

# A Study on the Development of App Ecosystem based Smart Home

Junsik Moon and Chan Young Park

Department of Architecture, Seoul National University, Seoul, Korea

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**Abstract** Smart Home has achieved remarkable developments over the past few decades. In the ICT (Information and Communications Technology) field, ‘app ecosystem’—a collection of multiple devices such as mobile phones and tablets, software (operating system and development tools), companies (manufacturers, carriers, app-stores, etc.) and the process through which data is transferred/shared by a user from one device to another device or by the device itself—has come into wide use since the advent of the smart phone. Due to the synergy effect of the ‘app ecosystem’, it has been applied to various fields such as televisions and automobile industries. As a result, both the Smart TV and connected vehicle have developed their own ecosystem. Although much research has been conducted on these two ecosystems, there is a lack of research regarding ‘App Ecosystem based Smart Home’ (AESH). This research focuses on the building scenarios based on ‘Tracking, Analyzing, Imaging, Deciding, and Acting (T.A.I.D.A), a future prediction method process. Rather than taking an approach from the perspective of providing and applying advanced technology for research on building future scenarios, this paper focuses on research from the perspective of architectural planning. As a result, two future scenarios of AESH are suggested.

**Keywords:** Smart Home; App Ecosystem; App Market; Scenario; Home Automation

## 1. INTRODUCTION

Since the introduction of the new concept, Smart Home (Home Automation), in the 1980s, the technology of Smart Home has achieved remarkable development along with Information Communication Technologies (ICT). As a result, the application field and control range of Smart Home have also been broadened.

The outline of the current mobile app ecosystem was completed when Apple first launched iPhone in 2007. A mobile app ecosystem is an organic system that has an interrelationship among applications, app stores, app developers, and manufacturers. The most significant difference between the current app ecosystem and the previous app ecosystem is the openness of app markets, which enables all developers to upload their applications on the market.

The openness of app markets has led an increase in the number and variety of mobile applications. Some applications based on innovative ideas have maximized the efficiency of mobile devices. Due to these features, the app ecosystem has been considered a key factor in the success of the smart phone industry. App ecosystems have spread to other various industries, such as home appliances and automobiles. In recent years, the Smart Home field has also gradually adopted the app ecosystem.

Corresponding Author: Chan Young Park  
Department of Architecture, Seoul National University, Seoul, Korea  
e-mail: pcy8013@hotmail.com

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However, manufacturers, distributors, platform providers, and tele-communication firms are leading the development of the app ecosystem adopted Smart Home while sidelining the architecture field. Even in the academic architectural circle, research on the application of the app ecosystem has rarely been conducted.

Therefore, this research focuses on building scenarios based on future prediction methodologies in terms of architectural planning, taking the requirements of occupants and architectural space relationships into account.

## 2. RESEARCH METHODOLOGY

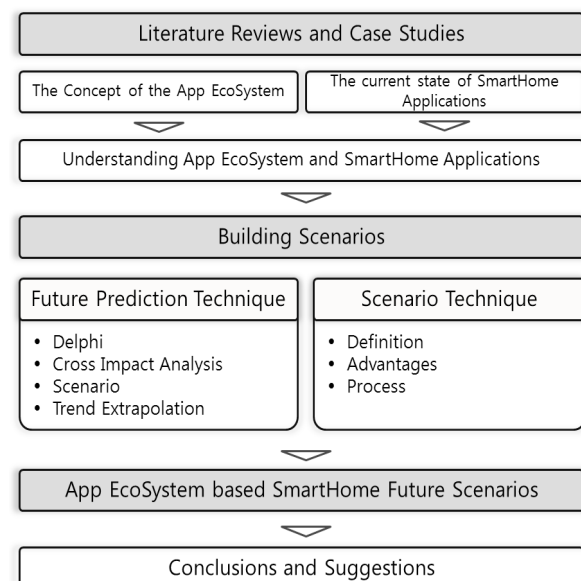


Figure 1. Flow Chart

This research consists of the following three steps. First, the concept and the formation of the app ecosystem are studied through literature reviews. At the same time, the current status of Smart Home applications is also investigated through case study analysis. Secondly, in the case of building scenarios, both future prediction techniques and scenario techniques are considered concurrently. Lastly, future scenarios of Smart Home combined with the app ecosystem are suggested.

