commuting.	
SECONDARY AGENTS	**Private Cars**	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some cars.	Some of the commuters travel in private cars to the railway station.	Some of the commuters travel in private cars to the railway station.	Some of the customers travel in private cars to the shopping area.
	Public autos/cabs	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some autos/cabs.	Most of the commuters travel in public buses/autos to the railway station.	Most of the commuters travel in public buses/autos to the railway station.	Some of the customers travel in public buses/autos to the shopping area.
	Municipal Market	They are not much affected as both of them sell different products.	They are not much affected as both of them sell different products.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.
EXTERNAL AGENTS	**City Planners**	They are opposed to the city planner's plans to setup more malls.	They have protested against the city planners' actions to remove them or relocate them.	They ask the city planners to remove or organize the vendors.	They ask the city planners to remove or organize the vendors.	They ask the city planners to organize the vendors and improve the infrastructure.	They ask the city planners to organize the vendors and improve the infrastructure.
	Police	The licensed permanent vendors do not spill out on the road during the inspection days.	They run away when police come or do not set up their stalls during the inspection days. Some just pay the fines.	They want the police to regulate the vendors.	They want the police to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.

Table A3 continued

		PRIMARY AGENT	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	Railway Station	Vehicular route		Municipal Market		
	Actors		Private Cars	Public autos/cabs		City Planners	Police
PRIMARY AGENTS	Permanent Informal Vendors	It is because of the railway station, the permanent vendors get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the mostly different products, the vendors are not concerned about it.	City Planners have provided a different level in most of the sidewalks for the permanent vendors to occupy. Because almost all the permanent vendors have license they do not take any measures to remove the permanent vendors. But at the same time if any vendors spill out on the road their goods are confiscated during inspection round.	They come on a weekly inspection to implement rules set up by planners.
	Temporary Informal Vendors	It is because of the railway station, the temporary vendors get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the mostly different products, the vendors are not concerned about it.	They want to remove them to improve the image of Mumbai as an organized city and to reduce the congestion caused because of the temporary vendors.	They drive them away by taking away their goods, imposing fines, to avoid crimes like pick pocketing, etc. They come on weekly inspection to impose rules set up by planners.
	Shopkeepers	It is because of the railway station, the shopkeepers get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market for their shops.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Commuters	Railway Station is the reason for their presence in this market area.	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They are not concerned about the commuters.	They want to reduce the congestion and organize place for the ease of their commuting.	They want to protect them and make a safer environment free from crime and other illegal activity.

Table A3 continued

		PRIMARY AGENTS	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	Railway Station	Vehicular route		Municipal Market		
	Actors		Private Cars	Public autos/cabs		City Planners	Police
PRIMARY AGENTS	Commuters who are also customers	Railway Station is the reason for their presence in this market area.	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They provide them goods on their way back home.	In future they want to provide formally designed spaces for shopping in the form of municipal markets.	They want to protect them and make a safer environment free from crime and other illegal activity.
PRIMARY AGENTS	Customers who are not commuters		They bring some of the customers to this market area.	They bring some of the customers to this market area.	They provide them goods.	In future they want to provide formally designed spaces for shopping in the form of municipal markets.	They want to protect them and make a safer environment free from crime and other illegal activity.
PRIMARY AGENTS	Railway Station		They bring some of the commuters to the railway station.	They bring most of the commuters to the railway station.	They sometimes influence the number of commuters using that particular railway station.	They want to reduce congestion around the railway stations.	They want to make the stations a safer area.
SECONDARY AGENTS	Private Cars	The railway station is the destination point for the car passengers.			They are a destination point for some cars.	They want to reduce traffic congestion around the railway stations.	They want to ensure traffic safety around the railway stations.
SECONDARY AGENTS	Public autos/cabs	The railway station is a major hub for the public bus and auto system.			They are a destination point for some autos/cabs.	They want to reduce traffic congestion and provide efficient transit points.	They want to ensure traffic safety around the railway stations.

