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Interplay and Implications of Urban Renewal under Dual Laws - An Agent-Based Simulation

Jau-Hung Yu[1] and Bin-Tzong Chie[2]

Abstract

This article focuses on the impact of the simultaneous implementation of dual laws on urban renewal implementation. Especially when the two laws have different case success rates. We refer to the agent-based model used by Acevedo et al. (2003) for the Los Angeles City Development Study. We used the Geographic Information System (GIS) data to replace the virtual grid. We selected the data of Taipei City for simulation. Compare with the "Urban Renewal Act" and the "Statute for Expediting Reconstruction of Urban Unsafe and Old Buildings" that are currently being implemented simultaneously. Simulations and studies were conducted based on the case success rate and the gap between the two laws. The study results show that only by widening the gap between the two laws can the "Urban Renewal Act" be used at a higher rate. This means clearer enforcement scope and conditions should be set in both regulations to avoid direct conflict.

JEL classification numbers: C15, C63, L38, P25, R52.
Keywords: Urban Renewal, Agent-based modeling, NetLogo, GIS.

[1] Department of Industrial Economics, Tamkang University.
[2] Department of Industrial Economics, Tamkang University.

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1. Introduction

Cities are aging, making urban renewal crucial for modern city development. This process involves considering various factors, including long construction periods, high capital needs, significant environmental changes, and substantial human and economic impacts. Urban renewal typically unfolds over an extended period, often driven by urban planning regulations in major cities. This entails executing renewal and renovation initiatives to revitalize old structures and regions.

The urban system is intricate, with impacts exceeding expectations. It encompasses housing, transportation, work, food, and living conditions, among others. These factors intertwine, complicating urban planning and revitalization efforts. Due to ever-evolving environmental conditions in cities, existing urban renewal laws frequently fall short of meeting current requirements. Consequently, when standard urban renewal laws prove inadequate or ineffective, authorities resort to crafting specialized legislation to address the issue.

Conflicts between general law and special law is often arise, affecting urban renewal planning. Special laws can remove limitations of general laws, leading to misconceptions about urban renewal goals. Incorrect perceptions may prioritize interests over urban development direction, neglecting the fundamentals of renewal. In this paper, an agent-based model with GIS (Geographic Information System) is applied to simulate the results of urban renewal implementation in two different scenarios within the urban development environment. The first scenario involves implementing a single urban renewal law, while the second scenario involves the simultaneous implementation of general and special urban renewal laws. By analyzing the simulation results of these scenarios, we aim to identify the key factors that require special attention when establishing urban renewal laws, particularly a special law.

The Taiwanese government is currently actively promoting urban renewal through a general decree and a 10-year period special decree for another to address related issues. These decrees include the “Urban Renewal Act” and the “Statute for Expediting Reconstruction of Urban Unsafe and Old Buildings”. Our focus is on Taipei, Taiwan, in alignment with our research.

Next section of this paper consists of a literature review that examines previous works on urban renewal, agent-based modeling, and the integration of NetLogo and GIS. Section three explains the utilization of Taipei City's zoning data as a model for establishing parameters and conducting experiments in alignment with Taiwan's existing urban renewal regulations. Section four delves into the discussion and depiction of the experimental outcomes. Finally, Section five provides a summary of the experimental findings, assesses the limitations of the study, and proposes potential future avenues for research.

2. Literature Review

The process of urban development is like a complex system, and agent-based modeling is one of the potential methodologies for dealing with complex systems. In this case, we used an agent-based model to simulate urban renewal. This section first discusses the origins and problems of urban renewal, then introduces the literature on urban complex systems, and then introduces how to deal with urban complex systems through agent-based modeling. Finally, NetLogo with GIS is used to implement an effective agent-based model.

2.1 Origin and Development of Urban Renewal

Between 1945 and 1950, after World War II, countries such as the United States, the United Kingdom, and Japan undertook major urban development projects to improve the quality of life for their people. In 1949, the U.S. government enacted the Housing Act to support this effort. By 1953, the Act had been amended to include the clearance and redevelopment of slum areas, leading to the emergence of urban renewal. This law authorized the government to acquire these dilapidated areas, renovate them, and then sell them to developers for urban revitalization, subsequently providing them to those in need. However, this strategy received criticism for potentially displacing low-income residents and favoring the wealthy, prompting widespread backlash at the time (Miles, 1954).

The two policies adopted in the Housing Act, public housing and urban renewal, are aimed at the elimination of slums and the revitalization of neighborhoods. However, twenty-five years after implementation, many scholars have found that the scheme has actually had the opposite effect of its intended purpose (Hoffman, 2000).

2.2 Complex Urban Systems

With the aid of information technology, the concept of complex urban systems has seen significant advancements. Originating in the 1950s, urban systematization aligns well with general systems theory in biology, as it undergoes evolutionary changes akin to ecosystems. Bertalanffy (1968) affirmed that the general systems theory employs mathematical and logical structures to partition the environment into distinct elements, linking interactions among these elements to create systems. Early urban system theories were initially seen as monolithic systems, with their principles centered around the interaction of various elements like architecture and transportation. Because of the simplicity of the architecture, researchers often focus on how to control the urban system so that an equilibrium situation is achieved. Consequently, such research is often biased towards the application of economic activities.

According to Batty (2005), several characteristics of cities prevent what researchers call equilibrium, including the following:

Nonlinearity: The changes in urban systems are not linear, and the relationship between the outputs and inputs of each performance is not a simple ratio, but a more complex and nonlinear relationship.

Multi-level system: A city combines subsystems at different levels, such as buildings, roads, vehicles, etc. Each subsystem contains its elemental characteristics, and through the interaction between elements, it produces activities.

Non-equilibrium: The city is constantly in a state of change, such as the increase and decrease of population, the demolition, and expansion of buildings, the change of social activities, the development of commercial activities, etc., so the structure and behavior of the city are also constantly changing, and there is no fixed state.