### 3. LITERATURE REVIEWS

#### (1) App Ecosystem

The concept of ecosystem used in the business field originated in 1985 to encompass ecological considerations when Michael Porter, Professor at Harvard University introduced the value chain framework in his book, "Competitive Advantage".<sup>1</sup> The concept has evolved over the last twenty years. The current ecosystem is a distributed and innovative system to achieve common goals, productivity and lowered cost through a symbiotic relationship.

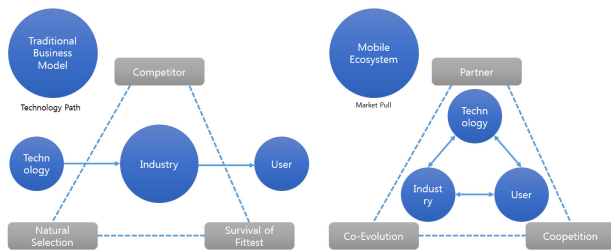


Figure 2. Concept Shift of Ecosystem

Fig. 2 shows the changes from the competition and value flows which are based on the traditional business model to the co-evolution and co-competition which are based on an ecosystem through a symbiotic relationship.<sup>2</sup>

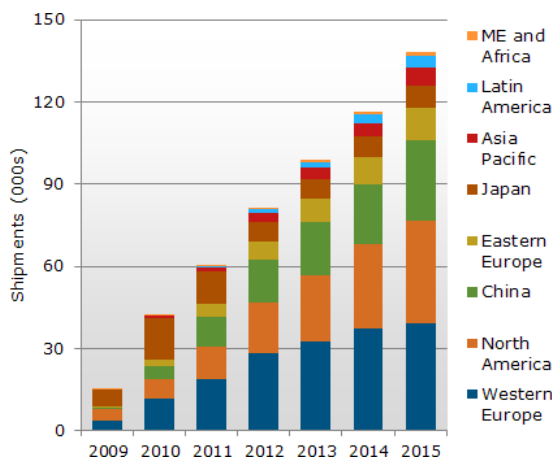


Figure 3. Smart TV Forecast

Since the introduction of the Smart Phone, the industrial

<sup>1</sup> Forte Solutions Group, <http://www.methodframeworks.com/blog/2011/strategic-planning-business-executive-essentials-part-3-12/index.html>

<sup>2</sup> Kwak Jeong-ho, KISDE Research Report, v23, n501, p.27

structure of the mobile tele-communications market has also changed from the value chain to the ecosystem. Typical examples are the cases of Apple and Google. As a result, great influence of mobile tele-communication companies, which have exclusive rights to network and broadband infrastructure, decreased remarkably. A new business model, the mobile app ecosystem, was created as well. The app ecosystem mainly consists of app stores, applications, operators, devices, developers, and customers.

#### (2) The Concept of App Ecosystem

The application of app ecosystem has extended to various industries. One of the representative instances is the Smart TV, also known as Connected TV, which has adopted the app ecosystem. It enables us to download all kinds of contents directly to the TV, such as movies, TV programs, music, and even applications. As a result, the adoption of app ecosystem maximized the efficiency of the current TV. According to Display Search research, by the end of 2015 the number of Smart TVs will exceed five hundred million. Display Search also predicted that in 2015, 35% of 46 inch or larger sized TVs in the US will be Smart TVs.<sup>3</sup>

The app ecosystem has been adopted beyond home appliances like TV to even the automobile industry. Smart Car, also known as Connected Car, allows us access to music, news, communication tools, and games. There are also significant possibilities to improve safety and security.

