LOGICAL AND SYSTEMATIC GRAND DESIGN OF ROAD MAP FOR SUPER SMART SOCIETY (SOCIETY 5.0) BEYOND INDUSTRY 4.0

= From the perspective of Organizational Design =

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Abstract: According to the promotion of Super Smart Society (so called Society 5.0)[*1] by the Japanese government and Keidanren (Japan Business Federation), Smart Community/City projects are becoming popular, and many cities and communities are challenging this movement. when the government/local authority formulates the grand design of these projects, it becomes common to clarify the necessity of the project and the reason among stakeholders by considering the value created by the project and cost/performance first, and then design a concrete road map including standardization and performance indicators. Under these situation, comprehensive/logical/systematic framework and the deployment of methodology for the grand design of Super Smart Society are indispensable. The aim of this study is to advocate the comprehensive framework and methodology for designing a concrete road map including standardization and KPIs (*K*ey *P*erformance *I*ndicator) for Super Smart Society from the perspective of Organizational Design[*2] focused on Smart Community/City. These framework and methodology are helpful for countries to consider promoting Super Smart Society effectively and efficiently.

Key Word: Industry 4.0, Super Smart Society and Society 5.0, Smart Community/City, Organizational Design, Standardization and KPI

1. Introduction

1-1) Overview of Industry 4.0

With a view to securing the future of Germany as a business location and of its industry,

the implementation strategy for Industry 4.0[*3] has been established by the corporation of various German industrial enterprises in 2011 by utilizing IOT (*I*nternet *o*f *T*hings)[*4] and CPS (*C*yber *P*hysical *S*pace)[*5]. Now Industry 4.0 concept is expanding globally and is having a big impact not only on industry sector but also on education and training sectors. There are four stages of the industrial revolution such as (refer to the Figure 1);

✓ Stage 1: Industry 1.0 (intervention of mechanical production powered by water and steam started the 1st industrial revolution

✓ Stage 2: Industry 2.0 (Mass production with machines powered by electricity and combustion engines. Introduction of assembly lines)

✓ Stage 3: Industry 3.0 (Electronics, IT, and industrial robotics for advanced automation of production processes)

✓ Stage 4: Industry 4.0 (Digital supply chain. Smart manufacturing. Digital products/services, and corresponding business model. Data analytics and action as a core competency)

Figure 1. Development stage of industrial revolution
(from Industry 1.0 to Industry 4.0)
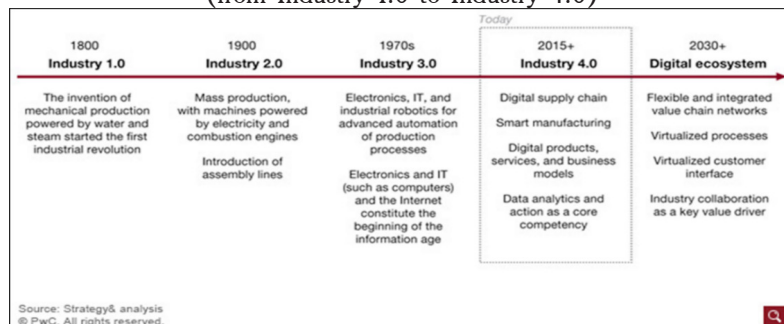
In the view of the famous Boston Consulting Group in the US, Industry 4.0 refers to the convergence and application of nine digital industrial technologies[*6] such as:

- Advanced robotics
- Additive manufacturing like 3-D printer
- AR(augmented reality)

- Simulation
- Horizontal/Vertical integration
- Industrial Internet
- Cloud system
- Cybersecurity and,
- Big Data ,Analytics and AI (*A*rtificial *I*ntelligence)[*7]

Industry 4.0 creates what has been called a **"smart factory[*8] focused on manufacturing sectors"**. Within the modular structured smart factories, CPS monitor physical processes, create a virtual copy of the physical world and make decentralized decisions of factory operation. The collaboration of IOT & CPS can contribute to these impacts in the field of manufacturing :

- Reduced operational costs
- Lower maintenance costs
- Improve decision making
- Higher customer satisfaction, and
- Continuous improvement

1-2)**Overview of Super Smart Society (Society 5.0) in Japan**

In Japan, we are facing natural disasters, socio-economic issues such as:

