# Integrated Planning Support System for low-income Housing [IPSS]

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## *Integriertes Planungs-Hilfssystem für Soziale Wohnungen - Zusammenfassung*

*Dieser Artikel berichtet über die Erforschung der Datenanforderungen für ein computergestütztes Online-System zur Unterstützung von bewohnerbeteiligten Wohnungsstrategien in Chile, sog. progressiver Wohnungsbau. Das IPSS-Projekt (Integrated Planning Support System) beabsichtigt, die Benutzer-BewohnerInnen mittels einer integrativen Kombination von Informations- und Kommunikations-Systemeinrichtungen in der Planung ihres Zuhauses zu unterstützen. Weiterhin wird das IPSS-Projekt die Automatisierung für norm-angepasste räumliche Konfiguration, schnelle Generation der Designdarstellungen und Kostenberechnung einbeziehen. Ziel ist die Bereitstellung logistischer Unterstützung von IT zur Planung der Wohnungsvergrösserung auf eine nicht-zwingende Weise, d.h. die Vielfalt der Entwurfslösungen zu bewahren, die durch die Ideen und eigenen Vorlieben des Bewohners hervorgebracht werden.*
*Unterstützung auf Computerbasis erlaubt im Wesentlichen, die räumliche, funktionale und konstruktive Wohnungsqualität verbessern zu helfen, sowie kosten-effizientere Wohnungslösungen.*
*Das IPSS stellt eine Sammlung von Modulen zur Unterstützung von: (1) Erfassung und Verwaltung von alphanumerischen und räumlichen wohnungsplanungs-relevanten Daten, (2) vorläufigem Entwurf und Kostenberechnung und (3) Zusammenarbeit zwischen Spezialisten und Kommunikation mit den Benutzer-BewohnerInnen für fachgerechte Beratung.*
*Der IPSS-Zugang wird mittels Internet o. ä. Kommunikations-Netzwerken geschaffen, was in einer späteren Entwicklungsphase die Implementierung mobiler Zugänge (Terminals) für die Benutzer-BewohnerInnen bedeutet. Die nächsten Seiten beschreiben kurz das Anwendungs-Scenario für das IPSS, die physischen Komponenten des progressiven Wohnungssystems in Chile, die logischen Komponenten vom IPSS und die Datenanforderungen des Systems. Die Systemanalyse ist nach einem top-down Prozess organisiert, entsprechend der Strukturierten Systemanalyse-Methoden.*

*Stichworte: progressiver Wohnungsbau, Benutzer-BewohnerIn, bewohnerbeteiligter Wohnungsbau, Territoriales Informationssystem (TIS).*

## *Sistema Integrado de Apoyo a la Planificación de vivienda de interés social - Resumen*

*El presente artículo reporta sobre la investigación de los requerimientos de datos de un sistema computarizado en línea para apoyar las estrategias de vivienda participativa en Chile, denominadas vivienda progresiva. El proyecto IPSS (Integrated Planning Support System) intenta apoyar a la usuario-habitante a planificar su hogar, a través de una combinación integradora de medios de sistemas de información y de comunicación. El proyecto IPSS automatizará procesos para configuraciones espaciales norma-adaptadas, generación rápida de representaciones del diseño y cálculo de costos. El objetivo es proveer apoyo logístico de la TI para planificar, de forma no imperativa, la ampliación de la vivienda, preservando así la diversidad de soluciones de diseño generada por las propias ideas y preferencias de las habitantes. El apoyo computacional permite esencialmente, ayudar a mejorar la calidad espacial, funcional y constructiva, así como soluciones habitacionales eficientes en su costo.*
*Consecuentemente, el IPSS propone un conjunto de módulos que apoyan: (1) la captura y administración de datos alfanuméricos y espaciales relativos a la planificación de la vivienda, (2) diseño preliminar y cálculo de costos, y (3) el trabajo colaborativo entre especialistas y la comunicación con la usuario-habitante para consultoría profesional.*
*El acceso al IPSS se llevaría a cabo mediante la internet u otra red de comunicaciones similar, lo cual significará, para una etapa posterior de desarrollo, implementar accesos móviles (terminales) para las usuario-habitantes. Las siguientes páginas describen brevemente el escenario de operación para el IPSS, los componentes físicos del sistema de vivienda progresiva en Chile, los componentes lógicos del IPSS y los requerimientos de datos del sistema. El análisis del sistema está organizado siguiendo un proceso top-down, según el método de análisis estructurado de sistemas.*