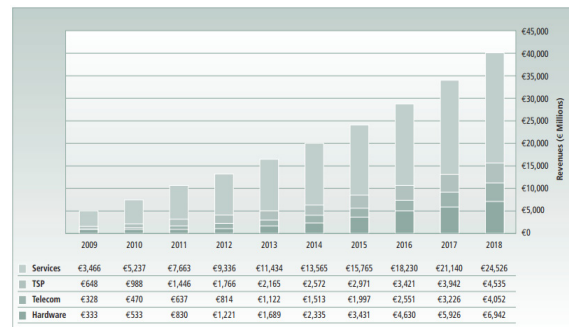


Figure 4. Smart Car Forecast

According to new market forecast as shown in fig. 4 the monetary value of global Smart Car market will increase to €39 billion in 2018, up from €13 billion in 2012. The competition for prior occupation of the market among major car manufacturers such as AUDI, Benz, BMW, GM, Honda and Hyundai is becoming fierce.<sup>4</sup>

#### (3) Sub-conclusion

In summary, the app ecosystem brought the following benefits:

1. The introduction of a countless apps from various third-party developers by opening the market to direct trading without a mobile operator.

<sup>3</sup> Display Search Quarterly TV Design and Features Report [http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xml/110705\\_connected\\_tv\\_shipments\\_to\\_exceed\\_138\\_million\\_units\\_in\\_2015.asp](http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xml/110705_connected_tv_shipments_to_exceed_138_million_units_in_2015.asp)

<sup>4</sup> Group Speciale Mobile Association [http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl\\_ma\\_forecast\\_06\\_13.pdf](http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl_ma_forecast_06_13.pdf)

2. The introduction of diverse, creative and innovative applications as a result of competition among developers.
3. Significant increase in the number of improvements in the multi-use of Smart Phones in the various apps mentioned above.

Therefore, the possible benefits and advantages to Smart Home in the event of app ecosystem adoption are promising.

#### 4. CASE STUDIES

##### (1) Methodology for Case Studies

Currently, the applications for Smart Homes only provide control functions for home appliances and building equipment. Smart Home solution firms tend to provide applications for mobile devices since the number of Smart Phone users is dramatically increasing. Even though these case studies are about the mobile app ecosystem, rather than about the app ecosystem for Smart Home, these results may be used as preliminary data for building scenarios.<sup>5</sup>

Thus the largest app markets in the mobile app ecosystem, Apple's App Store and Google's Play Store, were selected to investigate the current status of applications. Keywords and related links were used to search the apps, and the last date of survey was January 2, 2015. The keywords used were "Smart Architecture", "Smart Home", "IBS" and "Home Automation", and 88 Smart Home apps were found.

##### (2) Results of Case Studies

The analyzed apps were classified under twelve categories according

Table 1. The Building Control Applications of Mobile App Ecosystem

Function	Description	Number of App	Ratio app
Lighting	Power control system (room control)	72	86.7%
Heating and Cooling	Boiler & Air conditioner control system	62	74.7%
CCTV	Security camera control / Check in real time	37	44.6%
Security	Sense of movement, alarm in real time on a mobile device	33	39.8%
Energy	Check energy consumption in specific time or period	32	38.6%
Home Appliance	Control home appliance like TV, Home theater	24	28.9%
Door	Control the door opens and shuts	23	27.7%
Curtain	Control curtain & blinds	20	24.1%
Electricity	Control whole each device power	6	7.2%
Window	Control windows open and shut	6	7.2%
Water	Control whole or each water supply device	3	3.6%
Gardening	Control garden water supply	3	3.6%

<sup>5</sup> Choi, Y. J. et al. (2013), The Basic Study on Future Scenarios of SmartHome Based on the App Ecosystem, Journal of the Architectural Institute of Korea, 29(9), p234

to function. Lighting, heating and cooling functions represented over 70% of apps related to building controls. Most applications provided a simple control function for lighting and indoor temperature. Lighting and temperature can also be automatically controlled through a setting program. In the cases of CCTV camera application, current security companies tend to develop and provide the apps.

##### (3) Compatibility Issues

A key compatibility issue of App Ecosystem based Smart Home (AESH) is home gateway<sup>6</sup>. Most of the investigated apps and Smart Home systems were using their own home gateways or facilities not compatible with other hardware and software. In other words, the devices or facilities from a company only work with its own home gateway. If a consumer wants to use another company's devices, he or she must purchase another home gateway. In case of America, which was the first country to introduce Smart Home, home gateways were naturally standardized from long-established and relatively large companies in America. Big tele-communication companies such as Verizon and cable network firms such as Comcast sell the facilities from one of their subsidiary companies as a package.