- Aging population
- Caring for the elderly
- Decrease in tax revenue of local governments due to business failure and/ or withdraw of the local enterprises
- Aging of social infrastructure, and increase the expenses for maintenance
- Less job opportunity in rural areas than big city

Under this situation, Japan has its particular challenges "Super Smart Society: Society 5.0"[*9] which is not just as Industry 4.0 which mainly focuses on the digital transformation of current industry. Society 5.0 including aims to tackle several challenges by going far beyond just the digitalization of the economy and industry, towards the digitalization across all levels of the Japanese community/society and the (digital) transformation of society itself through innovation by utilizing the digital and IT technologies developed by Industry 4.0. Japanese government and local public bodies are challenging to solve these critical socio-economic and industrial issues by utilizing the Society 5.0 concept and framework through the government-private partnership including communities and citizens.

Just as in Industry 4.0 as the fourth industrial revolution, Society 5.0 is also depicted as an evolution in five societal stages advocated by Keidanren [*10] (refer to the Figure 2):

- ✓ Stage 1: Society 1.0 (Hunting society)

- ✓ Stage 2: Society 2.0 (Agrarian society)
- ✓ Stage 3: Society 3.0 (Industrial society)
- ✓ Stage 4: Society 4.0 (Information society)
- ✓ Stage 5: Society 5.0 (Super Smart Society)

Figure 1. Development stage of Social revolution
(from Society 1.0 to Society 5.0) [10]
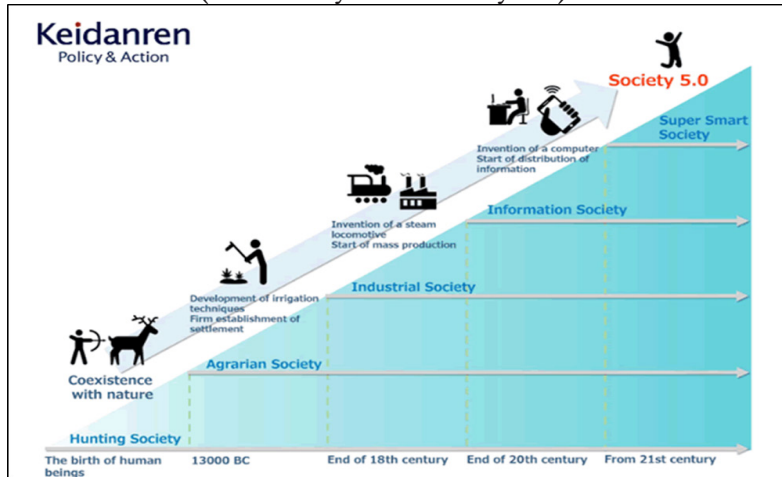
2. Feature, Characteristic and Platform of Society 5.0 in Japan

"Society 5.0" is not just about the digitalization of manufacturing, but digitalization across all levels of the Japanese society to address key social problems/ issues like labor shortage, aging workforce, natural disaster, etc. A major policy for the economy, society and the general public popularly called "Super Smart Society" (Society 5.0) is being strongly promoted by Council for Science, Technology and Innovation; Cabinet Office, Government of Japan. Efforts are now being arranged under government-private partnership and citizens to lead the change in the so-called fourth industrial revolution: Industry 4.0.

The Cabinet Office clarified the policy of Society 5.0 on the "5th Basic Plan (FY 2016-2020) in 20 years after Current Regal Framework of Japan's STI Policy: S & T Basic Law and Basic Plan"[11]. This policy is anticipated to introduce transformational change in an expansive scope of industrial solutions such as manufacturing, logistics, sales, transportation, medical care, finance and public services. This eventually will have effect on people's work and lives by giving them encouragement to realize high quality of life.

According to the 5th Basic Plan, configuration of Super Smart Society service

platform can be used for realizing the goal for Smart Society development: adding new value in the society. The platform of Super Smart Society consists of 20 services as follows (refer to the Figure 3) :

- Energy value chains
- New manufacturing systems
- Regional inclusive care systems
- Infrastructure maintenance and updates
- A society resilient against natural disasters
- New business and services
- Hospitality systems
- Global environment information platform
- Integrated material development system
- Smart manufacturing systems
- Smart good-chain systems
- Intelligent transportation systems
- Advanced security and social implementation
- Utilization of standard data
- Human Resource development
- Regulatory and institutional reform for new services
- Strengthening deployment of information communication platform
- Standardization of interfaces and data format
- Advanced security and social implementation
- Utilizing existing systems for positioning, authentication, etc.

