Smart Regions

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***Abstract*—The concept of Smart Regions is based on the vision of more cost-effective public administration. This vision comes after a period of de-industrialization and growing populations in cities. Growing populations in growing cities require better public services. At the same time, there is growth in new information technologies, which creates a new market and forms the basis for new industrial growth.**

Keywords-component; smart technology; smart grid, smart traffic, smart cites

I. INTRODUCTION

In 1980, Alvin Toffler published the best seller "The Third Wave". His argument was that an industrial period was over, and new information technology was about to lay the foundation for a new industrial period based on the following [1]:

1. Demand adaptation: From mass production to demand for services and products.
2. System integration: Of products and services.
3. Flexibility: Asynchronous management of services and manufacturing.
4. Decentralization: Of control and production.
5. Consumer and producer (ProCumer): The producer and consumer of goods and services.
6. Open innovation: Open, local, learning-based innovations.

It was not long before many manufacturing companies began to adopt this trend, leading to changes in order-based production and new concepts such as just-in-time production, total quality management and business process reengineering. Now it appears that the idea of Smart Cities is a symptom of similar fundamental and structural changes in public services. One changes the industry has faced since around 1980 is the transition from mass to order-based production.

The concept of Smart Cities can be described from pilot projects in the US, Asia and Europe. The purpose of Smart Cities has been to solve traffic problems, create new industrial growth and make better lives for people who live in large cities. Despite many sample projects, Smart Cities are still only a vision. In Norway, it is a vision of a more cost-effective public infrastructure, improved environmental conditions, improved quality of life and new industrialization. This vision does not come by chance. After a period of de-industrialization, towns have become service providers to growing populations, and they cannot finance sustainable public services. At the same time, there is rapid growth in new information technology. This growth creates its own market and provides a basis for new industrial growth.

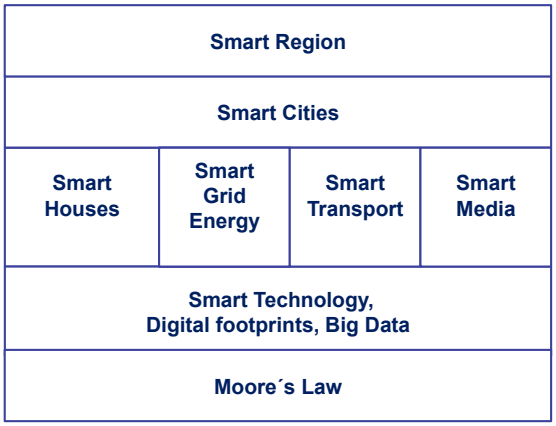

Figure 1. The relationships between Smart Technology and Smart Regions.

The concept of Smart Cities and Smart Regions has many perspectives. This approach is based on Moore's Law, and it integrates data and organizations at higher levels. Information technology integrates services in technological steps. The first step came with the development of the microprocessor in 1970, which integrated electronics and mechanics and thus changed industrial products and industrial production. The second step came in the 1990s, when the Internet transformed service industries. The introduction of the Smart Grid appears to be a symptom of a new step, one that will transform public services and public administration.

Moore's Law leads to exponential growth in the development of new information technologies, and these forms the basis for new technological platforms such as Smart Technology, digital footprints and Big Data. These new concepts will form the basis of new organizational concepts such as Smart Houses, Smart Grid Energy, Smart Transportation and Smart Media. A typical relation is shown on Figure 1. The new concepts now form the basis of what we have classified as Smart Cities and Smart Regions [2]–[5].

II. SMART GRID

In the 1800s, industry was tied to local energy sources. In Norway, there was a natural ownership relationship between energy producers and consumers. In the early 1900s, a large-scale hydropower development was initiated. This development led to function-oriented, large-scale production

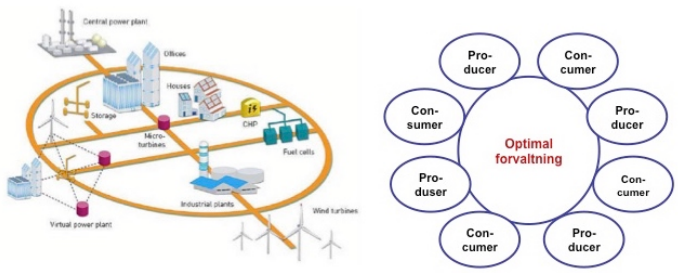

Figure 2. A typical Smart Grid concept.

with few producers and many consumers. The outcome of this change was that cities could grow independent of where the energy was produced. The growth of energy transport networks has thus influenced the locations and development of all communities, even until today. This concept can be formulated with the simple model

$$Y(t) = H(Energy)X(t)$$

where X(t) represents the energy manufacturers, H(Energy) the energy distribution network and Y(t) energy consumers. This function-oriented paradigm is based on the following:

1. Specialization: Specialized technology for many consumers.
2. Synchronization: Synchronized energy transmission from producer to consumer.
3. Centralization: Centralized energy transfer from few producers to many consumers.
4. Innovation: Related to energy and technology producers.
5. Costs: The consumer has little impact on costs.