##### (4) Sub-conclusion

88 applications that control buildings were available when this research was conducted. Most of the apps were developed in the U.S., followed by Korea, Germany and China. The apps can be categorized into twelve types, with most of the functions related to cooling and heating systems; however, these functions differ by country and housing type, and 83 of the apps were not compatible with each other.

Most Smart Home apps function as simple control, such as switching appliances on or off with a mobile device. There are frequent compatibility problems among facilities and apps due to the standardization of home gateway. Also, mobile devices using Android have produced fragmentation problems for different manufacturers, devices and OS versions.

Due to these problems, generalization and diversification of Smart Home were limited. Nevertheless, there are over 100,000 downloads of apps from big companies including manufacturers, distributors, security companies, platform providers and tele-communication companies. Moreover Korea Telecom (KT), Electronics and Communication Research Institute (ETRI), and home appliances companies in Korea planned the Smart Home field based on the app ecosystem.

The trend will lead apps regarding the steady increase of Smart Home and will be generalized in the near future. In the case of AESH standardization, which has already been researched in different fields, scenarios based on future prediction methods will be suggested in order to foresee the potential problems and establish developmental strategies.

<sup>6</sup> The critical technology, Home gateway, connects between wired & wireless access networks and home networks which provides streaming services, data sharing at home, additional services such as game, education and medical check via network, and functions as a remote controller and home security with a portable information device; it is easy to install, manage and use with security guaranteed.

## 5. FUTURE SCENARIO DEVELOPMENT

### (1) Methods for Studying the Future

There are many types of methods for predicting future factors such as Delphi method, Scenario planning, Cross-impact analysis, and Environmental scanning. The most two commonly used methods are 'Delphi method' and 'Scenario method'. Delphi method utilizes questionnaires of experts to accurately identify the uncertainties of the future. Scenario method describes various future situations with selected factors. The strengths of the scenarios are the following:<sup>7</sup>

1. It can be used as a strong planning tool since it is easy to understand the future.
2. It helps to understand which or how a certain factor affects situations as an effective studying tool.
3. The more uncertain the future is, the more accurate the method is, when compared to other methods.

This study adopted the Scenario method due to high uncertainty for AESH and the future in order to more easily understand or imagine the everyday life of the future.

### (2) Scenario Method and Process

There are various types of scenario methods; however, the fundamental analysis flow is the same. The analysis flow of T.A.I.D.A.<sup>8</sup>, which is one of the most well-known scenario methods, is shown in fig 5.

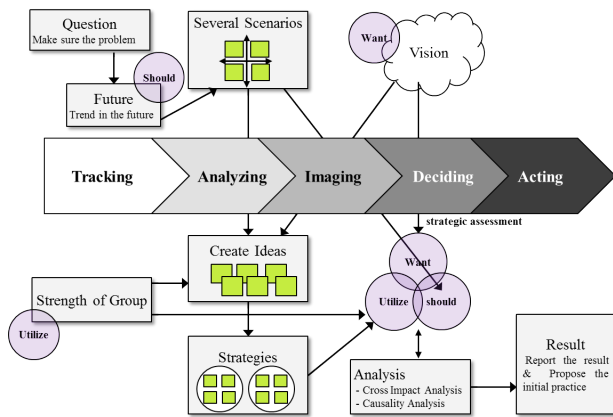


Figure 5. Process of T.A.I.D.A.<sup>9</sup>

<sup>7</sup> Kim, Y. W. and Kim, K. H. (2010) Future of news media. Seoul: Korea Press Foundation

<sup>8</sup> Branded by Kairos Future which is an international research company specializing in foresight

<sup>9</sup> Sohn, Young-Seok, Formulating R&D Strategy for Core Technologies in Ubiquitous Eco City Construction using the T.A.I.D.A Scenario Planning Methods and the Cross Impact Analysis, Journal of Architectural Institute of Korea, v.24 n.11 p147, 2008. Ibid., Choi, Y. J. et al. (2013) The Basic Study on Future Scenarios of SmartHome Based on the App Ecosystem, Journal of the Architectural Institute of Korea, 29(9), p234.