The final destination of Society 5.0 is to realize Human-centric society through these services.

Figure 3. Configuration of Super Smart Society Service Platform[*11].
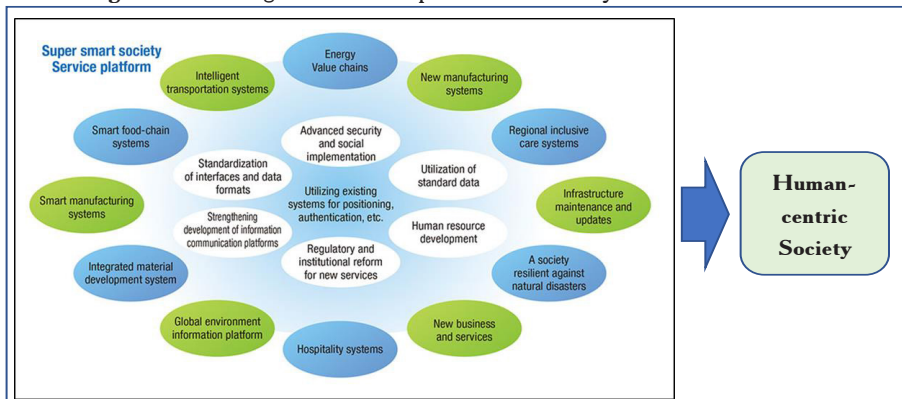
3. Smart Community/City project is the cell tissue of national -level Society 5.0

Under the guidance of the Cabinet Office and the Ministry of Economy, Trade and Industry, the Smart Community / City project is being developed in many areas. The development of an effective Smart Community / City project according to the characteristics of community/city lead to the realization of the Super Smart Society as a total. Smart Community/City project is a community & citizen -based project linking to the movement of Super Smart Society and corresponds to the cell tissue of national -level Society 5. The Figure 4 depicts the development process from Smart City to Super Smart Society through Smart Community such as: ①Organic deployment of Smart City → ②formation of Smart Community → ③organic deployment of Smart Community → ④Super Smart Society: Society5.0.

Figure 4. Development process from Smart City to Super Smart Society through Smart Community
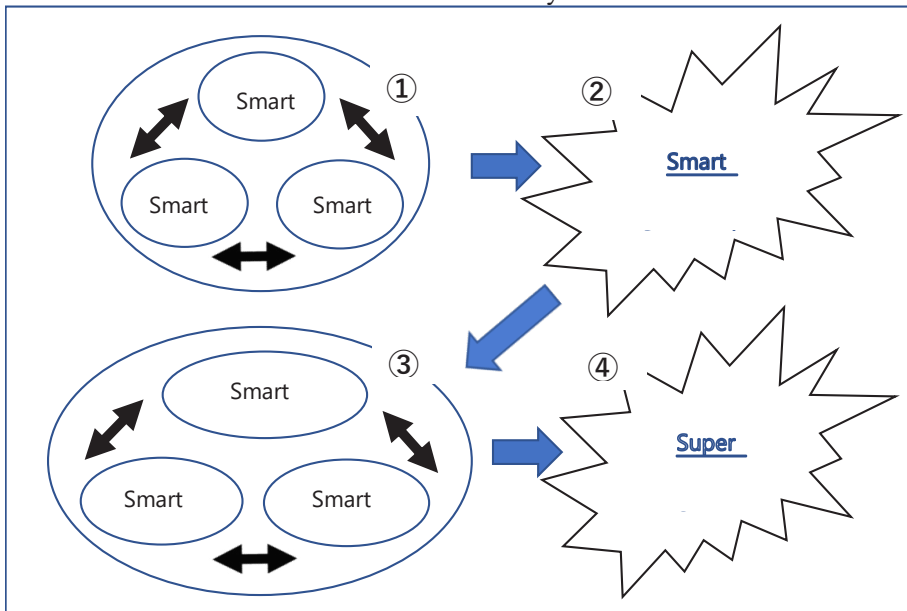
The following seven cases are widely advocated as model cases by the Ministry of Economy, Trade and Industry[*12]. These are characteristic projects due to regional issues and specificities.

