A STUDY ON CLASSIFICATION OF FACILITY ELEMENTS FOR SUPPORTING PROJECT DEFINITION OF URBAN RENEWAL MEGA PROJECT USING MORPHOLOGICAL BOX METHOD

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ABSTRACT: Urban renewal mega projects consisting of a number of individual projects should be approached from the program level. BIM (Building Information Modeling) can feed information from product models of individual facilities to program management. In order to this end, the projects that are parts of a program have broken down with consistent and integrated manner towards program management. This breakdown including project relations is expressed as PBS (Project Breakdown Structure). Facility breakdown structure that the usage of facility and spatial hierarchy is contemplated was built with morphological box method. Morphological box methods, means to discover and devise morphologies of unbiased, useful and new idea, has extended widely its range of application from space engineering to civil engineering design and architectural design. Data process modeling was designed which is applicable both to geographic information reflecting spatial hierarchy and applicable to BIM reflecting facility breakdown structure. Information on facilities classified according to it is used for economic feasibility analysis on pre-design phase, management in construction phase and facility management in maintenance phase as required. This paper presents a method to define the spatial hierarchy of facilities to support managing urban renewal mega projects at the program level. In order to this end, the project should be classified with a consistent breakdown facility.

Keywords: *Program Management, Morphological Box Method, Classification of Facility, Spatial Hierarchy, Urban Renewal*

1. INTRODUCTION

The urban renewal project of Korea for planning and developing a district including several blocks of houses in marginal conditions has gained popularity since 2002 [1]. There are many cases that more than two projects simultaneously progress at a large-scale site, so the urban renewal project has a property of a mega project [2][3]. The mega project has advantages that satisfy requirements of respective facility groups as well as maximize utilization of the space at the same time by arranging several facility groups complexly [3][4]. The research on development of a urban renewal project management system (i-PgMIS) capable of dealing with detailed and affluent data of various facilities is being progressed, and especially, it was pointed out that visualization is a powerful strategy supporting users under circumstances that the utilization of information is being expanded and complicated [5]. It is the real situation that construction IT such as BIM(Building Information Modeling), etc. is being introduced in a planning level of individual facilities [6].

The spatial hierarchy and characteristic information of facilities from projects was necessitated for applying the created information of BIM to i-PgMIS. However, there were few studies and standardized information of facilities by spatial hierarchy, instead of ordinary information of facilities by law. Therefore, the result of this study may be useful to establish facilities classifications for using visualized project definition of urban renewal project by morphological box method which is one of morphological researches.

The progressive method of this research is as follows.

- Reviews on spatial hierarchy and Morphological Box Method
- Based on Morphological Box Method, building up facility breakdown structure of urban renewal, which reflects spatial hierarchy
- Designing data process modeling to be applied to geographic information reflecting spatial hierarchy and building information modeling.
- Application and evaluation on project definition with visualizing functions of iPgMIS

2. LITERATURES REVIEW

2.1 Morphological box method

Morphological box method, also called 'Zwicky box' in memory of Zwicky who was a space engineer, is one of so called 'morphological researches' whose aim is to interpret not only intrinsic attributes in the structure of physical environment but structural chain mechanism, more abstract concept, among phenomena, behavior and concept [7]. Morphological Box Methods, means to discover and devise morphologies of unbiased, useful and new idea, has extended widely its range of application from space engineering to civil engineering design and architectural design[8]. In 5 steps progresses Morphology, multidimensional matrix box which consists of 'parameter' and 'variation.' Firstly, problems need to be possible to be formulated clearly and concisely[9]. Secondly, all of potential parameters, yet known to be valuable to solve problems, need to be localized to evaluate them. Thirdly, multidimensional Morphological Box has to be constructed which offers all of potential solutions to existing problems. Forth, all solutions in Morphological Box are to be scrutinized and evaluated considering its aims. Fifth, the solutions are able to be used as necessary means to this end by practical validation and verification. Namely, Morphological Box Method is to comprehend intricate problems through in some manner that a final model is developed by choosing variation factors of each criterion through Multidimensional cubed box filled with variation factors in each unit cube, or a criterion element, and evaluating it. Fig.1 demonstrates Three-dimensional configuration spaces. Fig. 2 describes the concept of Morphological box.