The first stage of T.A.I.D.A., 'Tracking', analyzes the trend of factors regarding present changes which would affect the future. Then, the 'Analyzing' stage classifies the factors which are predicted in the future through trends and analyzes the relationships between factors. The 'Imaging' stage creates a story about the future situation through data analysis after the Analyzing stage. Two scenarios regarding the smart home with the app ecosystem will be generated through the above process.

### (3) Future Scenario

This study suggested future factors and variables related to AESH, and gives shape to situation of the future after analyzing, classifying, and grouping those factors and variables.<sup>10</sup>

#### 1. Tracking - Issues & Current Status

The purpose of this study is to predict changing factors 'incorporated into the app ecosystem' through scenarios. Thus, other successful cases implementing the app ecosystem were reviewed. Smart TV, Smart Phone, and Smart Home were analyzed as notable examples. The references, factors, and variables related to smart TV, issue from the references which are related to app ecosystem based Smart Phone, and Smart Home-related issues are figured out.

#### 2. Analyzing - Factors extraction and grouping

Factors related to the future of AESH from Smart Phone, Smart TV, and Smart Home issues were drawn from related literatures and expert interviews. The factors were grouped.

Three key factors of the future of AESH were 1) Strategy, 2) Technology, and 3) Society. Each of the three key factors can be segmented into more detailed factors.

Key factor "Strategy" is an economical, industrial dimension factor to develop AESH. The strategy is divided into four detailed factors: "Business model for the participants in Smart Home app ecosystem", "Distribution model for app developers, facility firms", "Preoccupation and leading of AESH market", and "Creating a virtuous cycle of Smart Home app ecosystem by lowering the entry barriers and costs".

Key factor "Technology" is the technology to realize AESH. The technology is divided into four detailed factors: "Various high quality contents and killer apps", "Standardization between manufacturers and devices", "Improvements of app UX, design", and "Integrated control of home appliances".

Lastly, key factor "Society" is a social support environment to develop AESH. It is divided into two detailed factors: "Increasing the number of specialists on AESH", and "Relaxation of regulation, laws, system related to AESH".

#### 3. Imaging - Future Scenario Formulation

Each factor extracted in the previous section can be realized in three situations: realization, weak-realization, and un-realization. Then 60,000 possible scenarios can be created since each of the ten detailed factors includes three options.

Future scenario formulation was conducted in the following

<sup>10</sup> Choi, Y. J. et al. (2013) , The Basic Study on Future Scenarios of Smart-Home Based on the App Ecosystem, Journal of the Architectural Institute of Korea, 29(9), p234



steps. Out of sixty thousand plausible scenarios, fifty most viable scenarios were primarily selected and the final five scenarios were chosen through interviews with experts<sup>11</sup> in the secondary selection process.

Then, two most feasible scenarios were selected once again by the experts<sup>12</sup> through a verification process of the five scenarios. The verification process assessed the feasibility of the scenario as well as whether driving factors were successfully reflected in each scenario. The results of the verification are outlined in the tables below. (Table 2, Table 3) In the conclusion stage, factors, which require revision and complementation were deducted and further supplementary work was processed. The final scenario was derived through re-verification stage. Universal factors and detailed factors evaluated by the experts included the following elements. Comprehensively, three key variable factors are strategy, technology and social aspect.

The first universal factor of strategy includes the following four detailed variable factors: revenue model of business participants; distribution model for app developers and facility manufacturers; nation-led preoccupation of the market; virtuous circulation of app ecosystem.

- a. Firstly, it can be anticipated that app ecosystem based smart architecture is likely to have greater correlation with other various fields compared to the currently existing smartphone app ecosystem in terms of revenue model of business participants. Revenue model of business participants can be restricted to brokerage commission model<sup>13</sup>, the main revenue model in smartphone market, and advertisement and third-party model<sup>14</sup>. Furthermore, as there is a greater number of hardware and a larger variety of hardware required in smart architecture unlike the existing smartphone, market in market model<sup>15</sup>, which enables profit creation in affiliation with the hardware market simultaneously within the app market, or device rental model or flat rate model can be applied.
- b. Secondly, unlike the smartphone app ecosystem, it is anticipated that a new distribution model among application developers, device and sensor manufacturers, telecommunications carriers, contents providers and construction firms will be required in terms of distribution model of business participants. The most essential business members were application developers in case of smartphone

and television. The need for various incentives<sup>16</sup> for application developers to create a virtuous cycle in the initial phase of business is just as essential as the provision of a unified and convenient SDK (Software Developing Kit), customized for smart architecture.