Table A3 continued

		PRIMARY AGENTS	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	Railway Station	Vehicular route		Municipal Market		
	Actors		Private Cars	Public autos/cabs		City Planners	Police
SECONDARY AGENTS	Municipal Market	It is because of the railway station, the municipal market gets 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market .	They want to protect them and make a safer environment free from crime and other illegal activity.
EXTERNAL AGENTS	City Planners	The railway station is a dominant planning component for the city planners.	Private cars influence the planners to maintain the roads free from congestion.	Public buses and autos/cabs influence the planners to maintain the roads free from congestion and provide efficient transit.	Municipal markets require the city planners to maintain uncongested and efficient access to them		They act on the city planners' behalf to evacuate the temporary vendors.
	Police	The railway station is a major zone of vigilance for the police.	Private cars require the police to maintain safe travelling conditions.	Public buses and autos/cabs require the police to maintain safe travelling conditions.	Municipal markets require police to mainatin safety for their customers.	They ask the police to regulate the spaces so that their proposed organized plan can be implemented.	

Table A4 Analysis of State of Vile Parle market.

Spatial Condition	State of Market	Positive & Negative Features	Issues	Action taken by Authorities	Analysis using complexity theory
1. Density	Dynamism	1a. Congestion	Security issues like pick pocketing etc.	The authorities do not try to remove the permanent licensed vendors, but if any vendors spill out on the road their goods are confiscated during inspection. During inspection, the temporary vendors are targeted the most. Also no more new licenses are issued.	There is a non-linear dynamic relation of 'Tagging' between the permanent vendors, temporary vendors and the shopkeeper, i.e. formal shops and the stalls.
		1b. Access to sidewalk – Not easy in all areas	No convenient movement of customers.		
			Less pedestrian safety.		
			Access to formal shops blocked.		
2. Open space	Openness	2a. Ventilated			This type of layout has traditionally been part of the culture and hence this is the basic Internal Model of informal market system. Fig 5-9 shows the layout of market.
		2b.Feeling of safety			
		2c.More exit points			
3.Image	Perceived Image	3a. Lack of Infrastructure	Hygiene issues.	No measure is taken by the authorities to provide infrastructure for the licensed vendors to resolve the hygiene issues.	
4.Convenient Location	Location	4a.Convenience due to proximity to railway station			Location of Railway station is an essential environment and initial condition for the development of the Informal market.
Other Characteristics					
		5. Less Vehicular movement on 9m wide road.			

C. DADAR RAILWAY STATION:

Figure A9 Temporary informal vendors around Dadar Station

Figure A10 Dadar Informal railway market

Figure A11 Flower market below overpass next to Dadar Station

Table A5 Relationship between the agents in Dadar market

		PRIMARY AGENTS					
	Units	**Stalls**	**Stalls**	**Formal Shops**	**Commuting route**		
	Actors	**Temporary Informal Vendors**	**Moving Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**
PRIMARY AGENTS	**Temporary Informal Vendors**	They self organize themselves to form an economically viable informal market.		They get customers who also come to buy from the informal vendors and vice versa.	They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop in the formal shops or from the temporary vendors.
	Moving Informal Vendors			The shops influence the presence of the moving vendors in this system.	They sometimes find these vendors a problem.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop in the formal shops or from other vendors.
	Shopkeepers	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.
	Commuters	They are sometimes an obstacle in their movement as they occupy sidewalks and roads.	They go up to these commuters or stop them on their way to sell their goods causing hindrance.	They are not concerned about the commuters.			
	Commuters who are also customers	They are located conveniently for them.	They go up to these customers or stop them on their way to sell their goods	They provide them goods on their way back home.			
	Customers who are not commuters	They provide goods at a cheaper price.	They provide goods at a cheaper price. They go up to these customers or stop them on their way to sell their goods.	They provide them goods.			