Uncertainty: Urban system evolution is influenced by various uncertainties, such as economic, social, and political factors. The interactions and impacts of these factors and changes are frequently nonlinear and random, making the overall structure and behavior of urban systems uncertain and unpredictable.

To sum up, the city is an open system, composed of various elements and subsystems, and the subsystems overlap with each other, so the city is a dynamic system that is constantly in an unbalanced situation. Urban systems are not linear and are subject to constant turbulence and change. In such a situation, most cities cannot meet the expected planned development.

For these reasons, it seems more appropriate to use the concept of complex systems to deal with urban problems. In such systems, each element is usually referred to as an agent, and there will be interactions between agents as well. In complex systems, researchers are more concerned with the feedback of inter-agent activities. This level of development is to use the bottom-up method to construct a model of the city, and then generate a pattern of events and so on. In this way, unexpected emergence properties can be generated to help researchers think about various situations. In this type of study, real-time, unbalanced feedback can be generated to provide in-depth discussion among the researchers (Epstein, 1996).

Agent-based modeling (ABM) has the features of handling complex urban systems, and numerous studies employ ABM to simulate urban development. With the enhancement of computer processing power, the emphasis on reproducibility in experiments by ABM, and the scrutiny of experts and real data, the modeling approach has grown more refined and stringent in recent years, establishing ABM as a significant research method for complex systems (Grimm *et al.*, 2010).

ABM is an alternative to conventional theories and models. In dynamic modeling, traditional approaches require validation against simulated data. However, agent-based models introduce randomness, leading to varying results and challenging validation. Consequently, numerous repeated simulations, including sampling, are essential for validation, utilizing the distribution of outcomes as a validation reference.

2.3 Combine NetLogo with GIS

This study utilizes the NetLogo, widely adopted in academia, in conjunction with a geographic information system as its modeling tool for selecting tools and materials. Developed by Northwestern University, NetLogo is based on the Logo language programming concept. Under Professor Wilensky's leadership, the software has maintained its freedom and openness, providing good maintenance for the programming language. It also enhances compatibility with other platforms, supports parallel computing, and processes dynamic systems, making it an excellent research and development tool (Tisue and Wilensky, 2004).

Researchers utilize NetLogo to construct a simulated world by merging patches, creating agents (turtles), and running various programs and interactions. Acevedo *et al.* (2003) employed this approach to analyze the evolution of Los Angeles City from its inception. They utilized each grid to be two hundred meters square to generate a virtual map simulating the urban growth of Los Angeles spanning from 1907 to 1995. Nevertheless, since this is a simulation, ensuring its alignment with reality through effective sampling methods is a crucial aspect to consider. NetLogo offers numerous advanced features and libraries, such as integration with Geographic Information System (GIS).

The first real GIS in the world, developed jointly by the United States and Canada in the 1960s, primarily focused on researching and analyzing land, resources, population, and other related projects. With the rapid advancement of computerization, the use of GIS has become increasingly widespread.

GIS is a blend of automated information mapping, data processing, and spatial analysis technology. In GIS, a map is segmented into layers, each depicting different data types. This segregation prevents data from being muddled with information from other layers. The adoption of GIS by cities as their information processing solution has led to its technological advancement. Currently, most city-provided GIS includes urban map data, topology, land and property records, and spatial characteristics (Huxhold, 1991).

Many GIS archives contain vector drawing materials. When NetLogo is integrated with GIS, the simulation system can utilize the unit data and classification method directly from the GIS database, rather than relying on a grid-based approach. This allows for the importation of relevant data into the model, creating a simulation world that closely mirrors reality. By combining NetLogo with GIS data, the model can incorporate additional information and facilitate the design of visually enhanced effects in the simulation environment. This, in turn, aids researchers in observing and interpreting benchmarks more effectively (Walker and Johnson, 2019).

2.4 Taipei City, the Subject of the Study

Taiwan is situated in a high-risk earthquake zone, and many buildings older than 30 years fail to comply with current building safety standards. Consequently, ensuring building safety is a critical aspect of urban revitalization. To address the issue of outdated structures, government authorities have prioritized building reconstruction as a key policy measure. The Urban Renewal Act (*UR_Act*), enacted on 11 November 1998, offers substantial floor space incentives to incentivize building owners to undertake real estate maintenance and reconstruction for the public interest.

As of 2016, nearly 20 years have passed since the implementation of the *UR_Act* Ordinance. By that time, there were still only about 455 approved applications for urban renewal nationwide, including those from government units. The reason for such a delay is mainly due to the high compliance conditions of the subject matter and the problems that are prone to problems in preliminary planning and coordination. To this end, the government launched the "Statute for Expediting Reconstruction of Urban Unsafe and Old Buildings"(*ER_Act*) in mid-2017. The purpose of this special law is not only to strengthen the timeline *UR_Act* the unconstitutional amendment, but also to arouse the willingness of residents and builders to participate in urban renewal by promoting the redevelopment of dangerous old buildings. The *ER_Act* operates under a fixed implementation period, spanning from 2017 to 2027, with a total timeline of 10 years.

In dealing with the challenge of urban renewal integration, *ER_Act* is now seen as a superior option to *UR_Act* by residents and developers. One key advantage is the absence of size restrictions, along with the elimination of preliminary steps like public hearings or neighbor consultations, and a simplified review process. Consequently, numerous urban renewal applicants opt for *ER_Act* over better land consolidation and incentives to minimize development time and risk. Given this choice, large-scale urban renewal projects that were initially planned to be carried out in collaboration with neighboring areas are frequently abandoned in favor of smaller-scale alternatives.

In the aforementioned scenario, Taipei City emerges as a fitting focal point for this research. Taipei City has an urgent need for urban renewal, and the competent authorities hope to speed up the implementation of the *UR_Act*. However, due to the high restrictions on the subject matter, many cases are difficult to implement because the subject matter either does not meet the requirements or there are disputes between the households of the joint development, so they turn to a special law with short time to speed up or reduce the area of the base. As expected, many urban renewal cases have shifted to lex specialis.