- c. Thirdly, nation-led preoccupation in app ecosystem related IT industry is extremely significant when examining cases of Facebook, Twitter and Facebook. Therefore, if South Korea dominates the field of app ecosystem based smart architecture in advance, South Korea will be able to take a more advantageous position compared to other nations and take a leading position in the global market.
- d. Lastly, for the growth of app ecosystem based smart architecture, a virtuous circulation for the app ecosystem of smart architecture must be achieved on the preferential basis. To achieve such purpose, an increase in the number of useful applications followed by an increase in the number of application developers must be fulfilled to enhance the accessibility and entry of users. In the long term perspective, rather a short-term perspective, research and support should be sufficiently made in order to secure killer contents. Furthermore, support for effective and active marketing should be followed.

The second key variable factor of technology is composed of four detailed factors: various contents and killer application; standardization and unified specification; improvement in application, UI and hardware design; integrated control of electronic devices.

- a. Firstly, regarding various contents and killer applications, maintaining certain quality of applications is needed in order to give credibility to the users since smart home app ecosystem is closely related to security and safety of architecture and households. Killer applications that go beyond mere control applications functioning as remote controls are absolutely necessary. Moreover, analysis of user behavior is needed to provide the optimal level of service and user customized service. The highest level of security is also required as the service will be applied to architecture and households.
- b. Secondly, regarding standardization and unified specification, the need for nation-led unification of standard and specification is urgent. Unification of standard and specification enables easy connection of various manufacturers' end instruments to gateway.
- c. Thirdly, various innovative and intuitive UI and hardware design such as multi-touch, finger zoom-out are behind the success of app ecosystem established by Apple through the application market. Accordingly, it is anticipated that the exterior of home servers and end instruments should be appealing in development and maintenance linked with UI in smart architecture app ecosystem.

<sup>11</sup> Interviews with master's degree and doctoral students majoring in architecture and media were conducted twice

<sup>12</sup> Four experts in the field of architecture, interior architecture and digital architecture

<sup>13</sup> Refers to the model in which fixed commission according to the rate of use is distributed to the business owners after acquiring fixed ratio of commission from the app market when the users upload or download the app

<sup>14</sup> Refers to the model in which profit is created through additional service, premium service and advertisements included in the app after providing the app free of charge.

<sup>15</sup> Refers to the model in which sales profit is created in connection with the hardware market within the app market as the number and type of hardware required in smart architecture is large unlike smartphone industry

<sup>16</sup> Incentive can be in the form of distributing profit sharing related to app sales in a larger portion. Environment in which the ideas of developers are actively accepted and approved through regular developer meetings should be created for a more favorable working environment.

d. Lastly, ICT manufacturers are strenuously attending to ecosystem realization through household OS for integration of smart devices and electronic devices within households for integrated control of electronic devices. For revitalization of smart home app ecosystem, compatibility with ICT manufacturers as well as smartification of the architecture itself is an important factor. Compatibility and control of lighting equipment, air conditioning and heating facility control with electronic devices including refrigerators, televisions and rice cookers must be perfectly implemented.

In the last factor of social aspect, there are two detailed factors of expansion of professional human resources and relaxation of related law, system and regulation.

- a. Firstly, demand for experts engaging in diverse fields is likely to increase as smart architecture ecosystem requires a more closely intertwined affiliation with various fields compared to smart phone or television ecosystem. Moreover, the inflow of professional manpower in ICT field is increasing in steps with gradual growth of smart architecture; however, there is a shortage of human resources and educational programs regarding smart architecture in the field of architecture and construction. Courses on smart architecture could be supplemented in environmental facility, architectural planning and design and architectural construction curriculum of universities' departments of architecture and empowerment of professional manpower in smart architecture field are necessary.
- b. Secondly, categories of legislation and regulation applicable to smart architecture is still vague as the field is newly introduced just as smart television. Consequently, policy groundwork and deregulation are much needed for support and revitalization of the related field as the legislation and regulation on smart architecture can also be applied to construction law, communication related law and broadcasting law.

