Prototyping of A Citizen-oriented Digital Design Regional Planning Tool Enables to Narrow Down Their Rough Idea: A Case Study on the New Station Planning in Susono

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Background

Citizen collaboration is an important issue in regional management work, especially in cases of land readjustment projects or urban redevelopment projects as it is necessary to reach an agreement with the opinion of inhabitants. Estimating the budget of projects is also a significant part in the preproduction phase which may affect whether the project goes ahead or not and when for the financial issues of government. Furthermore, visualization of urban planning has been recognized as a powerful tool for representing the vivid future of urban areas to the public, helping the public to participate in urban planning. Automated urban design has been widely studied and implemented for engineering designs in order to quickly explore different design possibilities so that the designers could have a comprehensive overview and understanding of different design choices through their interaction with the computing tool. However, those tools are all focus only on the morphology of urban structure and mainly used for urban designers, therefore implemented based on professional designing software.

Methodology

Form generation pattern

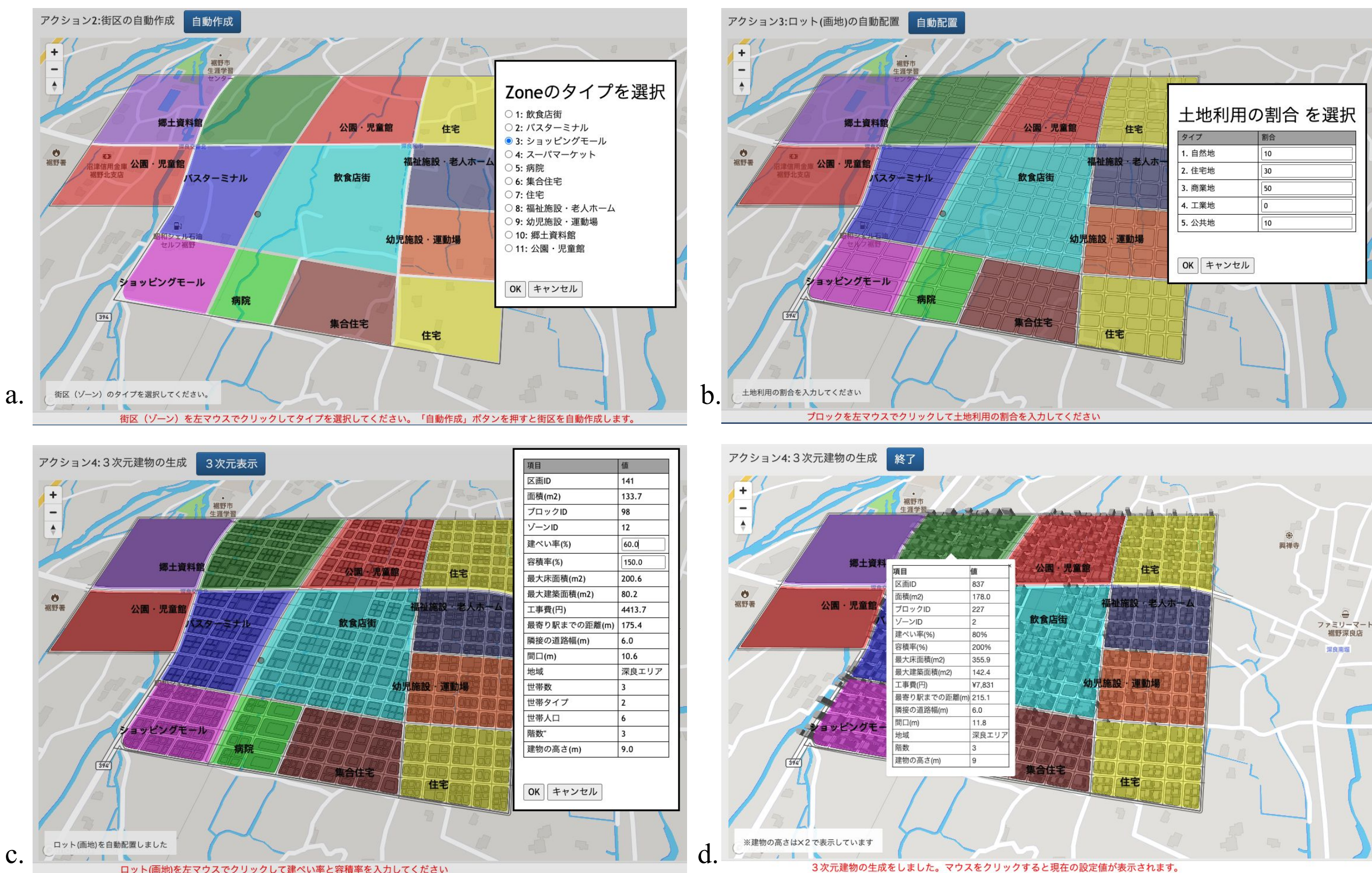| Action & Patterns		Description
Inputting basic information		
Regional data	Current land use	From Urban Planning Basic Investigation.
	Current road network	Labeled with hierarchy and width.
	Current building	From Urban Planning Basic Investigation.
	Nature and water system	From Urban Planning Basic Investigation.
Project data	Redline	From regional master plan.
	Conservation area	Decided by regional manager.
Creating zones		
AddAxis		Create axes from the midline of reserved road.
OrthogonalAxis		Calculate axes that perpendicular to a selected axis and pass-through reference points.
GridToCell		Insert the cells as polygon by inverting from the area of axes offset with the width
Creating Blocks		
MainAxis		Choose the main axis from two option:1. the LongerLine; 2, one of lines closer to north-south orientation
AddAxis		Generates a grid of axes considering the block dimension. Offset new axes until a grid is completely filled
GridToCell		Insert the cells as polygon by inverting from the area of axes offset with the width.
Lots subdivision(Dahal & Chow,2014)		
ShortAxis		The short axis of block's minimum bounding rectangle is divided by 2.
LongAxis		The long axis of block's minimum bounding rectangle is divided by user-assigned value of lot width.
Creating 3D building		
BuildShape		Scaling the lot polygon with the middle of the feature as anchor and used BCR as the scale.
AddHeight		Creating cuboid based on building shape with the height of each building.