However, when considering the parallel of the two laws, does it have a positive or negative impact on urban renewal? We aim to observe the functioning of this model.

3. Data and Model Construction

In order to comprehend the evolution process of contemporary cities. Acevedo *et al.* (2003) utilized the agent-based model by NetLogo to craft a research model for urban development in Los Angeles. We followed the same approach as NetLogo to build the model. To make the simulation more in line with present circumstances, we refer to the research method of Tisue and Wilensky (2004) and use GIS data as the foundation.

3.1 Introduction to the Model

Regarding the choice of cities and materials, given Taiwan's active pursuit of urban renewal and the concurrent implementation of both the *UR_Act* and *ER_Act*, Taipei

City represents over half of the urban renewal projects in Taiwan, thus we selected Taipei City as our simulation subject.

To better align with the actual urban structure and distinguish from the general urban model, we devised a new urban renewal model. The primary implementation involves three key stages: configuring the environment, creating new scenarios, and evaluating the outcomes. Following each iteration, the map undergoes a redrawal to enable real-time visualization of the data.

In the model, there are relevant executions and variables related to the *UR_Act*, and we use UR as the prefix letter. If there are relevant executions and variables about *ER_Act*, we use ER as the prefix letter.

3.2 Adoption of Data

During the model construction, urban geographic data is sourced from data published by relevant government authorities. The fundamental GIS data utilized in this research is the Taipei City urban planning data released by the Taipei City Government on December 17, 2019.

The GIS data of Taipei City is divided by administrative district. There are a total of 12 administrative districts in Taipei City, and there are a total of 15,210 records in the GIS file of Taipei City Metropolitan Plan. Among them, each data represents an independent use of partitions, as shown in Figure 1, this is a comparison of the two, in which the number of use partitions in each administrative district can be as high as 1,000, but the distribution is not even, mainly because of the different characteristics of the land, so that the size of the area is different.

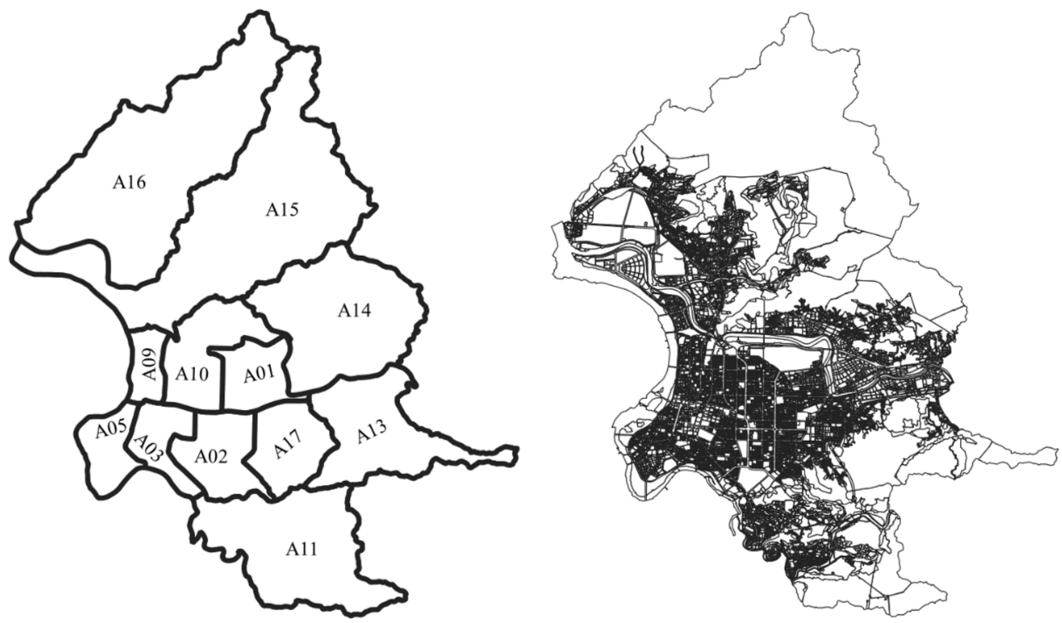

Figure 1: The Comparison between Taipei City Administrative District Map and Urban Plan (2019, December 17)

Different from the typical model-based processing, we utilize GIS in this urban plan for data processing. Each district serves as the simulation object, and data is transferred from the GIS file to create a comprehensive administrative district map world. In this microcosm, each partition functions as a patch, with varying sizes based on real-world conditions, thus aligning more closely with reality.

3.3 Model Construction

In this model, each urban renewal case is a separate event. In this stand-alone case, we simulated the reality of the case from the owner's willingness to proceed with the case until the event was approved by the government within the time limit. Once it is approved by the government within the time limit, it is considered successful in the model. Approval within the set timeframe denotes success in the model. Failure is declared if success is not achieved within the allowable period.

3.3.1 Model Settings

Table 1: Important variables

Variable name	**Illustrate**	**Default value**
p	Total Rounds of Simulation (Months)	120
Z_{no}	The number of zones that can be used for urban renewal	1,479
$Zcase$	A collection that qualifies for urban renewal and uses zoning	
Z_{size}	The size of each independent partition	
$Z_{Rebuilt\ size}$	The area that has been rebuilt	
$Z_{Left\ size}$	Area not yet redeveloped	
$Ucase$	Case collection using *UR_Act*	
$Ecase$	Case collection using *ER_Act*	
$UR_{positivity}$	Only implement *UR_Act*, and the degree of willingness to participate in urban renewal	2, 3, 4, 5
$ER_{positivity}$	*UR_Act* and *ER_Act* two regulations are implemented at the same time, and the degree of willingness to participate in urban renewal	5
UR_{min} 、 UR_{max}	Using *UR_Act*, the lower limit and upper limit of the operation month	24, 60
ER_{min} 、 ER_{max}	Using *ER_Act*, the lower limit and upper limit of the operation month	6, 24
UR_{sucess}	Only implement *UR_Act*, the success rate of each period	0.5%, 1%, 1.5%
ER_{sucess}	*UR_Act* and *ER_Act* two regulations are implemented at the same time, the success rate of each period	2%, 4%, 6%
UR_{500}: < 500 m^2 UR_{1000}: < 1,000 m^2 UR_{2000}: < 2,000 m^2 UR_{extra}: >2,000 m^2	*UR_Act* and *ER_Act* are the times when two acts are executed at the same time. Within the scope of different regions, the probability of using *UR_Act*.	UR_{500} : 0% UR_{1000}: 15% 70%, 90% UR_{2000}: 70%, 90% UR_{extra}: 90%