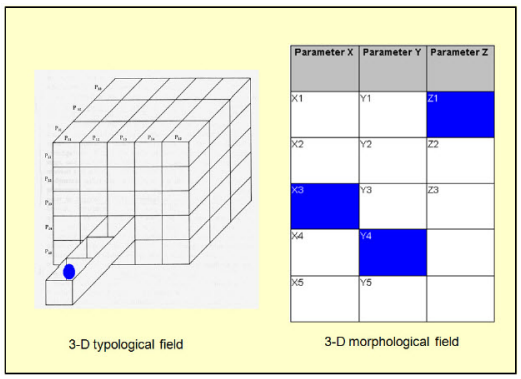

Fig. 1 Three-dimensional configuration spaces [10]

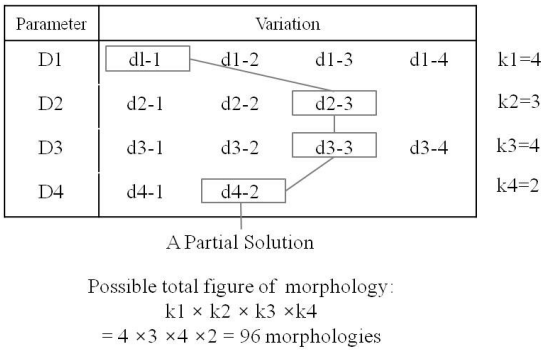

Fig. 2 Concept of Morphological box [9]

2.2 i-PgMIS

A project management system[1] of a program level that manages an entire life cycle of an urban regeneration project, has been developed such as a i-PgMIS(intelligent Program Management Information System) through a part of development on a national R&D projects.

The i-PgMIS can manage several projects being simultaneously progressed at once, and can generate Program Management Information System(PgMIS) on an individual project through the i-PgMIS Creation & Control System. Furthermore, the system can compose menus as a procedure basis that users can define on the basis of various urban renewal laws, so if a user logs in the system, necessary menus are provided. In the i-PgMIS, menus of

[1] Homepage address http://ipgmis.net/

Table1. Definition of fundamental concept of spatial hierarchy

	civic center	secondary central business district	regional center	regional center
functional	Business, Commerce, administration, service, accommodation	International business and commercial service, sub-centers of civic center	Residence, commerce, divisions of secondary central district	Neighborhood unit for dairy life
density,	Area of the densest population	Area of less dense population	Possibly will be able to be denser population area	
financial	Area of the highest value of land	Area of less high value of land		
social	Doing a pivotal role of transportation and commerce	Assisting transportation and commerce of civic center	To need more transfer stations and employment foundations for long-distance commute	Existing centrality, historicity, growth potential, nodal accessibility, balanced regional development, proximity of other zonal center

an integrated system and integrating unit system necessary for project management are being composed of operating expense management, project period management, performance management, documents management, community and visualization-based project definition that are necessary for an urban regeneration project. Especially, visualization-based project definition's module was developed for strengthening of visualization function for preparing construction IT development such as BIM, etc. and helping understanding of participants. If a 3D model was generated through visualization-based project definition in the initial project stage, decision-making of various stakeholders by interfacing information of generated mass and predicting its project expenses and project period. Accordingly, the present research aims to develop classification of facility elements capable of being utilized in case of supporting decision-making through mass generation in the initial project stage.

