

Study on Planning Support MAS Model for Impact Analysis of Large-Scale Shopping Center in Japan

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Dissertation Abstract

The commercial environment of many local cities in Japan is experiencing decline so local governments have developed all kinds of city center generation policies to constrain this trend and revitalize the central city commercial environment. However, it is difficult to evaluate the potential impact of current policies on the future of a city due to the uncertainty and complexity inherent in an urban system. This PhD research is committed to formulating a MAS model as an urban planning tool to support impact analysis of the central area regeneration policies on large-scale shopping center (B-shop) development.

Most regional city in Japan is experiencing decline in its commercial center. More and more large-scale shopping malls shifting to out-of-city location is commonly cited as the reason for the decline of city centers. Local governments efforts to promote the regeneration of central commerce have focused on regulating the location of large-scale shopping mall through issuing a series planning policies and regulations. There is an emerging need of a decision-making supporting tool to exhibit the effects of different planning policy scenarios on the regeneration of central city commerce. Considering urban development is a complex process that involves many stakeholders, conditions and factors, MAS, which has been shown powerful in better understanding the processes of urban development and growth, is supposed to be a promising tool for policy analysis. This PhD research is committed to formulating a MAS model as an urban planning tool to support impact analysis of the central area regeneration policies on large-scale shopping center (B-shop) development.

Different from most 'game-playing' MAS models which are based on pure agents' behavior disregarding urban planning institution, the Shopsim model introduces the real land use zoning and planning regulations as constraints for agent's behavior, which make it able to measure the likely impact of land use policy at the local level. The virtual urban space is constructed according to real local cities facing decline in Japan. Each cell constituting the space has the attributes indicating the characteristic of urban planning conditions (the urban planning area, the land use zoning types and

suitability). Four kinds of city individuals (Planner, developer, shop and household) are designed as agents that are affected by urban planning policies and interact with each other to generate market spatial pattern. The components of Shopsim are illustrated in Figure1 and the virtual urban space for simulations are showed in Figure2. Parameter sensitivity analysis and empirical calibration of Model suggested that Shopsim can work well to exhibit how market spatial pattern emergent from agents' interaction affected by urban planning policies, and therefore can be employed as a promising tool for supporting policy impact assessment.