*terminología: vivienda progresiva, usuario-habitante, vivienda participativa, Sistema de Información Territorial (SIT).*

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*Abstract*

*This article will report on the research for the data requirements of a computer-based online system to support user-involved housing strategies in Chile called progressive housing. The IPSS (Integrated Planning Support System) project intends to support the user-dweller in planning her home by means of an integrative combination of information and communicaton system facilities.*
*Furthermore, the IPSS project will process automation for norm-adapted spatial configuration, rapid generation of design representations, and cost calculation. The goal is to provide logistical support of IT for planning the dwelling expansion in a non-mandatory manner, i.e. preserving the design solutions diversity brought by the dweller's ideas and own preferences. Computer-based support allows, in principle, to help improving spatial, functional and constructive quality, as well cost-efficient dwelling solutions.*
*In addition, IPSS sets in place a collection of modules that support: (1) acquisition and management of alphanumeric and spatial housing's planning-relevant data, (2) preliminary design and cost calculation, and (3) collaborative work between specialists and communication with the user-dweller for professional consulting.*
*The IPSS access is accomplished by means of the internet or similar communications network, which will at later stages of development implement mobile accesses (terminals) for user-dwellers.*
*The next pages will briefly describe the scenario of operation for the IPSS, the physical components of the progressive housing system in Chile, the logical components of IPSS, and data requirements of the system. The system analysis is organized following a top-down process, according to the structured systems analysis methodologies.*

*keywords: progressive housing/dwelling, user-dweller, user-involved housing, Territorial Information System (TIS).*

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## Introduction

Already in 1962 N. John Habraken [1] proposes to understand dwelling solutions as processes instead of as products. As a matter of fact, the housing can be comprehended as a system that merges various logical components such as the prospecting, the planning, the design, the production, the provision, the lodging and the dwelling's administration.

"On the other hand, if we understand the housing not as a *closed good*, but as a *collection of goods, services and conditions* that address differentiated needs, it is possible to conceive it according to diverse components that can be at different levels of lacks and that are also possible to correct independently". [2]

The progressive housing system is one of the Chilean state housing programs that has shown increasing positive results in the last decade, in terms of the morphological diversity obtained among the design solutions for low-income housing.
Progressive housing program aims at the poorer low-income families, within the user-involved planning and self-construction

The progressive housing is, basically, an incomplete house that requires to be completed over time, by its own inhabitants depending on their needs and possibilities.
From a social and economic point of view, it assures shelter and property ownership, in a relatively quick manner, causing a decrease in the housing deficit in the population's poorer sectors, due to the very low cost of each dwelling.
From the sociological point of view, it supports the processes of the dweller's identification with her environment, not simply as a habitat, but, instead, individualizing the dwelling to the point that it is understood as home, unlike the sense of homogeneity felt toward most ready-to-use low-income housing developments.
From the architectural point of view, it generates bigger diversity among the dwelling solutions, responding with more flexibility to the family dynamics, and generating new and interesting design alternatives that result from the creativity of their inhabitants.

Although, the progressive housing system presents many logistics problems [3] the new Information and Communication Technology could help solve them.

[1] Habraken N. John; *Supports, an alternative to mass housing*, ed. Architectural Press, London, 1972, ISBN 0 85139 225 3, translated by B. Valkenburg.

[2] Mac Donald, Joan; *Vivienda progresiva (Progressive Housing)*, ed. Corporación de Promoción Universitaria, Santiago de Chile, 1987.