Table A5 continued

		PRIMARY AGENTS					
	Units	**Stalls**	**Stalls**	**Formal Shops**	**Commuting route**		
	Actors	**Temporary Informal Vendors**	**Moving Informal Vendors**	**Shopkeepers**	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**
PRIMARY AGENTS	**Railway Station**	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	The commuters use the railway station for daily commuting.	The commuters use the railway station for daily commuting.	
SECONDARY AGENTS	**Private Cars**	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some cars.	Some of the commuters travel in private cars to the railway station.	Some of the commuters travel in private cars to the railway station.	Some of the customers travel in private cars to the shopping area.
	Public buses & autos/cabs	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some autos/cabs.	Most of the commuters travel in public buses/autos to the railway station.	Most of the commuters travel in public buses/autos to the railway station.	Some of the customers travel in public buses/autos to the shopping area.
	Municipal Market	They sometimes experience loss of customers because of the convenient location of vendors.	They sometimes experience loss of customers because of the convenient location of vendors.		They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.
EXTERNAL AGENTS	**City Planners**	They have protested against the city planners' actions to remove them or relocate them and are opposed to their plans to setup more malls.		They ask the city planners to remove or organize the vendors.	They ask the city planners to remove or organize the vendors.	They ask the city planners to organize the vendors and improve the infrastructure.	They ask the city planners to organize the vendors and improve the infrastructure.
	Police	They run away when police come or do not set up their stalls during the inspection days. Some just pay the fines.	They mix with the crowd and run away when police come.	They want the police to regulate the vendors.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.

Table A5 continued

		PRIMARY AGENTS	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Railway Station**	**Vehicular route**		**Municipal Market**		
	Actors		**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Temporary Informal Vendors**	It is because of the railway station, the temporary vendors get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They want to remove them to improve the image of Mumbai as an organized city and to reduce the congestion caused because of the vendors.	They drive them away by taking away their goods, imposing fines, to avoid crimes like pick pocketing, etc. They come on weekly inspection to impose rules set up by planners.
	Moving Informal Vendors	It is because of the railway station, the moving vendors get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They have no control over them as they easily escape with the crowd during an inspection.	They have no control over them as they easily escape with the crowd during an inspection.
	Shopkeepers	It is because of the railway station, the shopkeepers get 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market for their shops.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Commuters	Railway Station is the reason for their presence in this market area.	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They are not concerned about the commuters.	They want to reduce the congestion and organize place for the ease of their commuting.	They want to protect them and make a safer environment free from crime and other illegal activity.

Table A5 continued

		PRIMARY AGENTS	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Railway Station**	**Vehicular route**		**Municipal Market**		
	Actors		**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Commuters who are also customers**	Railway Station is the reason for their presence in this market area.	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets, ignoring their convenience.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Customers who are not commuters		They bring some of the customers to this market area.	They bring some of the customers to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Railway Station		They bring some of the commuters to the railway station.	They bring most of the commuters to the railway station.	They sometimes influence the number of commuters using that particular railway station.	They want to reduce congestion around the railway stations.	They want to make the stations a safer area.
SECONDARY AGENTS	**Private Cars**	The railway station is the destination point for the car passengers.			They are a destination point for some cars.	They want to reduce traffic congestion around the railway stations.	They want to ensure traffic safety around the railway stations.
	Public buses & autos/cabs	The railway station is a major hub for the public bus and auto system.			They are a destination point for some autos/cabs.	They want to reduce traffic congestion and provide efficient transit points.	They want to ensure traffic safety around the railway stations.

Table A5 continued

		PRIMARY AGENTS	SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Railway Station**	**Vehicular route**		**Municipal Market**		
	Actors		**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
SECONDARY AGENTS	**Municipal Market**	It is because of the railway station, the municipal market gets 50% of their customers.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market .	They want to protect them and make a safer environment free from crime and other illegal activity.
EXTERNAL AGENTS	**City Planners**	The railway station is a dominant planning component for the city planners.	Private cars influence the planners to maintain the roads free from congestion.	Public buses and autos/cabs influence the planners to maintain the roads free from congestion and provide efficient transit.	Municipal markets require the city planners to maintain uncongested and efficient access to them		They act on the city planners' behalf to evacuate the informal vendors to avoid traffic congestion and improve the image of the city.
	Police	The railway station is a major zone of vigilance for the police.	Private cars require the police to maintain safe travelling conditions.	Public buses and autos/cabs require the police to maintain safe travelling conditions.	Municipal markets require police to mainatin safety for their customers.	They ask the police to regulate the spaces so that their proposed organized plan can be implemented.	