In this model, we utilize Taipei City's historical urban renewal case application data to identify use zones suitable for urban renewal. The focus this time is on residential and commercial areas. An important restriction to consider is the floor area ratio, with a minimum limit set at 225% in this simulation. Given these criteria, we assign a variable, Z_{no}, to represent the filtered number. Subsequently, we establish a case collection, $Zcase$, for the filtered instances.

$$Zcase_i = \{i : 1,2, \dots, Z_{no}\} \tag{1}$$

In the simulation interface created with NetLogo, each $Zcase_i$ represents a grid (patch). The division is clearly visible on the interface.

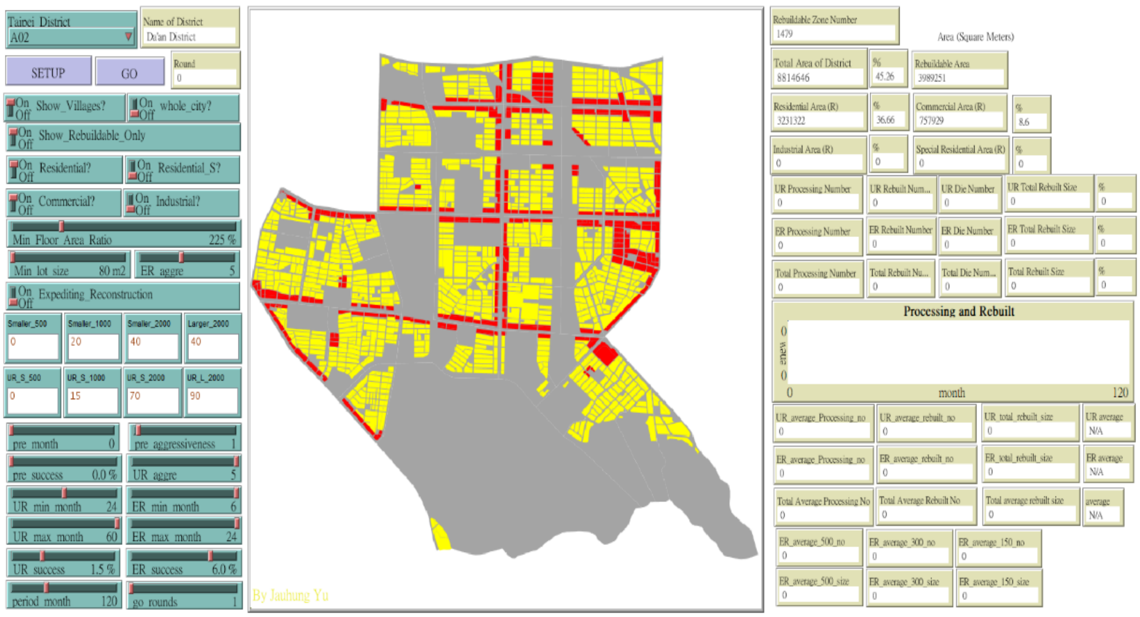

Figure 2: NetLogo user interface (A02, Daan District, Taipei City)

In each case Z_{case_i}, along with items linked to the GIS database, additional items are also defined: $Z_{i:size}$-representing the zone's area, $Z_{i:Rebuilt\ size}$-urban renewal completed area, $Z_{i:Left\ size}$-pending urban renewal area respectively. This was used as an inspection site when the new urban renewal project was launched.

Different color settings are also set for each type of partition in this interface. During the implementation process, the color depth of the same use area is changed. It is worth noting that the usage area is larger than the proportion of the area occupied by the application case, and the colors of each type of usage area are different, with residential areas in yellow and commercial areas in red. As the proportion of urban renewal cases in the use area increases, the color becomes darker, and the color depth is calculated by $Z_{i:Rebuilt\ size}$ / $Z_{i:size}$.

3.3.2 Legal Description

We begin by creating two sets. The initial set employs *UR_Act* for case construction, named U_{case_i}. The second set employs *ER_Act* for case construction, named $Ecase_i$. Below is an elucidation of the variances resulting from the utilization of these two statutes.

When the *UR_Act* was adopted, the size of the site and the application conditions were stringent, but the incentives provided by the government were also higher, and the maximum allowable floor area was 1.5 times that of the original law. In terms of the area limit of the base, the minimum required area varies according to the difference of each case, and most of them are more than 1000 square meters. The period between the initiation of the case and the approval of the government is also a long time. Generally speaking, it takes at least 2 years from the time the resident wishes to the time when the application is approved. When the operation period exceeds 5 years, it usually means that there is a dispute between residents or a problematic case, and the whole case may have to be replanned.

When utilizing *ER_Act*, restrictions are significantly eased. Primarily, the area limit is removed, allowing *ER_Act* for reconstruction as long as the area is under 500 square meters. Application cases with an area of less than 1,000 square meters also mostly adopt this law. Moreover, the review criteria are relatively lenient, typically resulting in a completion period of 6 to 24 months. Despite the high approval rate for applications, government incentives are lower. The maximum allowable floor area increase is capped at 1.3 times the original decree.