[3] vid. González, L.F.; *IPSS for low-income housing*, tech. report August 2001, http://infar.architektur.uni-weimar.de/ infar/deu/forschung/tech_report/index.html

## Operation scenario

The progressive housing production works - the same as the rest of the housing programs in Chile since 1978 - by means of a combination of public and private sector resources.
This means that the state manages, controls and subsidizes the housing demand, while the private sector is in charge of the housings design and construction, via a variety of operative instruments.

The main difference between the progressive housing program and conventional housing programs, comes from the fact that its planning and construction have to be carried out by the user-dweller. Dwellers purchase a dwelling basic unit that consists of a serviced plot and a so called sanitary unit, which essentially means a bathroom and an adjacent space for laundry. Additionally, a room can be added at the onset.
Furthernore, the main agents involved in the progressive housing's completion system are two: the user-dweller, and the consulting specialists (of the Service of Housing and Urbanism SERVIU, and of the Secretary of Communal Planning SECLAC).

The scenario of operation of the IPSS begins, in temporary and operational terms, when the SERVIU approves the construction of the project for a progressive housing development. Initially, SERVIU calls for public bid of projects and describes a few minimal design standards within the admission terms, e.g. what information is required and the means by which is recorded. The information has to be presented on paper, although almost every architecture bureau works nowadays with computer-based systems. Due to the lack of standards for digital formats of output data, this digital-analog gap is still very difficult to close.

In the IPSS scenario two operative stages are differentiated: (1) one for the acquisition and organizing of all alphanumeric and spatial information, and (2) one for planning (or modification), validation, and construction of each enlargement space. IPSS intends to provide support at both stages by the integrative combination of diverse management and generative tools.

To describe with more detail the operation scenario, it is worthwhile to make reference to the start up in 2002, of a pilot plan called *Territorial Information System* (TIS) by the Chilean ministries of Housing and Urbanism and of National Goods.

It is basically a GIS (Geographic Information System) linked to a large online database, and their main objectives are: (1) to systemize the handling of territorial and urban information within the national system; (2) to identify and to perfect the information required at different levels of decision-making, and their possibilities of construction as datum and of operation as information, and (3) to determine mechanisms by means of which instruments and information that they contain - and on which they are sustained - can be integrated to other databases (censuses, plans of sectoral investment, budgets and national bills, legislative information, statistics, etc.), in order to improve the insertion of the *Territorial Planning Instruments* into the decision-making processes related at all levels with the territorial development. The National Pattern (name for the new data standard planned) is being built as the main instrument, declared as an operative guide to support the production of territorial information.[4] This might be a first step in the standardization of planning-relevant digital data formats. This relevant precedent argues the plausibility of making profitable use of IT-tools, in the field of low-income housing, currently in Chile.

## Progressive planning

The enlargement of a progressive dwelling consists of planning and construction processes, isolated in time and space, where the progressive dwelling becomes piecemeally a home. Spaces are usually planned and built one by one with long intervals of time in between, depending on the space need and economic possibilities of its inhabitants.
This short-term planning system, mainly influenced by economic factors, consistently causes the rethinking of the growth guidelines within the dwelling. Because the user-dweller is unable to have a foreseeable idea about what kind of house her progressive dwelling could become, the IPSS program demands to undertake each design phase with the goal of producing a ready-to-use inhabitable space. Therefore, connection facilities for space, structure, and supply and evacuation systems, between each enlargement become a fundamental issue.

In this sense, we decomposed the progressive dwelling into a collection of physical components in order to get a detailed description.

01. Plot
02. Utilities (supply and evacuation systems)
03. Dwelling Basic Unit (bathroom and / or laundry)
04. Dwelling Expansion Unit

Each one of these components contains specific descriptive data that can be re-combined and used for different planning tasks. Furthermore, planning-relevant external information can be restructured, assigned and considered as an attribute of each existent or new component or subcomponent (smaller parts of a component). The fourth item *Dwelling Expansion Unit* represents the planned space, but even before it is designed, there already are many attributes that can be previously assigned in order to define roughly its shape.

## Logical structure of IPSS

In order to optimize resources, and to enable the user-dweller to access state-of-the-art technology, the IPSS will operate using online transactions methods. Based on a client-server architecture, the system will enable users (dweller and specialists) to interact directly with the computation system via terminals distributed along a communications network. In this sense, the IPSS will be able to support collaborative work between remote-located users (dweller and specialists teams).