Table A6 Analysis of State of Dadar railway market.

Spatial Condition	State of Market	Positive & Negative Features	Issues	Action taken by Authorities	Analysis using complexity theory
1. Density	Dynamism	1a. Congestion	Security issues like pick pocketing etc.	Even though the authorities have attempted to relocate the vendors or drive them away, the vendors keep on returning to the station market to run their business.	There is a non-linear dynamic relation of 'Tagging' between the temporary vendors, moving vendors and the shopkeeper. Although the vendors are temporary or moving, they still have a strong relationship with the shopkeepers and their surrounding.
		1b. Access to sidewalk – Not easy in all areas	No convenient movement of customers.		
			Less pedestrian safety.		
			Traffic congestion		
2. Open space	Openness	2a. Ventilated			This type of layout has traditionally been part of the culture and hence this is the basic Internal Model of informal market system. Fig 12 shows the layout of market.
		2b.Feeling of safety			
		2c.More exit points			
3.Image	Perceived image	3a. Lack of Infrastructure	Hygiene issues.	Authorities want to organize the vendors in a formal way within Hawker's plaza.	This present condition indicates that the informal market – an organized complex system – lies beyond the 'edge of chaos' within the 'chaos' region.
		3b. Not a planned space	Perceived as Disorganized		
4.Convenient location	Location	4a.Convenience due to proximity to railway station			Location of Railway station is an essential environment and initial condition for the development of the Informal market.
Other Characteristic					
		5. Less Vehicular movement on 9m wide road.			

D. HAWKER'S PLAZA:

Figure A12 Hawker's Plaza from outside

Figure A13 Vendors at Hawker's Plaza

E. GENERAL DATA:

Table A7 Illustration of the State of a market system

GENERAL 'STATE' OF INFORMAL MARKET						
State of the Market	***Positive and Negative Features***		***Spatial Condition***	***Issues***	***Action taken by Authorities***	***Outcome of Action***
Dynamism	*Positive*	Vibrancy; Feeling of safety due to crowd.	Density		Removal of vendors; Relocation off-site.	Loss of Vibrancy
	Negative	Congestion		Security issues; congestion; no sidewalks; pedestrians on street. Good camouflage for criminals for escaping.		
Openness (Not in enclosed space)	*Positive*	Better ventilation; more exit points	Open Space			Poor ventilation, large crowds; Fewer routes of escape.
	Negative	Many exit points		No control over the exit points.		
Perceived Image	*Negative*	Disorganized; Lack of Infrastructure.	Messy / Cluttered	Hygiene Issues; Messy look.		
Economy	*Positive*	Facilitation of micro-commerce				Loss of economic advantage for the vendors.
Location	*Positive*	Proximity to Railway Station	Convenient Location			Loss of convenient location.

Table A8 Comparison of the four case studies and its 'State of market'.

COMPARISON OF CASE STUDY OF INFORMAL MARKET SYSTEMS						
			Dadar (West) Station Market	**Santacruz (West) Station Market**	**Vile Parle (East) Station Market**	**Hawker's Plaza**
STATE OF INFORMAL MARKET						
State of the market	***Positive and Negative Features***	***Issues***				
Dynamism	*Vibrancy*		Yes	Yes	Yes	No
	Congestion		Yes	Yes	Yes	No
		Access to sidewalk	Moderately difficult	Very difficult to impossible	Very difficult	Not required
		Convenient movement of customers	No	No	No	No[1]
		Safety of pedestrians (customers)	No	No	No	Yes
		Security from pick pocketing, etc	No	No	No	Yes
Openness	*Ventilated*		Yes. Well ventilated.	Yes. Well ventilated.	Yes. Well ventilated.	No. Very compact and can get smelly.[3]
	Exit Point		Many points of exits.	Many points of exits.	Many points of exits.	Few points of exits.
	Feeling of safety [2]		Yes	Yes	Yes	No
	Control over exits		No	No	No	Yes
Messy	*Disorganized Image*		Yes	Yes	Yes	No
	Infrastructure - sanitation and water supply		Absent	Presence of sanitation but lack of water supply	Absent	Present
Convenience	*Proximity to station*		Yes	Yes	Yes	No[4]

Table A8 continued - Comparison of the four case studies and its 'Agents'.