Future land use simulation model

In each land use zone, 5 types of land use are randomly distributed based on the ratio from the result of land use composition analysis in the existing urbanization promotion area. The used building coverage area(u_BCA_i) and used floor area(u_FA_i) in lot i will be calculated as the product of lot area(A_i), permitted BCR/FAR, and the parameter(α/β) with the meaning of utilization rate of building :

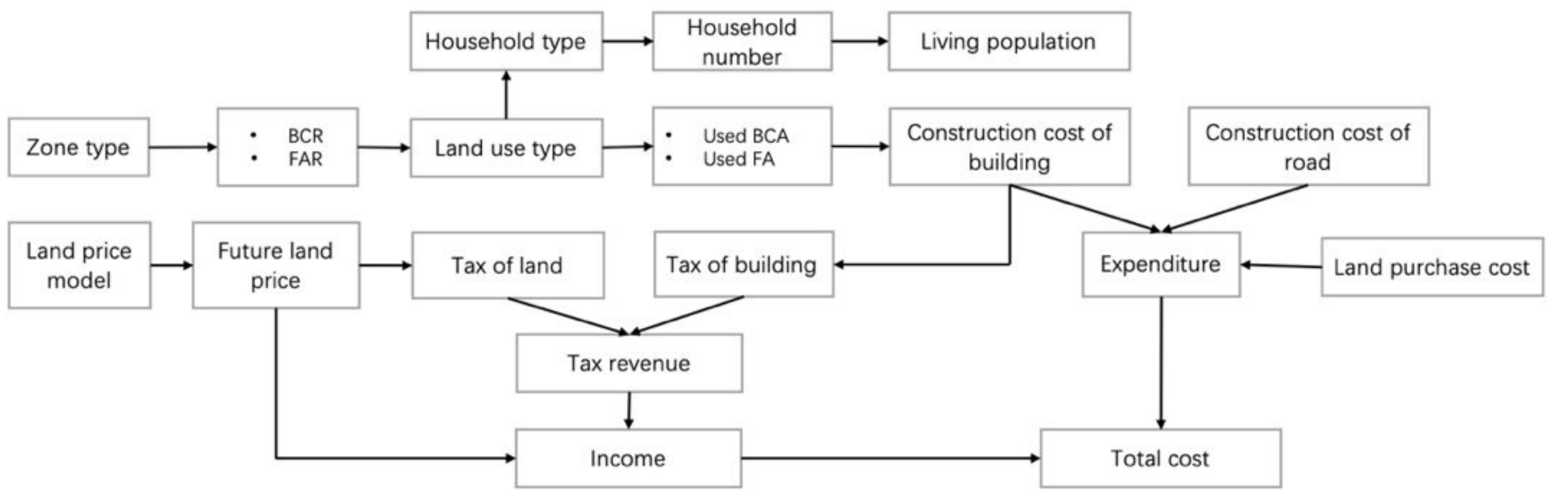$$u\_BCA_i = \alpha * A_i * BCR_i \qquad u\_FA_i = \beta * A_i * FAR_i$$
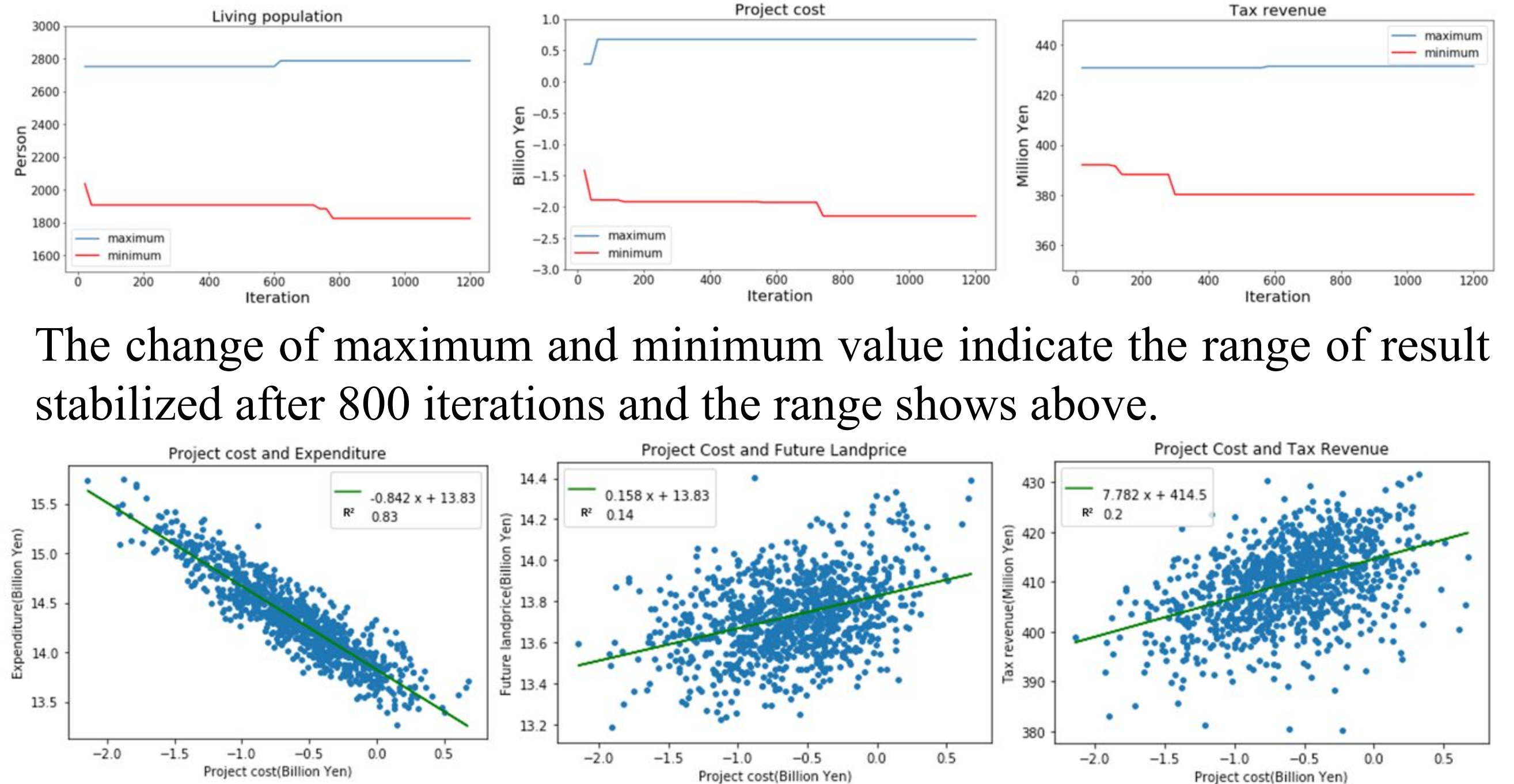
Cost & effect calculation

The building construction cost is calculated by the unit construction price of building from the 'Building Starts Survey' and a correction parameter. The current unit land price is estimated from the 'Real Estate Transaction-price Search Data'. The future land price is estimated based on a land price estimation model. We created a multi linear regression model using the 'Real Estate Transaction-price Search Data' for 10 years(2009-2019).

Future population model

Future living population is simulated based on the population-household type aggregation data and living space data from the "Population Census Survey" in 2012. In this step, lots are divided into the residential part and non-residential part. We assume citizens only live in residential land. For those lots in residential use, 7 types of households are randomly distributed based on the ratio from the census.

Result

The interface of the prototype

Cost & effect calculation

The change of maximum and minimum value indicate the range of result stabilized after 800 iterations and the range shows above.

The project cost highly depends on the volume of the public-use building. On the other hand, there is no significant correlation between the project cost and the tax revenue.

A web-based prototype of a citizen-oriented digital design regional planning tool is proposed to narrow down the rough idea of regional managers. The tool contains a generation pattern to create the future urban form and 3D model based on user-designed parameters as well as a calculation pattern to export the project budget at the same time.