We named the IPSS an integrated system, because it assembles a set of IT-tools that share a same relational database. The integrated IT-tools, thought to carry out diverse tasks related with the progressive housing, are based on varied systems like information-, communication-, and computer aided design systems. The design concept for the IPSS is based on the idea of reusing and of re-combining pieces of existent software.

In order to optimize the energy required for each computation process, and to facilitate the system maintenance (software modifications or its replacement) we structure IPSS as a collection of modules. A module is a group of activities and tasks that are carried out to produce a specific group of final products. However, the design of the user interface should present these functionally separated modules as a unified whole.

[4] Sistema de Información Territorial (Territorial Information System) http://www.sit.cl/index.htm

The modules are named (1) data acquisition module, (2) planning module, and (3) consulting module.[5]

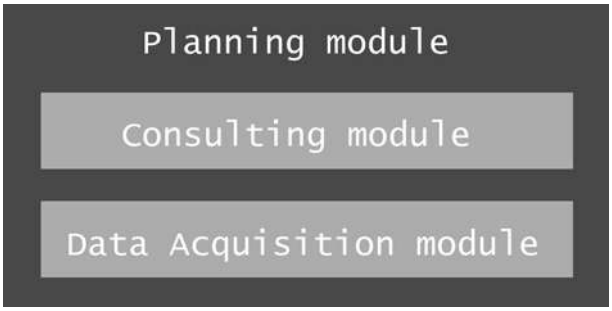


*Fig. 01: Organization of the IPSS modules*

### 1. Data Acquisition module

The module integrates a RDBMS (Relational Data Base Management System) for the indexing and retrieval of all planning-relevant data (alphanumeric and spatial).
The *Data Acquisition module* takes charge of gathering all descriptive data corresponding to a specific settlement of progressive housing, and of creating and maintaining data records for each planning case that be carried out with the support of the IPSS. In this way, the module is capable of retrieving data every time the user requires it during a planning or consulting session. After each session, the module updates the record data. Data relations will be made as the query requires it. A relational data model makes it possible.

The user-dweller has to deal with varied problems that are not only related to the dwelling's design, but also to its modification or reparation. Any information that be required in order to solve these problems - like for example, the graphic description of the water supply system's distribution in the house, or a reparation cost calculation - the *Data Acquisition module* retrieves this information from the database to be displayed by the user interface.

### 2. Planning module

The module attempts to combine diverse functionalities of *generative design systems* and of *decision support systems*. These functionalities address the design and evaluation procedures of spatial and basic constructive solutions.
The processes carried out within the planning module, can be summarized as the online comparison of user's input data with the stored data that coincide with the specific problem, and the immediate display of the outcomes.
The *Planning module* should allow both, interactive design activities, and three-dimensional visualization of the outcomes. Spatial and alphanumeric data, like cost values and technical specifications, should be displayed in an understandable manner.

Currently, we are researching the functional and operative characteristics of existent systems, like: case-based design systems, spatial decision support systems, systems based on shape grammar and AI-based (Artificial Intelligence) expert systems.

This top-level module is actually the one, of the three, that establishes the most direct contact with the user-dweller.

### 3. Consulting module

The module aims at both, the synchronous communication for consulting procedures between the user-dweller and the specialist, and the asynchronous CSCW (Computer Supported Collaborative Work) between specialists. The *Consulting module* will offer multimedia web-based communication techniques, like chating, white-board, and audio-visual communication. The module is in charge of making data interpretation easier. Information exchange between user-dweller and specialist is mainly supported by the fact of being able to refer to a single infographic three-dimensional model, and alphanumeric linked data.
Based on an object-oriented approach, each architectural element is able to display its attributes, in order to obtain more accurate description about the problem.

The *Consulting module* attempts to provide a better communication way between user-dweller and specialists, making easier to expose the ideas and questions of each one. On the other hand, this module conceives the integration of other computer aided planning tools to enable specialists teams to work on specific aspects and other alternatives of design solutions. Indirectly, the *Consulting module* will support approval procedures, and legal formalities for the construction of the user-dweller's design.