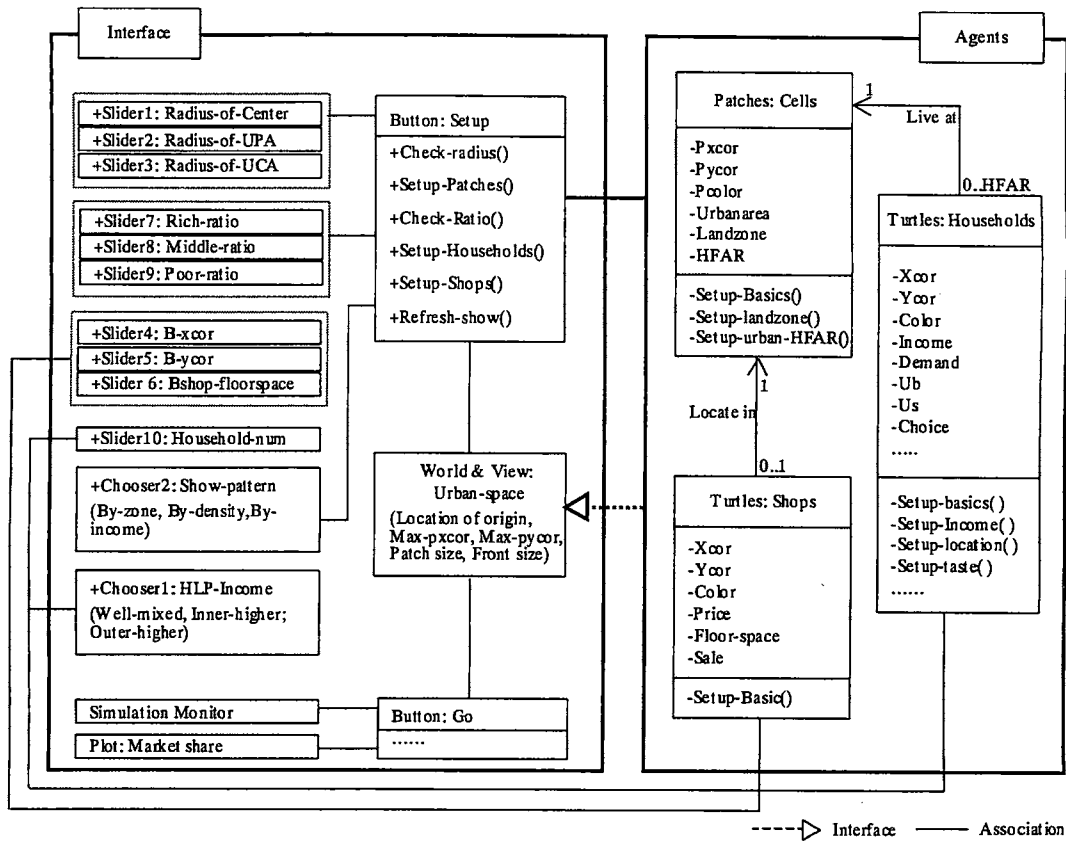


Figure1. The components of Shopsim.

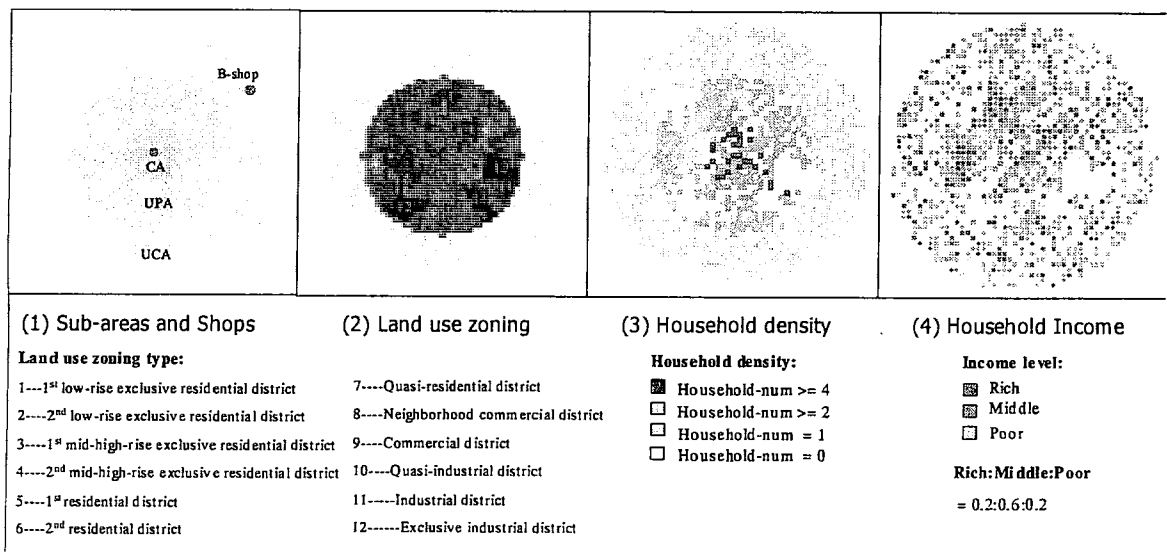


Figure2. The virtual urban space (urban planning conditions) generated by Shopsim.