COMPARISON OF CASE STUDY OF INFORMAL MARKET SYSTEMS					
		Dadar (West) Station Market	**Santacruz (West) Station Market**	**Vile Parle (East) Station Market**	**Hawker's Plaza**
TYPE OF AGENTS					
Type of Vendors	*Permanent vendors*	Absent	Present	Present	Present
	Temporary vendors	Present	Present – very few	Present	Absent
	Moving Vendors	Present	Present – very few	Absent	Absent
Type of Units of the vendors		1) No overhead structure. 2) Hand basket	1) Bamboo supports, plastic sheet roofing. 2) No overhead structure. 3) Wooden Planks, plastic sheet roofing. 4) Carts 5) Hand basket	1) Bamboo supports, plastic sheet roofing. 2) No overhead structure. 3) Wooden Planks, plastic sheet roofing. 4) Carts	1) Partitioned cubicles
Presence of a municipal market in the vicinity		Yes	Yes	Yes	It is a municipal market
	Success of municipal market vis-à-vis the vendors	No	No	No	No

Table A8 continued - Comparison of the four case studies and other data.

COMPARISON OF CASE STUDY OF INFORMAL MARKET SYSTEMS				
OTHER GENERAL RELEVANT DATA FOR INFORMAL MARKET				
	Dadar (West) Station Market	**Santacruz (West) Station Market**	**Vile Parle (East) Station Market**	**Hawker's Plaza**
Licensed vendors	No	No/ yes(handful)	Yes / no(handful)	Yes
Items of Sale	Clothes, vegetable, fruits and other small items	Clothes, vegetable, fruits and other small items	Vegetable and fruits	Clothes
Business Hours	4am to 11pm	8am to 10.30 pm	8am to 10.30 pm	10am to 10pm
Success of the Informal market	Yes, many customers	Yes, many customers	Yes, many customers	No, few customers
OTHER SPATIAL FEATURES OF INFORMAL MARKET				
Planned space	No	No	No	Yes
Road width	9m	12m	9m	
Vehicular movement on the road	Light movement, other vehicular present nearby	Heavy vehicular movement	Light movement, other vehicular present nearby	Not applicable
Parking facility	No	No	Yes	No[1]

Notes:
1. Could have been achieved with better design.
2. Safety here is related to a comfort a person feels when he or she is not part of a crowd; there are less routes of escape. This is particularly dominant factor for a female.
3. Economical constraints make it difficult to provide mechanical ventilation in this closed space.
4. Proximity to station is possible to achieve, provided that there is vacant land.

Color Coding	
	Positive Factors
	Negative Factors
	Neutral Factors

Table A9 Matrix showing the interaction between agents of an informal market

		PRIMARY AGENTS			
	Units	**Stalls**	**Stalls**	**Stalls**	**Formal Shops**
	Actors	**Permanent Informal Vendors**	**Temporary Informal Vendors**	**Moving Informal Vendors**	**Shopkeepers**
PRIMARY AGENTS	**Permanent Informal Vendors**	They self organize themselves to form an economically viable informal market.	They organize themselves around the permanent vendors to increase their visibility. They share customers. They will take the place of permanent vendors if the permanents vendors relocate.		They get customers who also come to buy from the informal vendors and vice versa.
	Temporary Informal Vendors	They influence their setup and share customers	They self organize themselves to form an economically viable informal market.		If the permanent vendors relocate, shops will influence the setup and location of the temporary vendors.
	Moving Informal Vendors				The shops influence the presence of the moving vendors in this system.
	Shopkeepers	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.	They both share each other's customers. They sometimes create a problem for the shopkeepers by blocking the access to their shops.	
	Commuters	They are sometimes an obstacle in their movement as they occupy the sidewalks.	They are sometimes an obstacle in their movement as they occupy sidewalks and roads.	They go up to these commuters or stop them on their way to sell their goods causing hindrance.	They are not concerned about the commuters.