Human interaction is necessary to assure the comprehension of the problem, and the preservation of heterogeneity (singularity) of shape of each progressive house.

## System data requirement

When architects design a massive housing project to participate in a public bid, they work with a lot of information. The project's descriptive data can be reorganized into file records together with data that describe construction normative, legally-binding and-use plan, and standard costs as well. These data can efficiently be processed to define the actual framework for planning the house expansion. The definition of this framework can be carried out by automated processing. Aims are norm-adapted and cost-efficient design solutions.

The system input data come from separate sources, and at separate stages in time. We odered the system input data into three main groups:

(1) The descriptive data (planimetry, digital models, and technical specifications) of the whole settlement’s project (plot allotment and urban infrastructure), and of each property type designed (plot, utilities and sanitary unit) are provided by the architects when submitting the project for the bid.

(2) The descriptive data of design normatives (Legally-binding land-use plan) are specified in the Law and General Ordinance of Urbanism and Constructions, and the possible exceptions for the specific urban area are provided by each municipality, when implementing the IPSS. These data are required for programming a submodule of the planning module, that compares these data with the user’s design intentions in order to automatically adapt his design to the norm.

(3) * The descriptive data of the user-dweller are provided by himself any time he accesses the IPSS with the porpose of beginning or continuing planning a dwelling enlargement.

[5] vid. *Modules Functionalities* Table [F]

* The user-dweller data requirements are currently being analyzed.

The user-dweller data can be decomposed into two main groups. One group is oriented to support decisions of sociological order, like e.g. hierarchization of needs, estimation of spacing need in relation to the number and characteristics of the dwelling's occupants, etc. The input method can be carried out by means of multiple choice forms.

The second group of data is oriented to the enlargement's design, namely the shape and the positioning of the enlargement unit. The input method can be carried out by means of 3D-sketching techniques or choosing space configurations from a catalog.**

We first, identified the embedded information in each physical component of the progressive housing system. Then, we made a selection of what data are relevant to the planning, and proposed a preliminary possible description standard of them. [6]

In order to design the data structure, we will base on an object-oriented approach, in which every physical component of the progressive housing system can be decomposed into entities that can be handled as object with specific attributes.

## Conclusions

The IPSS supports, in principle, dweller's facility management, by providing her with the proper tools in order to make optimal use of his own resources, in response to his own needs and preferences.

Many tasks involved in the architectural planning of low-income housing are possible of being supported by automatic processes, as long as we divide them into smaller parts that require less data and less energy to be carried out.

Computer supported planning systems can automatically pre-adapt the design solutions to the norm, so that the user-dweller doesn't have to care about dealing with too specialized and complex information, but at the same time the legality of the project is assured.

This principle can be used in order to improve dwelling quality in several aspects, like implementing, security norms against fire, anti-seismic structure standards, and sanitary norms for well ventilated and sunny rooms.

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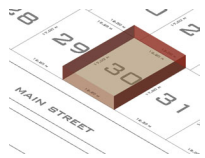
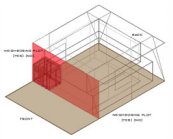
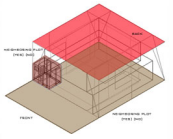
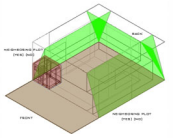
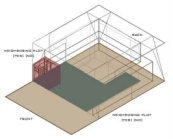
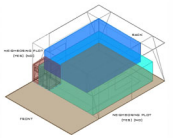
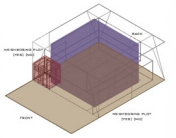
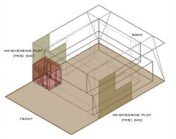
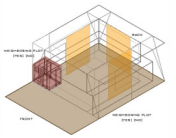
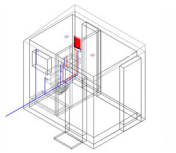
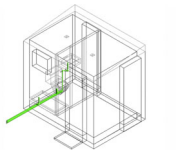
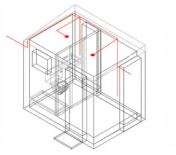
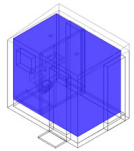
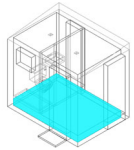
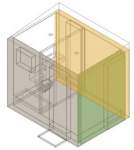
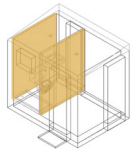
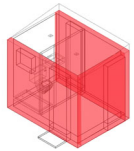
** The input methods for user-dweller data are currently being analyzed.