The large increase in centralized energy management has also introduced vulnerable energy sources. Modern society depends on a stable supply of energy with minimum costs. In the USA and the EU, there are emerging concepts for energy management based on the Smart Grid, which can be defined as an: "electric power network that intelligently integrates the actions of all users connected to it through generators to consumers using two-way communications, new control technologies, distributed computing and associated sensors, including installing this equipment on the premises of network users".

The goal of the Smart Grid is long-term, more robust, more flexible energy management. Here, Smart Technology will form the basis for smart energy management, optimize overall energy management, protect the energy administration's own safety, and repair errors that occur in the network. This means that the Smart Grid is based on symbiosis between energy technology and Smart Technology. Smart Technology is based on new instrumentation, new communication systems and artificial intelligence. Thus, Smart Grid energy management can be formulated by the simple system model:

$$S(Smart\ Grid, t) = \{N(Grid, t), S(Nodes, t), L(t)\}$$

where N(Grid, t) represents the energy network, S(Nodes, t) represents Smart Technology that optimizes the energy flow in the network, and L(t) represents the landscape for network distribution. In this concept, in principle, all nodes S(Nodes, t) represent energy producers and consumers as shown on Figure 2. This new Smart Grid concept reminds us of the development of the Internet in the 1980s. Some typical features are:

1. Customization: Energy sources are selected based on local needs and cost-effectiveness.
2. System integration: Energy supplies from different technological platforms are integrated.
3. Flexibility: Energy management and production are highly flexible.
4. Decentralization: All local energy consumption is in principle based on local, decentralized management.
5. Consumer and producer: All energy nodes are energy consumers and producers.
6. Costs: Energy is cost-effective in real time.
7. Open innovation: There is open innovation in the production of new services

The new players in this innovation process are the new energy consumers. Smart Houses are a typical example: house cooperatives may profit from their own energy production. This energy production can be so important that it may become a problem for stable voltage supplies. On the production side, there is a growing network of small and large energy suppliers who, hour by hour, optimize their own energy production using climate models and the expected selling price. Smart Grid networks must have technology that, in real time, optimizes line capacity to reduce overall energy loss; monitors vulnerability; and repairs faulty networks.

A second group is the car industry, which has seen rapid growth in the production of electric cars. It appears as though Smart Garages will soon be part of energy management in Smart Houses. The expected result is cheaper, more stable energy [6]–[9].

III. SMART TRANSPORT

Transport was originally based on a simple and flexible concept, the need for communication between settlements and resource areas. Roads were where people congregated. The development of second-generation industrialism increased demand for more efficient transport between raw materials, production and marketing. In the 1800s, Europe began to develop costly transport via water channels. When transport systems they were finished, they began developing railways. After the railways were extended came a new, costly period of developing road networks. Transport is anchored to current technology, and road networks have changed the development of settlements. At the same time, the growth in transport has become a problem for cities and costly for societies. This growth has been a key motive for developing smarter cities, which feature:

- Specialization: Transport services based on specialized technology such as cars, ships, trains, planes, etc.
- Synchronization: Transport services are generally synchronized to the same transport technology.
- Centralization: Centralized planning and transport system management on the same transport technology.
- Closed Innovation: Innovation is related to the service or communications technology manufacturers.
- Costs: The consumer has little impact on transport costs.

The EU has released an updated development program for transport in connection with the research program Horizon 2020. The purpose of this program is to reduce Europe's dependence on oil and improve environmental conditions. An integrated transport system is planned for 500 million transport service consumers. One assumes that 18 million people are added to the current transportation system, which is threatened by actors outside of the EU. One therefore sees transport as a venue for new innovation and new industrialization.