    ✓ Case#1. Complex urban area

        1-1. Kashiwanoha Smart City: Electricity interchange by using private-

based electric line.

1-2. Fujisawa sustainable Smart Town: Unique electric power generation & storage integration system.

✓ Case#2. Detached house

Sagamihara Hikarigaoka Echo Town: Active use of natural energy in community units.

✓ Case#3. Communal house

● Park Tower Nishi-Shinjuku M'sPort: Optimum operation of electric power by HEMS (*H*ome *E*nergy *M*anagement *S*ystem) & MEMS (*M*icro *E*lectro *M*echanical *S*ystems).

✓ Case#4. Commercial facility

● Sakai City Smart Community: Advanced composite use of recycled waste water.

✓ Case#5. Educational facility

● Chubu University Smart-Echo Campus: Smart Grid inside campus.

✓ Case#6. Industrial complex

③ Sendai Core industrial complex: Integrated Micro Grid between supply side and user side.

4. Smart Community/City related Standardization

Looking at the development of Smart Community / City from a global perspective, there are several attempts, one of which is the standardization of Smart Community / City project.

According to the standardization following effects can be expected. improving energy efficiency

- increasing safety
- planning sustainable urban development
- developing reliable road network
- effective means of transportation
- reducing pollution, and
- dealing with water and wastewater management

ISO series are widely known as a typical standardization, there is also an attempt to standardize Smart Community / City project by ITC.

The typical ISOs related to Smart Community / City currently published are the following areas*[13]. (Refer to the Table 1)

Table 1. ISO standardization work on Smart Cities(ISO/IEV JTC1-26)[*13]

ISO/TC No.	Related fields and corresponding work to Smart Cities
1. ISO/TC268	Sustainable development in communities.
2. ISO/TC163 and ISO/TC205	Building environment design, and Thermal performance and energy use in the building environment.
3. ISO/TC257	General technical rules for determination of energy saving in renovation projects, industrial enterprises and regions, and reduce greenhouse gas (GHG) emissions.
4. ISO/TC242	Energy management, focuses on the field of energy management.
5. ISO/TC59	Buildings and civil engineering works, subcommittee and design life.
6. ISO/TC223	Social Security develops standards for public and private organizations.
7. ISO/TC241	Road traffic safety management systems.
8. ISO/TC204	Intelligent transport systems, focuses on standardization of information, communication and control systems
9. ISO/TC TMB	ISO/TC Technical Management Board.

5.   Smart City/Community related KPI

The second global trend for Smart City / Community Project is the setting of Key Performance Indicators (KPIs). Key performance indicators (KPI) are a set of quantifiable measures that a company uses to gauge its performance over time. These metrics are used to determine an organizational progress in achieving its strategic and operational goals, and also to compare an organizational performance against other organizations. Now KPI management is becoming not only for private sectors but also public sectors. This means that we can utilize KPIs for Super Smart Society as well.

When choosing which KPIs will offer the most valuable insights, SMAET is important.

- *S*pecific: KPIs show the tangible performance goals
- *M*easurable: KPIs are quantitative
- *A*ttainable: KPIs are achievable when trying to do the best
- *R*ealistic: KPIs are linking to the job/task directly
- *T*ime-based: KPIs can be measured within a given period

KPIs presented by ITU-T FG SSC are shown below[*14] (refer to the Table 2).

Table 2. Typical KPIs linking to Smart Community/City[*14]

KPI (Key Performance Indicator: ITU-T FG SSC)	
1. Network facilities	Network infrastructure, broad-bands access, etc.
2. Information facilities	Network-based services, appliances of GIS (Geographic Information System), etc.
3. Environment	Water resources and toxic substances monitoring, etc.
4. Building	Energy saving technologies, intelligent buildings, etc.
9. Transportation	Road sensing terminals, clean energy transport, clean energy sharing transport (ex. Car/bike sharing), etc.
10. Security and safety	Crime rate, accident ratio (victim, damaged object), disaster prevention, Information security, etc.
11. Sanitation	Solid waste disposal management, waste water recycling, etc.
12. Healthcare	Electronic medical records, coverage of community e-health service with ICT measures, etc.
13. Education and training	Hatching smart tech from knowledge centers (research centers, universities etc.), penetration of e-learning system, etc.
14. Openness	Immigration-friendly environment, international communication enhanced due to ICT measures, etc.
15. Participation in public life	Online civic engagement & participation in voluntary work due to ICT help, etc.
16. Comfort	Environment, food and health safety, etc.