3. CLASSIFICATION OF FACILITY ELEMENTS

3.1 Definition of fundamental concept of spatial hierarchy

Traditionally, the theoretical basis on urban space structure is based on the central place theory for clarifying ideal distribution of urban scale and function suggested by Walter Christaller. Afterward, the central place theory was developed to an urban system theory by several scholars such as Losch, Barry, etc. While Burgress explains urban regional structure by the theory of concentric circle, he called the central place with the highest centrality compared to other central places as a central business district [11].

On this wise, spatial hierarchy, whose functions depend on spatial level, breaks an urban down into center of a city, a secondary center of the city, regional city and district. Table 1. describes the basic concept of spatial hierarchy.

3.2 Building up facility breakdown structure with morphological box method

Parameter composed 7 items that includes Spatial Hierarchy, function of facility, and utilized 5 topics- Obligational service, Mark of spatial hierarchy level, Service distributed system of spatial facility, Public/private facility, Pleasant/unpleasant Facility- which was suggested by way of urban facility classification at KRISH.

The type of facilities was defined as 6 kinds such as residential facilities, commercial facilities, cultural facilities, business facilities and public facilities by reflecting properties of facility groups through legal consideration.

Based on previous definition, commercial facilities were equivalent to neighborhood facilities, the types of facility can be defined flexibly by morphological box method: civic center(H1)-commercial(F2)-optional (S2)- liner facilities (M2)- providing services to area (D2)- Pleasant facilities (P2). How many configurations are there in a morphological field? This is easy to calculate: simply multiply together the number of conditions each parameter.

3.3 PBS (Project Breakdown Structure)

Table2. Single field configuration of 1728 possible

Parameter	Variation					
Spatial Hierarchy(H)	H1 civic center		H2 secondary central business district		H3 regional center	H4 zonal center
Function of facility (F)	F1 residential	F2 commercial	F3 cultural	F4 business	F5 accommodation	F6 public
Obligational service(S)	S1 obligational		S2 optional			
Mark of spatial hierarchy level(M)	M1 dotty facilities		M2 liner facilities		M3 surfaced facilities	
Service distributed system of spatial facility(D)	D1 providing service to facilities area		D2 providing services to area		D3 providing service to zonal area	
Public/private facility (E)	E1 exceptable		E2 un-exceptable			
Pleasant/unpleasant Facility(P)	P1 unpleasant facilities		P2 pleasant facilities			

The range of program management corresponds to single or multiple complex facility construction project, and the hierarchic relationship among projects is expressed as PBS(Project Breakdown Structure). This research defines the space defined according to a type such as housing facilities, commercial facilities, cultural facilities, business facilities, accommodation facilities and public facilities, by being bound to single facilities or is including definitional function of facilities capable of defining a space type at one facilities. A project can be defined by being bound to individual facilities or multiple facilities.

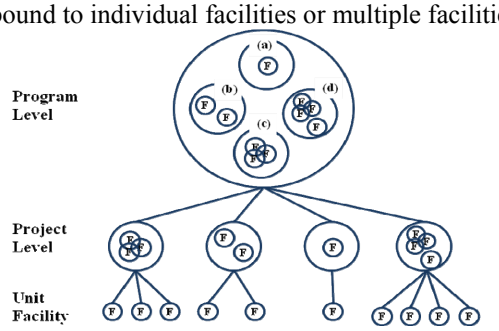

Fig. 4 Schematic drawing of Project breakdown structure

Fig 4 is a picture explaining program management and PBS. (a) is a project that single facilities become one building, and in case of (b), a building formed by two facilities composes one project, and in case of (c), complex facilities composed of multiple facilities at one building consist of one project. In addition, in case of (d), it is a shape composed of a building formed by one facilities in a mixed-use building that multiple facilities are composed to one building.

4. APPLICATION

4.1 Facility breakdown structure built with morphological box method

Project A is located in Cheongnyangri 4th Zone of Seoul, and is composed of residence, offices, sale, culture, accommodation, hotel and department store which are ranged from underground 6th floor to ground 60th floor.