Horizon 2020's mobility innovation appears to be based on the same thinking that underlies the concept of Smart Grid energy, fully integrated services based on open innovation:

- Additional customization: Cost-driven adaptation to transport service needs.
- System integration: All land and water transport service systems are integrated.
- Flexibility: There is user-controlled flexibility in the choice of transport services.
- Decentralization: All transport services have autonomous self-regulation in relation to their own costs.
- Consumers and producers: There is greater transparency in transport services management.
- Costs: Transport networks' development and management determine their own costs in real time.
- Open innovation: There is open innovation of new transport services

Producers of Smart Technology are already in the process of mapping the digital tracks for road networks, directly from cars and cell phones. Producers of Smart Technology and Smart Media are on track to become the new players in managing digital transport tracks and thus to set new guidelines for managing transport and communications [10]–[12].

IV. SMART CITIES

The ideological basis for the second-generation industrialization dates back to Adam Smith in the 1700s, with the following characteristics:

- Specialization: Manufacturing, operations, expertise, training, products, etc.
- Division of labor: Production, products, training, etc.
- Synchronization: Operations, logistics, etc.
- Mass production: In order to reduce unit costs

These formed the basis for a sustained period of growth in large cities and laid the foundation for the design of public services. Estimates from the United Nations show that in 2050, approximately 70% of the world's population will live around 27 mega cities. This large growth in cities has also led to a major strain on infrastructures, welfare and ecosystems. In the 1980s, there was overproduction of many products, which led industry to introduce new technologies and adapt to markets using order-based production. A similar reorganization has not yet occurred in public service management.

There are now Smart Cities pilot projects in the US, Asia and the EU. The EU has initiated approximately 50 sample Smart Cities projects. In 2013, the European research program Horizon 2020 included Smart Cities in its comprehensive program. We see here that the smart concept is part of a series of new themes, including the following:

- Eco-City: Green infrastructure and ecosystem management.
- Digital City: Equivalent to what we have classified as Smart Media.
- Social City: Smart Governance, Smart Living, Smart Economies, Smart Industry, the Smart Grid, Smart Transportation, Smart Buildings, Smart Hospitals, Smart Safety and Security, etc.

The Smart Regions research project has examined the ideas behind the smart concept and the ideas behind the Smart Grid as a generic concept that can be used to develop more cost-effective public services. The results of this survey indicate that the Smart Grid concept reflects a more underlying development process that affects structures in public social planning.

This development can be traced back to Moore's Law, which states that the processing power of electronic circuits doubles every two years. This evolution introduced growth in electronic packaging density and in data integration. Growth in data integration leads to organizations that are integrated at higher levels, and organizational integration leads to an interdisciplinary, systems approach to public service management.

The 1970s led this instrumentation integration via microprocessors, which led to reorganizing industrial production. The 1990s brought the Internet and the reorganization of the service industries. It appears that the idea behind Smart Technology, the Smart Grid, and Smart Transport in coming years will lead to a corresponding transformation of public services, following which these new concepts will be integrated as Smart Cities and Smart Regions. Open innovation networks will lead to public services that

must adapt to a common code of need customization, integration, decentralization, cost-effectiveness and research development of public services, for and by the consumers and producers at the same time.

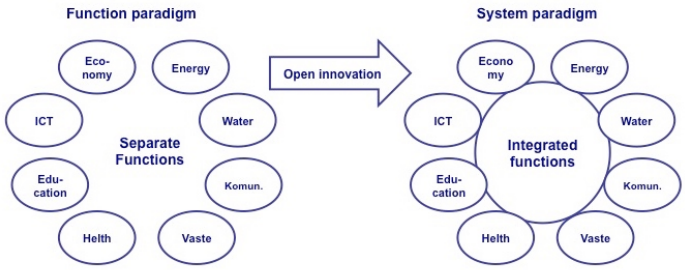

Figure 3. Open innovation of Smart Cities.

In this research, it may appear that system-oriented organizations must be realized via Smart Governance. Despite a multitude of sample projects, there is no generic model for Smart Cities, the concept of which is commonly understood as a shift from function-oriented to system-oriented thinking, that is, Smart Cities are managed as systems of systems. Managing public services in Smart Cities can be formulated with the following simple system model:

$$S(\text{Smart City}, t) = \{N(SB, t), S(ST, t), L(t)\}$$

where N(SB, t) represents the network between services in a Smart City; the network thus defines the framework what constitutes Smart Cities. S (ST, t) represents smart services such as Smart Media, Smart Houses, the Smart Grid, and Smart Transport that are optimized to share services in real time, and these services will change via open innovation. L(t) represents the city's landscape, and the model entails the following:

- Needs adaptation: Ongoing analysis of data and selected cost functions in more or less real time.
- System integration: All public services have a multidisciplinary approach to system integration in more or less real time.
- Flexibility: There is user-controlled flexibility in the design of public services.
- Decentralization: Public services are managed by decentralized internal controls.
- Consumer and producer: Public services are consumers and producers of services in multidisciplinary systems.
- Cost: Priorities and policies are chosen based on cost indicators.
- Open Innovation: Public services are research-based, with open innovation treasury services, as shown on Figure 3.