LEGEND		Direct relation		Indirect relation

Table A9 continued

		PRIMARY AGENTS			
	Units	**Stalls**	**Stalls**	**Stalls**	**Formal Shops**
	Actors	**Permanent Informal Vendors**	**Temporary Informal Vendors**	**Moving Informal Vendors**	**Shopkeepers**
PRIMARY AGENTS	**Commuters who are also customers**	They are located conveniently for them.	They are located conveniently for them.	They go up to these customers or stop them on their way to sell their goods	They provide them goods on their way back home.
	Customers who are not commuters	They provide goods at a cheaper price.	They provide goods at a cheaper price.	They provide goods at a cheaper price. They go up to these customers or stop them on their way to sell their goods.	They provide them goods.
	Railway Station	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.	They sometimes influence the number of commuters that use that particular railway station.
SECONDARY AGENTS	**Private Cars**	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some cars.
	Public buses & autos/cabs	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are sometimes an obstacle in their flow.	They are a destination point for some autos/cabs.
	Municipal Market	They sometimes experience loss of customers because of the convenient location of vendors.	They sometimes experience loss of customers because of the convenient location of vendors.	They sometimes experience loss of customers because of the convenient location of vendors.	
EXTERNAL AGENTS	**City Planners**	They have protested against the city planners' actions to remove them or relocate them and are opposed to their plans to setup more malls.	They have protested against the city planners' actions to remove them or relocate them and are opposed to their plans to setup more malls.		They ask the city planners to remove or organize the vendors.
	Police	The unlicensed vendors do not set up their stalls during the inspection days or just pay the fine when they are caught.	They run away when police come or do not set up their stalls during the inspection days. Some just pay the fines.	They mix with the crowd and run away when police come.	They want the police to regulate the vendors.

LEGEND		Direct relation		Indirect relation

Table A9 continued

		PRIMARY AGENTS			
	Units	**Commuting route**			**Railway Station**
	Actors	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**	
PRIMARY AGENTS	**Permanent Informal Vendors**	They are not concerned.	They buy goods from them on their way home from the station.	They buy goods just from them or when they come to shop in the formal shops.	It is because of the railway station, the permanent vendors get 50% of their customers.
	Temporary Informal Vendors	They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop in the formal shops or from the permanent vendors.	It is because of the railway station, the temporary vendors get 50% of their customers.
	Moving Informal Vendors	They sometimes find these vendors a problem.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop in the formal shops or from other vendors.	It is because of the railway station, the moving vendors get 50% of their customers.
	Shopkeepers	They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.	It is because of the railway station, the shopkeepers get 50% of their customers.
	Commuters				Railway Station is the reason for their presence in this market area.

LEGEND		Direct relation		Indirect relation

Table A9 continued

		PRIMARY AGENTS			
	Units	**Commuting route**			**Railway Station**
	Actors	**Commuters**	**Commuters who are also customers**	**Customers who are not commuters**	
PRIMARY AGENTS	**Commuters who are also customers**				Railway Station is the reason for their presence in this market area.
	Customers who are not commuters				
	Railway Station	The commuters use the railway station for daily commuting.	The commuters use the railway station for daily commuting.		
SECONDARY AGENTS	**Private Cars**	Some of the commuters travel in private cars to the railway station.	Some of the commuters travel in private cars to the railway station.	Some of the customers travel in private cars to the shopping area.	The railway station is the destination point for the car passengers.
	Public buses & autos/cabs	Most of the commuters travel in public buses/autos to the railway station.	Most of the commuters travel in public buses/autos to the railway station.	Some of the customers travel in public buses/autos to the shopping area.	The railway station is a major hub for the public bus and auto system.
	Municipal Market	They are not concerned.	They buy goods from them on their way back from the station.	They buy goods just from them or when they come to shop from the informal vendors.	It is because of the railway station, the municipal market gets 50% of their customers.
EXTERNAL AGENTS	**City Planners**	They ask the city planners to remove or organize the vendors.	They ask the city planners to organize the vendors and improve the infrastructure.	They ask the city planners to organize the vendors and improve the infrastructure.	The railway station is a dominant planning component for the city planners.
	Police	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	They want the police to regulate the vendors to ensure their safety.	The railway station is a major zone of vigilance for the police.