Shopsim provides key functionalities like interactive policy scenario development and the ability to visualize and quantify simulation outcomes spatially. A combined public transportation scenario (CPTS) are designed and simulated in Shopsim. The scenario of CPTS approximates the situation in which bus-first is a common practice among households, and availability-improving policy and parking-control policy are implemented. The simulation results indicated that the positive impacts of public transportation policy on regeneration of a local city center could be achieved by carefully planned integrated measures. The impact of the new B-shop on the commercial environment of the city center are visualized in three policy scenarios: Center Activation (CA), Railway Station Development (RSD), and Neighbouring Commerce Promotion (NCP). Comparing Results from these scenarios indicated that the CA scenario, which encourages large-scale shops to locate in the center commercial area without upper limitation for floor space, might be an effective measure to improve the activity of center commerce if there is a reasonable limitation on B-shop's floor space. The scenarios are illustrated in Figure3 and their detail descriptions are given in the dissertation.

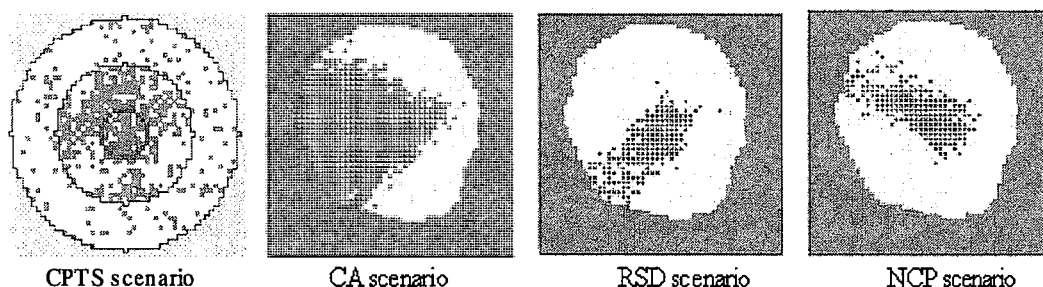


Figure3. Illustration of scenarios simulated in Shopsim.

As mentioned above, the Shopsim model is constructed in the context of Japan and the simulation results for a virtual city are encouraging. But it does not necessarily mean that the Shopsim model is ready to be applied in reality because practically the virtual urban environment of the Shopsim is pretty ideal. For future research, Shopsim can be expected to yield progress in a number of areas: (i) in the design of a realistic virtual urban environment (for example, projecting the scale and configuration of real land use zonal structure into virtual city) suitable for supporting urban planning decision-making and (ii) in the methods and techniques to derive empirical behavior rules for agents when they experience hypothetical changes that happen in their urban environments (for example the competing strategies of existing shops when a new one is opened). (iii) in the ways to identify the rules that underlie spatial patterns generated from interaction of agents. To achieve these progresses, large volume of data needs to be extracted from reality and processed in the MAS model, which unfortunately to our knowledge cannot be done under current popular MAS developing environments. To solve this problem, we suggested that connecting MAS and GIS could be a possible promising way. It is well known that data for planning are generally available in GIS form that might be readily integrated into the database for model development. Furthermore the calculation and visualization of summary indices within GIS can help identify spatial patterns and processes of interest.

学位論文審査結果の要旨

本学位申請論文に対して、審査委員全員で面接と試問を行うとともに、審査委員会にて論文の内容について検討し、審査方針を決定した。7月31日に口頭発表を行い、同日最終審査委員会を開催した。これらにより慎重に協議した結果、以下の通り判定した。

申請論文は、複雑系システムにおけるシミュレーション手法として有効なMAS（マルチエージェントシステム）を用いて、大規模商業施設の立地による各種の影響評価を行うことのできる計画支援モデル（Shopsim）を開発し、それを日本の都市や都市計画的ゾーニングを前提として仮想的条件を設定することによりシミュレーションを行い、計画支援システムとしての可能性を検証している。本システムの適用により、住民の購買、住宅のタイプと立地、交通手段などの選択行動をシミュレーションすることにより、各種の都市整備施策や計画代替案の検討が可能であることを示した。これらの成果は、MASを活用した計画支援システムの構築に有効なものであり、わが国におけるこうした計画技術の進展に大いに貢献するものである。

以上、研究成果は、今後のわが国における計画支援システムの充実、発展に有用である。また、学術的な知見が得られた上、その成果により社会に大きく貢献する。よって、本論文は、博士（学術）の学位に値するものと判定される。