6. **Theoretical approach for the grand design of Smart Community/ City project from the perspective of Organizational Design**

For the grand design of the country-level Super Smart Society, methodology of Social Design from the Macro point of view is effective. However, for the regional-level Smart Community/City project that is the component (cell tissue) of Super Smart Society, the methodology of Social Design tends to be less specific.

In this study, we advocate the methodology for grand design of Smart Community/City project from semi-macro/micro perspective based on the concept of Organizational Design advocated by Gary L. Neilson[*15] (Refer to the Figure 5). Features of this methodology are:

- Define Community/City as a hierarchical structure consisting of 4 layers.
- Achieve an optimal grand design by combining two complementary groups, formal and informal functions.

➢ Formal function:
The 1st layer : Decisions
The 2nd layer: Motivators
The 3rd layer: Effective utilization of information
The 4th layer: Structure
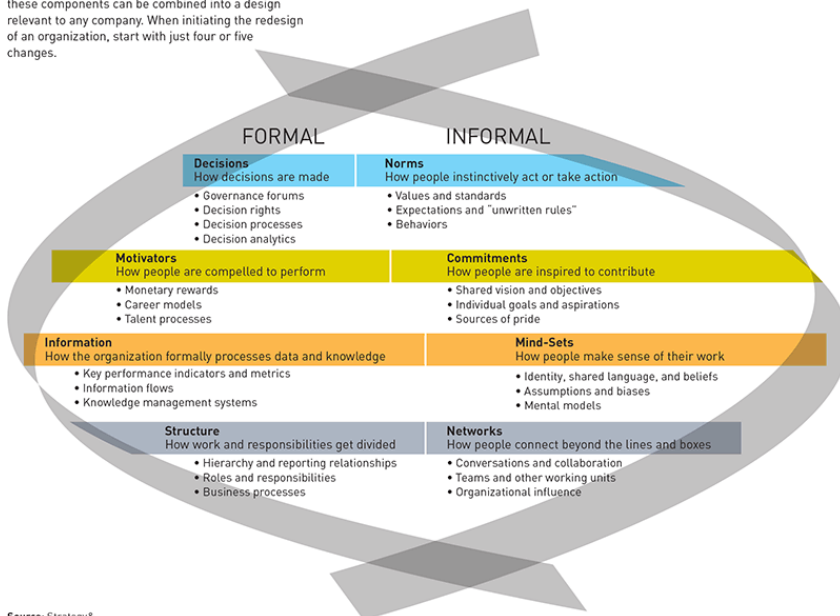➢ Informal function
The 1st layer: Norms
The 2nd layer: Commitments
The 3rd layer: Mind-sets
The 4th layer: Networks

Figure 5. Total framework of Organizational Design advocated by Gary L. Neilson[*15].

Exhibit 1: **The Eight Elements of Organization Design**

Grouped into complementary pairs (the four rungs), these components can be combined into a design relevant to any company. When initiating the redesign of an organization, start with just four or five changes.

FORMAL / INFORMAL

Decisions — How decisions are made
- Governance forums
- Decision rights
- Decision processes
- Decision analytics

Norms — How people instinctively act or take action
- Values and standards
- Expectations and "unwritten rules"
- Behaviors

Motivators — How people are compelled to perform
- Monetary rewards
- Career models
- Talent processes

Commitments — How people are inspired to contribute
- Shared vision and objectives
- Individual goals and aspirations
- Sources of pride

Information — How the organization formally processes data and knowledge
- Key performance indicators and metrics
- Information flows
- Knowledge management systems

Mind-Sets — How people make sense of their work
- Identity, shared language, and beliefs
- Assumptions and biases
- Mental models

Structure — How work and responsibilities get divided
- Hierarchy and reporting relationships
- Roles and responsibilities
- Business processes