LEGEND		Direct relation		Indirect relation

Table A9 continued

		SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Vehicular route**		**Municipal**		
	Actors	**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Permanent Informal Vendors**	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They want to relocate the licensed vendors in formally designated buildings and remove others completely. This is to improve Mumbai's image as an organized city and to reduce the congestion caused because of the vendors.	They drive them away by taking away their goods and imposing fines, to avoid crimes like pick pocketing. They come on a weekly inspection to implement rules set up by planners.
	Temporary Informal Vendors	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They want to remove them to improve the image of Mumbai as an organized city and to reduce the congestion caused because of the vendors.	They drive them away by taking away their goods, imposing fines, to avoid crimes like pick pocketing, etc. They come on weekly inspection to impose rules set up by planners.
	Moving Informal Vendors	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the vendors.	As the municipal market sells the same goods, the vendors generally do not locate themselves near this market.	They have no control over them as they easily escape with the crowd during an inspection.	They have no control over them as they easily escape with the crowd during an inspection.
	Shopkeepers	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market for their shops.	They want to protect them and make a safer environment free from crime and other illegal activity.

LEGEND		Direct relation		Indirect relation

Table A9 continued

		SECONDARY AGENTS			EXTERNAL AGENTS	
	Units	**Vehicular route**		**Municipal Market**		
	Actors	**Private Cars**	**Public buses & autos/cabs**		**City Planners**	**Police**
PRIMARY AGENTS	**Commuters**	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They are not concerned about the commuters.	They want to reduce the congestion and organize place for the ease of their commuting.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Commuters who are also customers	They bring some of the commuters to this market area.	They bring some of the commuters to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets, ignoring their convenience.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Customers who are not commuters	They bring some of the customers to this market area.	They bring some of the customers to this market area.	They provide them goods on their way back home.	They want to provide formally designed spaces for shopping in the form of municipal markets.	They want to protect them and make a safer environment free from crime and other illegal activity.
	Railway Station	They bring some of the commuters to the railway station.	They bring most of the commuters to the railway station.	They sometimes influence the number of commuters using that particular railway station.	They want to reduce congestion around the railway stations.	They want to make the stations a safer area.
SECONDARY AGENTS	**Private Cars**			They are a destination point for some cars.	They want to reduce traffic congestion around the railway stations.	They want to ensure traffic safety around the railway stations.
	Public buses & autos/cabs			They are a destination point for some autos/cabs.	They want to reduce traffic congestion and provide efficient transit points.	They want to ensure traffic safety around the railway stations.
	Municipal Market	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.	They bring some of the commuters as well as the customers to this market area. The commuters and customers are the reason for the presence of the shops.		They have provided formally planned market .	They want to protect them and make a safer environment free from crime and other illegal activity.
EXTERNAL AGENTS	**City Planners**	Private cars influence the planners to maintain the roads free from congestion.	Public buses and autos/cabs influence the planners to maintain the roads free from congestion and provide efficient transit.	Municipal markets require the city planners to maintain uncongested and efficient access to them		They act on the city planners' behalf to evacuate the informal vendors to avoid traffic congestion and improve the image of the city.
	Police	Private cars require the police to maintain safe travelling conditions.	Public buses and autos/cabs require the police to maintain safe travelling conditions.	Municipal markets require police to mainatin safety for their customers.	They ask the police to regulate the spaces so that their proposed organized	

LEGEND		Direct relation		Indirect relation

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