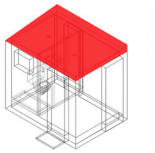
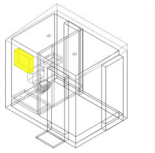
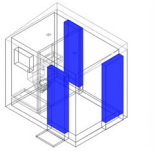
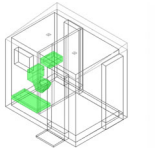
[6] vid. *System Data Requirement* Tables [I] – *Initial Dwelling*, and [E] – *Dwelling Expansion*.

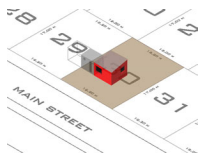
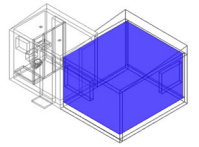
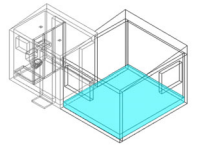
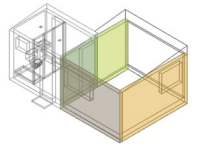
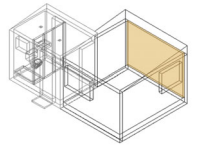
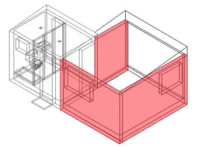
| F | MODULES FUNCTIONALITIES | | | | |
|---|---|---|---|---|---|
| | DATA ACQUISITION MODULE | PLANNING MODULE | | CONSULTING MODULE | |
| MAIN FUNCTIONALITIES | CREATION, MANAGEMENT AND MAINTENANCE OF THE ONLINE DATABASE | ONLINE DESIGN & EVALUATION OF DWELLING SOLUTIONS | | ONLINE COMMUNICATION BETWEEN REMOTE-LOCATED USERS | |
| EXTENDED FUNCTIONALITIES | | IT DESIGNS | IT EVALUATES | SYNCHRONOUS | ASYNCHRONOUS |
| | ALLOWS TO ACCESS THE DATABASE | PRE-ADAPTING THE SHAPE AND ITS POSITIONING TO THE URBAN DESIGN NORMS | CONSTRUCTION COSTS | TEXT MESSAGING | DATA TRANSFER TO EXTERNAL CAD-SYSTEMS AND GIS |
| | SHARES AND INTEGRATES DATA BETWEEN DIFFERENT APPLICATIONS | PRE-ADAPTING THE SHAPE TO MATERIAL DIMENSIONS | GROWTH ALTERNATIVES | VOICE CONVERSATION | |
| | CONTROLS THE SHARED ACCESS TO DATA | PRE-ADAPTING SHAPE TO THE SPACE FUNCTION | PARTI LAYOUT | VIDEO CONVERSATION | |
| | | | SPACING NEED | WHITE-BOARD | |
| | ASSURES THE DATA INTEGRITY | | | 3D VISUALIZATION | |
| USERS | ADMINISTRATOR | DWELLER | | DWELLER AND SPECIALIST | SPECIALISTS TEAM |