3.3.3 Urban Renewal Cases are Generated

The focus of this article is the implementation of urban renewal in the region under the implementation of two different laws. The first situation is that *UR_Act* is executed alone, and the second situation is that both *UR_Act* and *ER_Act* are executed in parallel at the same time. We delineate the attributes of these two execution conditions, each spanning a simulation period of *p* months.

When *UR_Act* is performed alone, we use $UR_{positivity}$ to indicate the market's willingness to participate in urban renewal. In this case, the number of cases generated each month is C_i

$$C_i = (i = 1 \dots p;\ Prob\left(UR_{positivity}\right) Z_{no}) \tag{2}$$

When *UR_Act* and *ER_Act* regulations run concurrently, we utilize $ER_{positivity}$ to show the market's willingness in urban renewal. With the expanded availability of *ER_Act*, the application process and complexity are lessened, without any area restrictions, and operation limitations are greatly reduced. Under such circumstances, due to the increase in cases with an area of less than 500 square meters, the number of cases every month is relatively high.

$$C_i = (i = 1 \dots p;\ Prob(ER_{positivity})\, Z_{no}) \quad (3)$$

In the actual environment, each case applying for urban renewal is independent, and it is impossible to determine the probability area size of each case. Therefore, this model observes the base area size and percentage of urban renewal cases in Taipei City based on the data from 2017 to 2021, as the probability of occurrence of urban renewal case base area.

Therefore, when cases occur every month and *UR_Act* performs alone, the case area size will be randomly generated based on the past case status in Taipei City. Among the cases approved by *UR_Act*, 10% is less than 1000 square meters; 45% is between 1000~2000 square meters; 45% is greater than 2000 square meters. After completion, the information will be added to the $Ucase_i$ collection.

If *UR_Act* and *ER_Act* are carried out simultaneously, based on past data from Taipei City, properties with an area less than 80 square meters are all considered exceptions. Hence, the distribution of area sizes in Taipei City's historical data is as follows: less than 500 square meters accounts for approximately 40%, 500 to 1,000 square meters for 20%, 1,000 to 2,000 square meters for another 20%, and over 2,000 square meters for the remaining 20%.

When both *UR_Act* and *ER_Act* regulations are simultaneously enforced, what is the utilization ratio of *UR_Act*? This pertains to historical data. All locations with a base area below 500 square meters will adhere to *ER_Act*. For instances with a base area size ranging from 500 to 1000 square meters, 15% of users will utilize *UR_Act*; for area size between 1000 and 2000 square meters, the usage of *UR_Act* will be 70%; and for size exceeding 2000 square meters, the adoption rate of *UR_Act* will be 90%.

After the data is confirmed, the newly generated cases will be added to the collection of U_{case} or E_{case} depending on the usage laws.

3.3.4 Determine the Success or Failure of the Case

Judging whether a case is successful or not is mainly based on two data, namely the success rate of the case in that month and whether the case operation time exceeds the upper limit of the required period. With *UR_Act*, we designate UR_{sucess} as the success rate variable; with *ER_Act*, we use ER_{sucess}. Every month, each piece of data in the urban update collection will be randomly judged based on the success rate to determine whether the case passes the review in this round. If it cannot pass, but does not exceed the upper limit of the operation period UR_{max} or ER_{max}, the case will be kept until the next month. If unsuccessful and exceeds the operation period limit, the case will be deleted.

3.4 Experimental Design

First, in terms of the experimental design, we focus on a single administrative region as the simulation target. This is done to account for the unique characteristics of each administrative region. Each region may have varying levels of implementation due to their distinct characteristics. Therefore, it is more suitable to compare based on a single region rather than conducting assessments across different regions.

We choose to use A02 Daan District as the target, and the data is taken from Taipei City Urban Planning (2019, December 17). The conditions are set as the minimum floor area ratio must be above 225%, and the zoning category can only be residential or commercial. In A02, for those who meet the above conditions, 1,479 zones can be used for simulated reconstruction, and the total area that can be simulated for reconstruction is 3,989,251 square meters, which accounts for 45.26%.

Secondly, we set the simulation period to 120 months. This is because, as cities grow and develop, the impact of regulations will evolve over time, and regulations may undergo revisions. Thus, the earlier simulation approach is inadequate for evaluating long-term enforcement status. Consequently, considering the current scenario, we establish the *UR_Act* cycle as 24~60 months and the *ER_Act* cycle as 6~24 months.

3.4.1 Setting of the Monthly Success Rate

The simulation of *UR_Act* and *ER_Act* under real circumstances depends not only on the production ratio but also on the difference in case success rates between the two regulations. In cases involving *UR_Act*, the success rate is relatively low due to the low number of applications and the diverse statuses of each case. Conversely, with *ER_Act*, where conditions are simple and no expert review is needed, the success rate is expected to be significantly higher. This study compares various combinations of monthly case success rates: 0.5%, 1%, and 1.5% for *UR_Act*, and 2%, 4%, and 6% for *ER_Act*.

To calculate the expected success rate of an individual case based on monthly approval rates, the formula can be outlined as follows: E represents the case's expected success rate, p denotes the monthly expected success rate, and n signifies the maximum number of months.

$$\boldsymbol{E} = \sum_{x=1}^{n} \boldsymbol{p}^{x}(\mathbf{1}-\boldsymbol{p})^{(x-1)} \tag{4}$$

From the above description, it is evident that implementing both *UR_Act* and *ER_Act* laws simultaneously results in a total of 9 combinations for the success rate of each case. *UR_Act* has a single option, with 3 choices available. As shown in Table 2:

Table 2: Monthly success rate and case success rate

Enforcement	Monthly success rate	The maximum number of months that can be worked	Case success rate
UR_Act	0.5%	60	25.97%
UR_Act	1.0%	60	45.28%
UR_Act	1.5%	60	59.62%
ER_Act	2.0%	24	38.42%
ER_Act	4.0%	24	62.46%
ER_Act	6.0%	24	77.35%