Table 3. Facility abstract

Project	A	B
Image		
Location	Cheongnyangni 4th Zone	Yeoji-dong, Jongro-gu
Site Area	59,889.00m2	26,216.60m2
Gross floor area	594,889.50m2	336,026.12m2
Building-to-land ratio	53.31%	57.21%
Floor space index	994.87%	840.78%
Scale	From underground 6th floor to ground 60th floor	From underground 7th floor to ground 36th floor
Functions	Residence, Business, Officetel , Sale, culture, accommodations, hotel, department store	Residence, Business, Officetel, Sale , cultural assembly
Development type	Urban and residential environment promotion project	Urban renewal project

Project A is planned to include a hotel with a scale of 295 rooms at two buildings of a landmark tower of 50th floor and 46th floor(200m) and include residential towers of 5

buildings of 40th ~56th floor that contain long-term charter and national housing.

Project B includes business and apartment houses ranged from underground 7th floor to ground 36th floor as major facilities in Yeoji-dong, Jongro-gu, and its floor space index is 840.78 as a general commercial region.

Using morphological box method, Project A is categorized as follows: H2(secondary central business district), F1(residential)-F2(commercial)-F3(culture)-F4(business)-F5(accomodation)-F6(public)–S1(obligational)-S2(optional)-M2(dotty facilities)-M3(surfaced facilities)-D2(providing services to area)-E2(un-exceptable).

In the same manner, Project B is categorized as follows: H4(zonal center), F1(residential)-F4(business)-F6(public)-S2(optional)-M2(liner facilities)-M3(surfaced facilities)-D2(providing services to area)-E2(pleasant facilities). Above mentioned facilities, designated as order of rank based on PBS, are defined by grouping into unit or numbers of complex one.

Table 4. Using morphological box method

Parameter	Variation											
	Project A						Project B					
Spatial Hierarchy(H)	H1	H2	H3	H4			H1	H2	H3	H4		
Function of facility(F)	F1	F2	F3	F4	F5	F6	F1	F2	F3	F4	F5	F6
Obligational service(S)	S1	S2					S1	S2				
Mark of spatial hierarchy level(M)	M1	M2	M3				M1	M2	M3			
Service distributed system of spatial facility(D)	D1	D2	D3				D1	D2	D3			
public/private facility (E)	E1	E2					E1	E2				
pleasant/unpleasant Facility(P)	P1	P2					P1	P2				

4.2 Database design considering spatial hierarchy

Two methods are commonly used to support management of facilities data with spatial information: GIS+RDB. In this approach, geographical information system(GIS) is used to model, manipulate and analyze the spatial data, and Relational Database(RDB) is used to handle facilities data. The disadvantage of this method is that the business data and spatial data are maintained separately and it is hard to provide a uniform views to user.

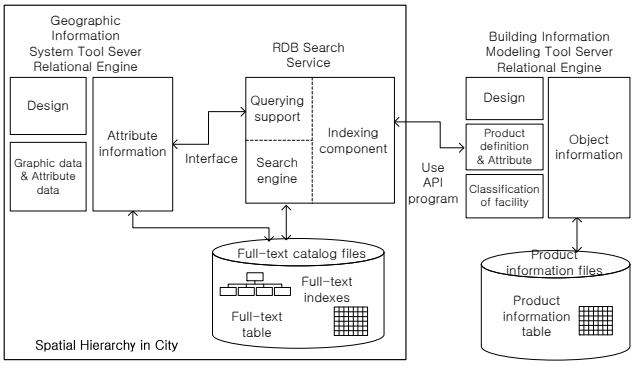

Fig. 5 Design of Data Process Modeling

The spatial hierarchy, as demonstrated in Fig. 5, covers graphic data(point, line, polygon), attribute data(district, rank, interval scale, ratio scale) [12]. Data Process Modeling was designed by applying facility breakdown structure for which morphological box method is integrated with BIM.