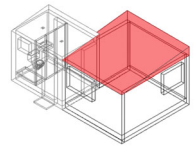
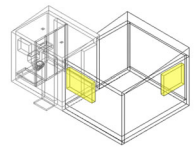
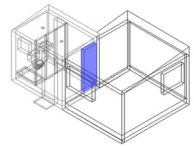
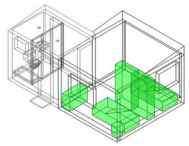
| I | SYSTEM DATA REQUIREMENT – INITIAL DWELLING | | | | |
|---|---|---|---|---|---|
| **PHYSICAL COMPONENT** | **ENTITIES** | **DATA ATTRIBUTE** | **DATA DESCRIPTION** | **DATA CONTENT** | **INFOGRAPHIC MODEL** |
| Plot | Piece of serviced land | Geographic Positioning | Endpoints 3D Coordinates | (X, Y, Z) |  |
| | | Property Lines | 3D Polyline | (X, Y, Z) | |
| | Real estate record | Housing Program to which it belongs | Name | ID Code | |
| | | Settlement to which it belongs | | | |
| | | Block Number | ID Number | ID Code |  |
| | | Plot Number | | | |
| | | Domiciliary Address assigned | Street name, Number | Alphanumeric | |
| | Plot type | Insertion Pattern within the settlement structure | Corner, Middle | ID Code |  |
| | Plot walls | Geometry relative to Property Lines Coordinates | Box | Origin, Length, Height, Thickness | |
| | Legally-binding land-use plan | Land Uses permitted | Dwelling, Commercial premises, Workshop, Entrepreneurial. | ID Code |  |
| | | Clustering System | Continuous, Paired, Isolated | ID Code | |
| | | Official Line | Line | (X, Y, Z) | |
| | | Building Line | 2D Surface (vertical) | Origin, Length, Width |  |
| | | Maximum Height of the building | 2D Surface (horizontal) | Origin, Length, Width | |
| | | Distance Space between buildings<br>*Wall height and openings related* | 2D Surfaces (vertical) | Origin, Length, Width |  |
| | | Shadow Grade Lines | 2D Surfaces (inclined) | Origin, Length, Width, Inclination Angle | |

| | | | | | |
|---|---|---|---|---|---|
| | | Site Occupancy Index<br>*Number x plot surface = max. surface to build at the first floor* | 2D Surface (square horizontal Area at ground level) | Origin, Length, Width |  |
| | | Floor-Space Index<br>*Number x plot surface = max. surface to build at each upper floor* | 2D Surface (square horizontal Area at upper level) | Origin, Length, Width |  |
| | | Cubic Index<br>*Number x plot surface = max. total surface to build on the plot* | 3D Boxes Union (extrude the free-to-build Areas, then add) | Origin, Length, Width, Height | |
| | | Adjacent Surface Index<br>*max. neighbor-adjacent surface per side* | 2D Surfaces (square vertical Area) | Origin, Length, Width |  |
| | | Openings Surface Index<br>*max. windows surface on each neighboring wall regarding to its material and thickness* | 2D Surfaces (square vertical Area) | Origin, Length, Width | |
| Utilities | Water supply system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) |  |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code | |
| | Sewage system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) |  |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code |  |
| | Electricity supply system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) | |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code |  |
| | Gas supply system * | idem | idem | | |

| | | | | | |
|---|---|---|---|---|---|
| Dwelling Basic Unit | Space Function | Bathroom (shower, bathtub)<br>Laundry / Drying Facility<br>Extra Room | Name | ID Code |  |
| | Interior Space | Natural Ventilation Openings<br>*min. windows surface per space on exterior walls* | 2D Surface (square vertical Area) | Origin,<br>Length, Width |  |
| | | Air Volume<br>*min. interior space air volume* | Box | Origin,<br>Length,<br>Width, Height | |
| | Floor | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Box | Length,<br>Width,<br>Thickness | |
| | | Materiality | Description text | ID Code |  |
| | Walls | Neighboring wall, interior wall, exterior wall | Name | ID Code | |
| | | Structural or Non-Structural | Name | ID Code | |
| | | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Box | Length,<br>Height,<br>Thickness | |
| | | Materiality | Description text | ID Code | |
| | Roof | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Wedge | Length,<br>Width, Height | |
| | | Direction of Water's Gradient | Rotation Angle of wedge about the Z axis | Angle | |
| | | Materiality | Description text | ID Code | |
| | Windows | Position<br>*Wall's coordinate system* | 3D Coordinates | (X, Y, Z) | |