**(4) Scenario 1 – High revitalization of AESH**

"Scenario 1" assumes that all ten detailed factors are realized, and AESH can be highly applied.

Mr. Moon is a public servant working for ' AESH support center' under the Ministry of Trade, Industry and Energy in Korea. He studied architectural design for his bachelor's degree and acquired a Ph.D. for investigating research on AESH. During the holidays, he decided to redecorate the interior of his home which has remained the same over the last years.

He accessed an AESH-exclusive app store, which provides millions of AESH related applications. Then he downloaded the application "Samoo Design for AESH" designed by Samoo Design, a Korean construction design firm. After installing the app, he selected "Featured design of the month" function and got a picture of an open type living room in which the number of walls were minimized. The walls were painted blue and green reflecting the season of July.

Table 2. Failure or success of factors

Key factors	Detailed factors	Fail/Success
Strategy	Business model for the participants in Smart Home app ecosystem	O
	Distribution model for app developers, facility firms	O
	Preoccupation and leading of AESH market	O
	Creating a virtuous cycle of Smart Home app ecosystem by lowering the entry barriers and costs	O
Technology	Various high quality contents and killer apps	O
	Standardization between manufacturers and devices	O
	Improvements of app UX, design	O
	Integrated control of home appliances	O
Society	Increasing the number of specialists on AESH	O
	Relaxation of regulation, laws, system related to AESH	O

When he selected "Change designs" function at the bottom of the screen, the walls in his room started to move slowly with a message appearing instructing him to clean up the furniture in the room. At the same time, the ceiling of the room went up and the blocks of the walls rotated. Instantly, the room changed its color to blue. Within three minutes, the whole structure and atmosphere of his house was completely changed.

His wife works at a company that develops sensors used for AESH. She took part in the development of sensors for AESH. The sensors were very popular as an alternative to scales and game consoles, therefore, her company earned sizable profits and she received a big bonus.

She bought food on the way home for dinner and put them in the refrigerator. Soon after, a text message with the names of the food in refrigerator and their expiration dates were sent to her Smart Phone from the home gateway in their house.

AESH technology will further evolve to configure energy efficient and productive arrangement of the interior design customized for each resident's lifestyle. Moreover, users will be able to control house settings and interior of the house through the app system, which will provide integrated control to minimize use of separate interface. As Asian firms realized the importance of AESH in an earlier stage and partnered to establish a common protocol for smart home devices, they were able to position themselves at the top in the smart home market.

**(5) Scenario 2 – Revitalization of AESH by IT companies**

"Scenario 2" assumes that the following detailed factors are enabled in terms of technology, and does not take views and opinions of the architectural field into account.

Table 3. Failure or success of factors

Key factors	Detailed factors	NA(x)/PA(△)/A(O)*
Strategy	Business model for the participants in Smart Home app ecosystem	△
	Distribution model for app developers, facility firms	△
	Preoccupation and leading of AESH market	X
	Creating a virtuous cycle of Smart Home app ecosystem by lowering the entry barriers and costs	△
Technology	Various high quality contents and killer apps	△
	Standardization between manufacturers and devices	O
	Improvements of app UX, design	O
	Integrated control of home appliances	O
Society	Increasing the number of specialists on AESH	X
	Relaxation of regulation, laws, system related to AESH	△

\*(NA : None Applicable / PA: Partly Applicable / A:Applicable)

An office worker Mr. Moon received Google TV set top box he ordered on the internet a few days ago. As soon as Android OS was installed and configured, a list of home appliances in his house was shown on the screen of the smart TV. A message popped up asking if he wants to interlock them with the device. After selecting the 'Yes' button, a list of all the types of food in the refrigerator with their expiration dates, CCTV screen from the living room, and electricity and gas usage of the last month were displayed on the smart TV screen.

He accessed the "Android@Home" category on Google play store using his smart TV remote control and looked for Smart Home apps that can be used on the Google TV that he purchased. To his disappointment, there were no major additions to the top charts when compared to the last month; apps related to controlling the refrigerator, rice cooker and CCTV have stayed on the top of the app store charts for more than a month.