3.4.2 Area allocation ratio

When the *UR_Act* and *ER_Act* regulations are implemented at the same time, changes in regulations and changes in the environment will affect the selection ratio. Therefore, we use the adoption ratio of *UR_Act* for evaluation. In different area ranges, if the usage ratio of *UR_Act* changes, will it have an impact on the overall urban renewal case? To do this, we created 3 additional combinations, as shown in the Table 3 below:

Table 3: Combinations of *UR_Act* and *ER_Act*

Enforcement	<500 m^2	500~1000 m^2	1000~2000 m^2	>2000 m^2
UR_Act	0%	15%	70%	90%
UR_Act + ER_Act	0%	15%	70%	90%
UR_Act + ER_Act	0%	70%	70%	90%
UR_Act + ER_Act	0%	15%	95%	95%

3.4.3 Positivity

The number of urban update cases generated each month is randomly generated. The variable used is $UR_{positivity}$ or $ER_{positivity}$. The randomly generated number is between 0 and the variables. Referring to past data, if *UR_Act* and *ER_Act* are executed at the same time. The variable represented is $ER_{positivity}$, which we set to 5.

However, if there is only a single enforcement *UR_Act*, it is more difficult to judge the case, so for the variables representing the positiveness, we set the range from 2 to 5, and the success rate of the cooperation is 0.5%, 1.0%, and 1.5%, with a total of 12 combinations. Each set of simulations performs 200 rounds.

But if *UR_Act* is executed alone, it will be difficult to determine the occurrence of the case. Therefore, for the variable $UR_{positivity}$ representing "*Positivity*", we set it to 2, 3, 4, and 5. The success rates are set at 0.5%, 1.0% and 1.5%. There are 12 combinations in total. We simulated 200 rounds for each group.

3.4.4 Total number of experiments

The focus of the experiment is the comparison between two execution conditions, including the execution of *UR_Act* alone, and the simultaneous execution of both *UR_Act* and *ER_Act*. Combining the two parameters of success rate and area ratio, it can be seen that there are a total of 27 different sets of experiments. Each group performs 200 rounds.

Including the variations in "*Postivity*", there are a total of 39 different combinations in this study. Each set of simulations runs for 200 rounds, generating a total of 8,800 experimental data points. The outcomes are then observed and assessed based on various combinations and attributes.

4. Experimental results

How to evaluate whether the implementation of urban renewal is good or bad, the evaluation criterion is not only the number of successful cases, but also the overall success of the application for approval. Observed items include the total area, the area ratio between *UR_Act* and *ER_Act*, and the average area of *UR_Act*. How the law needs to be designed to achieve the desired goal has become the focus of discussion.

We examine 37 sets of various parameter configurations, success rates, area ratio combinations, and enforcement laws in urban change scenarios. Our goal is to understand how *UR_Act* and *ER_Act* can mitigate conflicts between laws, boost the prevalence of *UR_Act*, and enhance regulatory harmony.

4.1 *UR_Act* executing alone

Table 4: The results of *UR_Act* simulation based on the combination of monthly approval success rate and Positivity

Approval success rate	Positivity	Total number of completions	Average area (m^2)	Total area completed (m^2)
0.5%	2	11.3	2,347	26,425
0.5%	3	15.2	2,349	35,589
0.5%	4	19.5	2,367	46,116
0.5%	5	23.8	2,360	56,229
1.0%	2	21.6	2,374	51,072
1.0%	3	28.8	2,357	67,663
1.0%	4	35.4	2,374	83,899
1.0%	5	43.1	2,369	102,139
1.5%	2	29.7	2,352	69,893
1.5%	3	40.6	2,355	95,436
1.5%	4	49.0	2,345	114,901
1.5%	5	59.6	2,360	140,725

In Table 4, simulations are performed with *UR_Act* executed alone. As there will be no difference in the legal constraints in the short to medium term, the average size of reconstruction cases will not be affected regardless of the success rate of approvals. However, the degree of positivity represents the degree to which the leading unit promotes urban renewal, and the success rate represents the strictness of the review unit's requirements for the case. Therefore, if the government vigorously promotes urban renewal, the success rate of approval will increase as the positivity increases, leading to an increase in the number of cases.

4.2 Two Laws are Enforced Simultaneously

For the case where the two regulations *UR_Act* and *ER_Act* are executed at the same time. We made 3 different choice types.

In *type 1*, we set the area ratio based on the current situation data from the real world and only make changes in the success rate of the case. The relevant data obtained from the simulation execution are shown in Table 5.

Table 5: Type 1 - simulation results based on monthly success rate combination (dual regulations in parallel)

Approval success rate		Total number of completions		Average area (m^2)		Total area completed (m^2)			Area ratio
UR	ER	UR	ER	UR	ER	UR	ER	Total	UR
0.5%	2.0%	8.0	77.6	2,491	471	19,782	36,522	56,304	35.1%
0.5%	4.0%	8.7	133.2	2,428	471	20,955	62,763	83,718	25.0%
0.5%	6.0%	8.3	171.6	2,405	470	20,027	80,606	100,633	19.9%
1.0%	2.0%	16.0	78.0	2,334	473	36,349	40,005	76,355	47.6%
1.0%	4.0%	15.7	132.9	2,022	471	29,504	67,108	96,612	30.5%
1.0%	6.0%	15.8	173.3	1,943	471	28,211	82,472	110,683	25.5%
1.5%	2.0%	21.8	77.6	2,461	469	53,735	36,416	90,151	59.6%
1.5%	4.0%	21.7	132.0	2,452	473	53,130	62,468	115,597	46.0%
1.5%	6.0%	21.3	171.5	2,455	468	52,383	80,250	132,633	39.5%

We can note that the average areas of *UR_Act* and *ER_Act* will not change due to changes in the approval and success rates. But as the approval success rate increases. When the total number of cases completed increases, the proportion of the total completed area of *UR_Act* will increase significantly.