Networks — How people connect beyond the lines and boxes
- Conversations and collaboration
- Teams and other working units
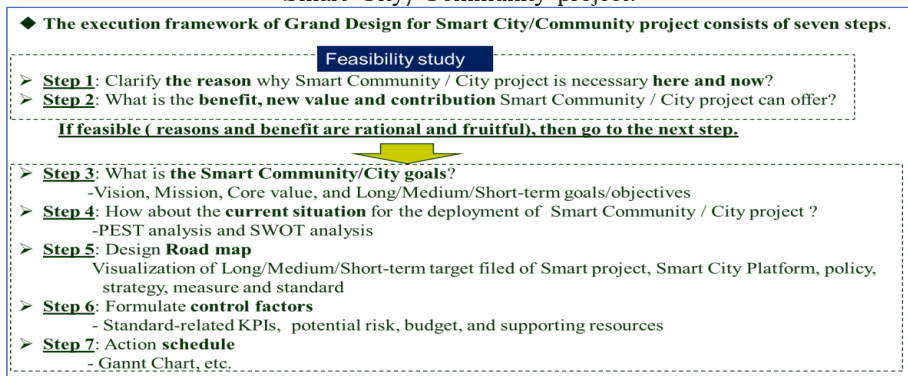- Organizational influence

Source: Strategy&

Since Smart Community/City project is a participatory open project, it is necessary to consider both formal and informal perspectives. In this study, we proposed the methodology of grand design with emphasis on formal functions, while also considering informal ones (refer to the Table 3) for setting up the effective grand design.

Table 3. Components of Grand Design for Smart Community/City

Formal function	Informal function
◆ Decisions 　- Vision, Mission, Core Value, policy, strategy of goals/objectives	◆ Norms 　- Citizens' Charter 　- Philosophy
◆ Motivators 　- Improvement of QWL	◆ Commitments 　- Public participation
◆ Information 　- Standards, KPIs, risk factor, measure, etc.	◆ Mind-sets 　- Sustainable development/growth
◆ Structure 　- Smart Community/City platform & processes	◆ Networks 　- Industrial government- academia collaboration

The development of the methodology for the grand design of Smart Community/ City project linking to Super Smart Society was planned under the initiative of APO, and examined the utilization of the methodology by APO member countries on April 2019 in ROK. The execution framework for the grand design of Smart City/Community project by utilizing our methodology consists of seven steps as follows (refer to the Figure 6):

Figure 6. The execution framework for the grand design of Smart City/Community project.

◆ The execution framework of Grand Design for Smart City/Community project consists of seven steps.

Feasibility study
➢ **Step 1**: Clarify **the reason** why Smart Community / City project is necessary **here and now**?
➢ **Step 2**: What is the **benefit, new value and contribution** Smart Community / City project can offer?

If feasible (reasons and benefit are rational and fruitful), then go to the next step.

➢ **Step 3**: What is **the Smart Community/City goals**?
　　　-Vision, Mission, Core value, and Long/Medium/Short-term goals/objectives
➢ **Step 4**: How about the **current situation** for the deployment of Smart Community / City project ?
　　　-PEST analysis and SWOT analysis
➢ **Step 5**: Design **Road map**
　　　Visualization of Long/Medium/Short-term target filed of Smart project, Smart City Platform, policy, strategy, measure and standard
➢ **Step 6**: Formulate **control factors**
　　　- Standard-related KPIs, potential risk, budget, and supporting resources
➢ **Step 7**: Action **schedule**
　　　- Gannt Chart, etc.

7. Finding and Conclusion

As a result of group exercise by APO member countries, we got the result that the methodology for the grand design of Smart Community / City project from the viewpoint of Organizational Design from semi-macro/micro perspective is effective.

In the future, we have a plan to expand the methodology for the grand design on a global basis, and expand the different types of standards and KPIs in consideration of the diversity of society, economy and industry in each country and the peculiarities of community and city.

8. Acknowledgement

The methodology of the grand design for Smart Community/City project presented in this study was created and applied at the "Workshop on Developing Standards for Smart Cities, Project title: 19-IN-80-GE-WSP", organized by APO, which was implemented in March, 2019 (Venue: Seoul, ROK). We would like to thank APO for providing this opportunity and APO member countries for supporting us apply this methodology to clarify standards.

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