However, the situation is much better than a few years ago. Not long ago, devices manufactured by different companies, such as Google, MS, Apple, Samsung and LG were not compatible with each other. For example, he bought Smart Home XBOX at a high price; however, it was not compatible with the Samsung fridge and air conditioner in the living room.

After all, XBOX was not only the kid's game console but also a smart home device. His wife works for a company that develops sensors used for Smart Home. She used to complain that demands for Smart Home sensors are not as high as the previous predictions. In these circumstances, it might be more proper to say "Smart appliances of Home" instead of "Smart Home" as only some controllers, such as Home appliances, lights and CCTV are provided by the market.

Nevertheless, as a result of some large IT firms strong marketing strategies based on powerful assets, the number of Smart Home gateway consumer is gradually increasing, and she is also still hopeful that the company's revenue will see a growth sooner or later.

## 6. CONCLUSION

Future forecast scenarios of AESH by using scenario technique among various future forecast techniques were presented. Through literature investigations and present-condition investigations, "Strategy", "Technology" and "Society" were selected as the three key factors which have major impacts on the future of AESH.

First of all, "Strategy" indicates business and industrial strategy for developing AESH and can be subdivided into four detailed factors: "Business model for the participants in Smart Home app ecosystem", "Distribution model for app developers and equipment providers", "Preoccupation and leading of AESH market", and "Creating a virtuous cycle of Smart Home app ecosystem by lowering the entry barriers and costs".

"Technology" refers to the technologies required to implement Smart Home app ecosystem and can be subdivided into "Various high quality contents and killer apps", "Standardization between manufacturers and devices", "Improvements of App UI (User Interface) and design", and "Integrated control for home appliances".

"Society" is the social conditions and support for developing AESH and consists of two detailed factors: "Increasing the number of specialists on AESH" and "Relaxation of regulation, laws, system related to AESH". About fifty scenarios have been drawn in consideration of the previous factors, and the two presented scenarios are regarded as the most practical in light of the opinions of experts.

Further research will build more scenarios dealing with the remaining cases. Counter strategies will also be suggested according to the results of the scenarios. Further discussions are also needed in order to analyze how Smart Home adopted app ecosystem changes the meaning of architecture, human behavior, and the function of buildings beyond mere technology application and utilization.

## REFERENCES

- Kim, Y. W. and Kim, K. H. (2010) Future of news media. Seoul: Korea Press Foundation.
- Riley, M. (2013) Programming your home : automate with Arduino, Android, and your computer. Seoul:Insight
- Ryu, H. S. et al. (2006) Mobile Platform Business. Seoul: Hanbit Biz.
- Huh, J. D. et al. (2010) Technology Trends of Mobile App Store, Electronics and Telecommunications Trends, 25(3), 52-61
- Kim, S. A. and Cho, Y. J. (2008) A Basic Study on the Implementation of Intelligent Spatial Service Scenarios, Journal of the Architectural Institute of Korea, 24(6), 117-124
- Kim, S. M. and Koh, S. J. (2012) The Journal of Korea Information and Communications Society, 29(10), 9-14
- Kwak, J. H. (2011) Communications Policy, 23(2), 26-27
- Choi, Y. J. et al. (2013) The Basic Study on Future Scenarios of SmartHome Based on the App Ecosystem, Journal of the Architectural Institute of Korea, 29(9), 229-240

- Lee, H. R. (2004) *Electronics and Telecommunications Trends*, 19 (5), 71
- Park, H. J. et al. (2013) *KEIT PD Issue Report*, 13(5), 85-102
- Park, J. H. and Shin, K. J. (2012) A Study on the Future Dwelling Functions through Domestic Future House Pavilions, *Journal of the Korean Institute of Interior Design*, 21(2), 3-13
- Park, M. S. (2012) *Communications Policy*, 24(6), 1-29
- Shim S. G. et al. (2012), *Journal of KIISE*, 30(8), 19-25
- Son, Y. S. and Kim, U. (2008) Formulating R&D Strategy for Core Technologies in Ubiquitous Eco City Construction using the T.A.I.D.A Scenario Planning Methods and the Cross Impact Analysis, 24(11), 147
- Yoon, S. S. (2010) *Korean Irrigation and Drainage*, (45), 21  
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