If you observe the execution status of the two methods, you can find that the completion area ratio is mainly affected by the success rate of *UR_Act*. As long as the success rate of *UR_Act* is low, the proportion of total completed area of all urban renewal projects will be low.

Table 6: Type 2 - pull up *UR_Act* ratio to 70% in area of 500 m^2 to 1000 m^2 (dual regulations in parallel)

Approval success rate		Total number of completions		Average area (m^2)		Total area completed (m^2)			Area ratio
UR	ER	UR	ER	UR	ER	UR	ER	Total	UR
0.5%	2.0%	13.8	64.5	1,776	414	24,544	26,756	51,300	47.8%
0.5%	4.0%	13.9	108.0	1,779	412	24,708	44,447	69,156	35.7%
0.5%	6.0%	13.6	142.5	1,807	418	24,606	59,657	84,263	29.2%
1.0%	2.0%	25.5	64.5	1,854	418	44,938	26,710	71,648	62.7%
1.0%	4.0%	25.9	110.4	1,852	419	44,514	45,865	90,379	49.3%
1.0%	6.0%	25.5	142.2	1,871	425	43,602	59,826	103,428	42.2%
1.5%	2.0%	35.6	64.1	1,800	416	64,043	26,610	90,653	70.6%
1.5%	4.0%	36.0	109.8	1,790	416	64,351	45,668	110,019	58.5%
1.5%	6.0%	35.5	140.8	1,793	413	63,458	58,235	121,693	52.1%

As shown in Table 6. In *type 2*, in order to understand the impact of the proportion of the two ordinances in different area ranges when the two ordinances *UR_Act* and *ER_Act* are implemented at the same time, we increase the usage ratio of *UR_Act* in a small area. The design method is to increase the proportion of *UR_Act* to 70% for cases with an area of 500~1000 square meters. Through the simulation results, it is found that under this adjustment, the total number of *UR_Act* completions increased slightly, but the average completed area decreased. In such a situation, even though the *UR_Act* area ratio increases, the average area completed decreases. For urban renewal, such a change is a bad outcome.

Table 7: Type 3 - the difference between the restrictions of *UR_Act* and *ER_Act* has widened significantly (dual regulations in parallel)

Approval success rate		Total number of completions		Average completed area (m^2)		Total area completed (m^2)			Area ratio
UR	ER	UR	ER	UR	ER	UR	ER	Total	UR
0.5%	2.0%	9.0	73.0	2,615	393	23,516	28,700	52,216	45.0%
0.5%	4.0%	9.5	118.6	2,603	387	24,793	48,402	73,195	33.9%
0.5%	6.0%	9.2	154.4	2,595	388	23,799	63,148	86,947	27.4%
1.0%	2.0%	16.5	69.4	2,200	397	31,722	48,570	80,292	39.5%
1.0%	4.0%	17.3	118.8	2,748	403	44,205	49,296	93,501	47.3%
1.0%	6.0%	16.9	154.0	2,708	397	44,568	61,242	105,811	42.1%
1.5%	2.0%	24.1	68.6	2,614	389	62,901	28,585	91,486	68.8%
1.5%	4.0%	24.0	118.0	2,606	389	62,553	48,925	111,478	56.1%
1.5%	6.0%	23.6	153.1	2,598	390	61,365	62,653	124,018	49.5%

As shown in Table 7. In *type 3*, the purpose is to understand what happens when the difference in proportions between two regulations increases significantly. We aim that when the two regulations *UR_Act* and *ER_Act* are implemented at the same time, the proportion of urban renewal cases using *UR_Act* to handle an area of less than 1,000 square meters will remain unchanged, but the proportion using *UR_Act* to handle an area larger than 1,000 square meters will be significantly increased to 95%. At this time, the total completed area will not be higher than that of *UR_Act* executed alone, but the benefits include that the total number of cases remains at a certain level, while the average completed area of *UR_Act* and its proportion increase.

4.3 Comparison of 3 Types

Based on the data provided, the total area of urban renewal completed by executing *UR_Act* alone is simply affected by the *Positivity* and *success rate*, whereas the average area remains relatively unaffected. However, if cases with a scope of less than 500 square meters can also apply, the two regulations *UR_Act* and *ER_Act* must be implemented at the same time. However, if we hope to promote large-scale urban renewal projects, the project area should be promoted as large as possible. Only in this way can urban renewal comply with the arrangements of the urban plan. Therefore, expanding the selection gap between *UR_Act* and *ER_Act* would be a beneficial decision.

To compare the results of three different conditions when the two regulations *UR_Act* and *ER_Act* are implemented at the same time, we take the proportion of the completed area of the case using *UR_Act* as a consideration, as shown in Figure 3. In comparison, if we want to increase the proportion of the completed area of cases that adopt the *UR_Act* for urban renewal, the best way is to maintain the success rate of cases that adopt the *ER_Act* under a certain limit, but those cases that adopt the *UR_Act* The success rate of cases should be improved.