4.3 Application and evaluation on project definition with visualizing functions of i-PgMIS

As a result of survey and analysis on project A, in the currently progressing urban regeneration project, the residential facilities, department store, hotel and officetel were major components, and project B could be known that business and residential facilities are major components in one case.

Project A Project B

Fig. 6 Application on project definition with visualizing functions of i-PgMIS

To manage the project, the facility information can be integrated with BIM design information and be used for feasibility study and maintenance. Information on facilities classified according to it is used for economic feasibility analysis on pre-design phase, management in construction phase and facility management in maintenance phase as required. By extension, this can be used to apprehend nation-wide facility information.

5. CONCLUSIONS

On this study, the author obtained following results by constructing spatial hierarchy-based facility breakdown structure available to be applied to iPgMIS. Spatial hierarchy, whose functions depend on spatial level, breaks an urban down into center of a city, a secondary center of the city, regional city and district. The attributes of facility in urban renewal are defined as housing, commercial, cultural, business, accommodation, and public. Facility breakdown structure that the usage of facility and spatial hierarchy is contemplated was built with morphological box method. Data process modeling was designed which is applicable both to geographic information reflecting spatial hierarchy and building information modeling reflecting facility breakdown structure. The author using visualization function, the method was applied to iPgMIS in order to define the project, whose results were found that the information, distribution/properties of facilities, was combinable and compatible.

Morphological box method is not positively necessary to categorize facilities; moreover, some types of facilities capable of being broken down by it may exist. Nevertheless, the application of morphological box method will be promoted to progress future researches more systemically and scientifically given that pertinent criteria and factors are consistently considered by using it to find practical factors in order to comprehend certain facilities' attributes.

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REFERENCES

[1] Kim, H. A. "Approach to Expand the Role of the Private Sector in Mega Projects." Construction and Economy Research Institute of Korea, 2007

[2] Bent Flyvbjerg et., al, "Megaprojects and Risk", Cambridge University Press, 2003

[3] Choi HyeMi, Lee SungBok, Kim JuHyun, "Development of Program Management Information Systems for Urban Renewal", LH Journal, vol.1 no.1, 2010

[4] Kim, J. H., Y, J. Y., Kim, K. H., Kim, J. J., "A Conceptual Model of Intelligent Program Management Information System(iPMIS) for Urban Renewal Mega Projects in Korea", Journal of Asian Architecture and Building Engineering, pp. 57-64, 2009

[5] Frank, H. J., and Drosdol, J., "Information and knowledge visualization in development and use of a Management Information System (MIS) for DaimlerChrysler - A visualized dialogue and participation process", Knowledge and Information Visualization: Searching for Synergies, vol. 3426, pp.364-384, 2005

[6] Eastman, C. M., Teicholz, P., Sacks, R., and Liston, K. "BIM handbook : a guide to building information modeling for owners, managers, designers, engineers, and contractors", Hoboken, New Jersey: Wiley, 2008

[7] Sin Ki Chul, "An Inquiry into the Architecture of the Spatial City: On a Typological Definition and a Morphological Design of Railroad Stations", The Journal of Korea Planners Association, vol. 31 no. 6, p.107, 1996

[8] Sohn Sei-Kwan, Han Ki-jung, "A Study on the Research Methods of Typomorphology", Journal of the Architectural Institute of Korea Planning & Design, vol.12 no.6, pp.73-83, 1996

[9] Fritz Zwicky, "Discovery, Invention, Research – Though the Morphological Approach, Toronto, The Macmillan cp., pp.107-108, 1969

[10] Tom Ritchey, "Modelling Complex Socio-Technical Systems Using Morphological Analysis", 2002

[11] Kim JongYoon, Kim HyunSu, "A Study on the Functional Characteristics of Large-scale Mixed-use Complex", The Journal of Korea Planners Association, vol.45 no.2, pp.149-163, 2010

[12] Oh GyuSik & Jung SeungHyeon, "GIS for Urban Spatial Analysis", Hanul, Seoul, p.50, 2011