| | | | | | |
|---|---|---|---|---|---|
| | | Geometry | Box | Length,<br>Height,<br>Thickness |  |
| | | Materiality | Description text | ID Code | |
| | Doors | Position<br>*Wall's coordinate system* | 3D Coordinates | (X, Y, Z) | |
| | | Geometry | Box | Length,<br>Height,<br>Thickness |  |
| | | Materiality | Description text | ID Code | |
| | Furniture / Devices | Bed (couple, single)<br>Closet<br>Lavatory<br>Bathtub<br>Shower<br>WC<br>Oven<br>Refrigerator<br>Dishwasher<br>Couch<br>Dinner Table | Name | ID Code |  |
| | | Position<br>*Floor's coordinate system* | 3D Coordinates | (X, Y, Z) | |
| | | Geometry | Box | Length,<br>Width, Height |  |
| These components correspond to the initial dwelling that the user-dweller buys to the state.<br>* gas utilities depend on the project. | | | | | |

| E | SYSTEM DATA REQUIREMENT – DWELLING EXPANSION | | | | |
|---|---|---|---|---|---|
| **PHYSICAL COMPONENT** | **ENTITIES** | **DATA DESCRIPTION** | **DATA DESCRIPTION** | **DATA CONTENT** | **INFOGRAPHIC MODEL** |
| Dwelling Expansion Unit | Space Function | Bedroom (couple, n° pers.)<br>Bathroom (shower, bathtub)<br>Living-room<br>Kitchen<br>Shop<br>Workshop (type)<br>Terrace | Name | ID Code |  |
| | Interior Space | Natural Ventilation Openings<br>*min. windows surface per space on exterior walls* | 2D Surface (square vertical Area) | Origin, Length, Width |  |
| | | Air Volume<br>*min. interior space air volume* | Box | Origin, Length, Width, Height |  |
| | Floor | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Box | Length, Width, Thickness | |
| | | Materiality | Description text | ID Code | |
| | Walls | Neighboring wall, interior wall, exterior wall | Name | ID Code |  |
| | | Structural or Non-Structural | Name | ID Code | |
| | | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Box | Length, Height, Thickness | |
| | | Materiality | Description text | ID Code | |

| | | | | | |
|---|---|---|---|---|---|
| | Roof | Position<br>*Plot's coordinate system* | 3D Coordinates | (X, Y, Z) |  |
| | | Geometry | Wedge | Length,<br>Width,<br>Height | |
| | | Direction of Water's Gradient | Rotation Angle of wedge about the Z axis | Angle |  |
| | | Materiality | Description text | ID Code | |
| | Windows | Position<br>*Wall's coordinate system* | 3D Coordinates | (X, Y, Z) | |
| | | Geometry | Box | Length,<br>Height,<br>Thickness |  |
| | | Materiality | Description text | ID Code | |
| | Doors | Position<br>*Wall's coordinate system* | 3D Coordinates | (X, Y, Z) | |
| | | Geometry | Box | Length,<br>Height,<br>Thickness |  |
| | | Materiality | Description text | ID Code | |
| | Furniture / Devices | Bed (couple, single)<br>Closet<br>Lavatory<br>Bathtub<br>Shower<br>WC<br>Oven<br>Refrigerator<br>Dishwasher<br>Couch<br>Dinner Table | Name | ID Code | |
| | | Position<br>*Floor's coordinate system* | 3D Coordinates | (X, Y, Z) | |
| | | Geometry | Box | Length,<br>Width,<br>Height | |

| | | | | | |
|---|---|---|---|---|---|
| Utilities | Water supply system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) | |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code | |
| | Sewage system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) | |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code | |
| | Electricity supply system | Pipes Layout (isometric) | 3D Polyline | (X, Y, Z) | |
| | | Fittings | Points | (X, Y, Z) | |
| | | Inlets | | | |
| | | Outlets | | | |
| | | Technical specifications | Description text | ID Code | |
| | Gas supply system * | idem | idem | | |
| * eventually | | | | | |