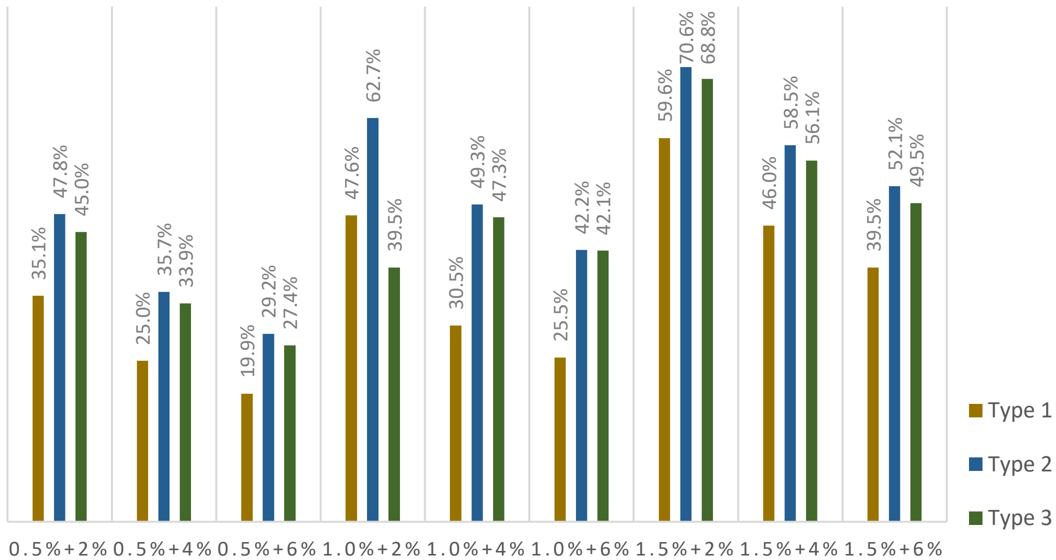

Figure 3: In 3 scenarios, *UR_Act* completion area proportion is utilized

5. Conclusion

5.1 Discussion

By simulating various parameters, this study conducted a total of 37 experiments. The experimental results were collected, and analyzed, and key points of interaction and observation between the two laws were obtained as follows:

1. The number of completed cases is based solely on the success rate and Positivity of the law itself. After selecting different legal provisions, the total number of completed cases will only be affected by the success rate of the selected legal provisions themselves, and the impact between the interactions is not high. If you want to change the law, it usually takes a long time to implement and consider, so it will not be affected by the other party. The *Positivity* of the households arranged by the government and the success rate of the law represent the only reasons for the success.

2. The difference in success rate will affect the area ratio of UR_Act and ER_Act. In formulating long-term urban plans, the Government should aim to develop a large area as a whole and avoid the renewal of small buildings with a single detached as much as possible. This is because a small area of redevelopment can destroy the integrity of the overall usage zoning. When *UR_Act* the implementation of the law, for cases where *UR_Act* is adopted, the norms can be adjusted as much as possible to maximize the success rate, and more observations and restrictions should be made for cases where *ER_Act* is adopted.

3. Widening the gap between the two regulations would be a better option. If we want to increase the number of urban renewal cases on a large scale, the gap between the two laws will inevitably widen. The way to increase it is to make a clear choice of the area requirements between the two. Only *UR_Act* can be selected for large-area cases, and only *ER_Act* can be selected for small-area cases. In this way, there will be no conflict between the laws and regulations, and there will be no hesitation between the two options when the residents negotiate.

Taipei City is an example. The simultaneous implementation of the Taipei City *UR_Act* and *ER_Act* regulations has raised a series of problems because the two have similar goals, principles, and enforcement methods, which can lead to a conflict between the two choices.

5.2 Considerations for Parallel Regulations on Urban Renewal

Firstly, it is important to comprehend the fundamental principles and objectives of *UR_Act* and *ER_Act*. *UR_Act* typically seeks to enhance the urban environment, encourage urban renewal, optimize land use, and foster sustainable urban development. *ER_Act* primarily concentrates on refurbishing and upkeeping hazardous old structures to safeguard residents' safety. Despite both regulations being connected to urban development and enhancement, they differ in their focus and goals.

At present, there is overlap in the implementation of the two ordinances at the same time, and the main problem is that the permissible limits of the two laws are too close. In order to solve this problem, the easiest way is to revert to a single enforcement of the urban renewal ordinance, but at the same time, take into account the reasons why the current residents choose to *ER_Act*, and revise the content of the provisions. This ensures that urban renewal is planned and executed more consistently and in line with the urban plan.

Currently, there are overlapping issues in the simultaneous implementation of the two regulations. The main issue is that the allowable limits of the two laws are too close. To address this, the simplest solution is to revert to a single implementation of urban renewal regulations. However, given the high proportion of residents currently opting for the *ER_Act*, relevant regulations need to be adjusted to ensure consistency in urban renewal planning and execution.

Another approach is to avoid a direct conflict between the two regulations by widening the gap between the two regulations and setting clearer implementation scope and conditions for implementation. For example, in different area ranges, the applicable conditions can be made more explicit. It is also possible to adjust the restrictions of the regulations in different regional environments. By defining the scope of application more precisely, conflicts in implementation can be minimized, allowing for better cooperation between the regulations.

In addition, to enhance implementation efficiency, a dedicated coordination body can be established to oversee the unified planning and execution of urban renewal and the refurbishment of hazardous old structures. This entity can align the interests of all stakeholders and guarantee that the enforcement of the two regulations not only avoids conflicts but also complements each other to attain superior urban development outcomes.

To address the issue of enforcing two regulations simultaneously, whether by reinstating one regulation or increasing the gap between the two restrictions, it is essential to carefully separate cases during formulation and implementation. This will reduce overlap, ensuring smoother case selection and a more balanced implementation.

5.3 Research and Development Proposals

The key to completing urban renewal in urban planning is still determined by the government's legal planning. People's participation and success rate are crucial factors, mainly influenced by the restrictions on the law's content and the feasibility of enforcement. This is a topic that requires the government's special attention.

The decisive factors for the success of the case are mainly divided into two parts, one is the content and restrictions of the law, and the other is the cooperation of the residents. Regardless of the Act chosen, each case varies widely based on factors like size, location, and cost. Future research should focus on building trust among residents.

In addition, since Taipei City is an area with high building density, there is a substantial demand for redevelopment projects. For instance, in Taipei's Daan District, the current urban renewal eligibility spans almost 4 million square meters, while the estimated urban renewal area in 10 years will only be 100,000 square meters. According to the design and implementation of the current law, it is not possible to achieve the desired urban renewal goals. Consequently, exploring alternative approaches will emerge as a key area of future research.

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