Smart Cities are managed as systems of systems, which entails multidisciplinary management at various levels; each level has great freedom to innovate, within a defined purpose [13]–[16].

V. SMART REGION

The historical concept of regional divisions is also based on function-oriented thinking, with regions divided into administrative and geographical boundaries. In Norway, there are three administrative levels, and each level is responsible for specialized tasks, with budgets for specialized purposes. Communities are responsible for topics within small geographical areas, and counties comprise a number of communities. Such a functional structure can easily lead to costly parallel services.

This function-oriented structure was built during a time of stable communities and poor communication. Over a period of 50 years, there has been a significant transfer of jobs from the 2nd-generation industrialization and public service industries. The result is that we have a very expensive public sector. Meanwhile, new information led to access for everyone to the same information in real time, so that now people can access public services from a completely different basis.

Large regions are not necessarily cost-effective. Large organizations are not the same as cost organizations. Scaling of organizations is based on function-oriented thinking. Larger units can easily result in less flexibility and greater cost if they are not organized following smart concepts.

In 1980, Michael Porter launched his theory of industrial clusters, which was based on the notion that there is a web of businesses that together produce a joint product. On Norway's northwest coast, there are marine industrial clusters related to the fishing and shipping industries and an industrial cluster in connection with the furniture industry. The theory of industrial clusters represented a change from function-oriented thinking to a system-oriented product philosophy. Rather than each company's serially producing stock, production subsystems were instituted that fit into larger industrial systems. The result has been greater flexibility and less vulnerability, and now everyone can share in total GDP. If we follow this line of thinking, a Smart Region can be formulated with a simplified system model:

$$S(\text{Smart Region}, t) = \{N(\text{Smart Region}, t), S(\text{Smart Cities}, t), S(ST), t), L(\text{Location})\}$$

where N(Smart Region, t) represents a network of public relations. In this model, it is again the network that defines the region's framework. S(Smart Cities, t) represents Smart Cities. S(ST) represents smart services such as Smart Transportation and the Smart Grid. L(Location) represents the regional landscape and ecosystems. A region that is managed as a system of systems can be characterized as follows:

- Sustainable: Regions take responsibility for their own sustainability compared with other regions.

- System integration: Regions are responsible for integrating their Smart Cities, Smart Grids, Smart Transport, natural resources, etc.
- Flexibility: Local flexible solutions as an alternative to large-scale solutions.
- Decentralization: Public services managed by decentralized internal controls.
- Consumer and producer: Each region balances its role as a resource producer and consumer with other regions.
- Cost: Priorities and policies are chosen based on cost indicators.
- Open innovation: Public services are research-based, with open innovation treasury services.

Smart Regions represent higher-level system integration that links regions to other regions. Thus, each region must take responsibility for safeguarding open innovation on its own terms while adapting to open innovation in other regions.

VI. DISCUSSION

Smart Regions examine the ideas behind the smart concept, and the ideas behind the Smart Grid concept are generic and can be used to develop more cost-effective public services. The survey results indicate that the Smart Grid concept is a symptom of a more underlying development process that affects structures in public social planning. This development can be traced back to Moore's Law, which states that the power of electronic circuits will double in two years. Growth in electronic packaging density introduces growth in data integration, and growth in data integration leads to higher-level organizational integration. Integrating organizations then leads to an interdisciplinary and systems approach to public service management.

In the 1970s, instrumentation was integrated via microprocessors, which led to the reorganization of industrial production. The 1990s brought the Internet, and with it, the reorganization of the service industries. It appears that Smart Technology, the Smart Grid, and Smart Transport in the coming years will lead to a corresponding transformation of public services, following which these new concepts will interact to form the basis for Smart Cities and Smart Regions. The open innovation network will lead to public services that must adapt to a common code of customization, organizational integration, decentralization of controls and cost-effectiveness. Transforming from function-based to systems-based organizations will introduce research-based public service development.

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