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**Value network design approach for sanitation system in developing countries  
- Lessons from two Japanese models -**

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*Abstract: This study focuses on and analyzes two Japanese cases; one is current sanitation system consists of centralized sewerage system and decentralized treatment, other is excrement recycling system which had been existing until early 20th century. This study aims to discuss on reasonable tactics and approach for sanitation system in developing countries on the basis of lessons from two Japanese models. Two sanitation models in Japan were analyzed in the light of value flow network. Both systems satisfied common 6 important factors; (1) clear policy, (2) appropriate actor who realizes that policy, (3) effective information, (4) financial system, (5) people's participation, and (6) technology. Current Japanese model succeeded under central government's great initiative based on rapid economic growth. It is difficult to apply to developing countries. On the other hand, Edo period model was market economy system, which was driven by value flow network therefore this system was economically independent. Expected issue when this concept was applied for current developing countries is driving force which enables us to overcome the value-cost balance of excreta and people's acceptance.*

**Keywords:** *Resource recycling sanitation, urine and feces reuse.*

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## **INTRODUCTION**

Sanitation system for low income people in the world is still difficult issues, although it is stated as one of MDGs target and is tackled by many countries and international organizations. For example in rural area of Sub-Saharan Africa and Southern Asia, populations using an improved sanitation facility at 2008 are still 24% and 26% respectively (UN, 2010). UNDP estimated that Sub-Saharan Africa will achieve the sanitation goal at 2076 (UNDP, 2006). On the other hand, in Southeast Asia, water flush toilet has been diffused rapidly however appropriate treatment facility is not following this trend (Ushijima et al. 2011). Those issues will remain as post-MDGs problems.

Current scheme of sanitation system provided by international donor is involving public participation and capacity development aspect, however it is basically the concept of public

service, therefore it is intensely affected by budget issue: government's ability to pay for the system, and people's willingness to pay. Those two are difficult to overcome in most of developing countries which economic levels of people and government are low. Economically independent or less dependent sanitation model are desired to overcome this fundamental issue.

This study focuses on and analyzes two Japanese cases; one is current sanitation system consists of centralized sewerage system and decentralized treatment, other is excrement recycling system which had been existing until early 20th century. This study aims to discuss on reasonable tactics and approach for sanitation system in developing countries on the basis of lessons from two Japanese models.

## **CURRENT JAPANESE MODEL**

### **Overview of current Japanese model**

Japanese government has clear policy consists of two major ways of domestic wastewater management; centralized sewerage system for high population density area, and decentralized Johkasou system for low population density area. There are related laws for each system. According to the Sewerage act (Ministry of Land, Infrastructure, Transportation and Tourism, 1958) people have to connect their wastewater pipe to sewerage system in sewerage covered area. According to the Johkasou act (Ministry of the Environment, 1983) people who live in non-sewerage covered area have to install Johkasou. As exceptions, several schemes to use community plants those are managed by community are supported by local government.

The first modern centralized sewerage system was constructed in 1860's but it served for quite limited area (Japan Sewage Work Association, 2012). Because Japan has long history to use human excreta for agriculture, as described in next chapter, water flush toilet and sewerage system or Johkasou system are simultaneously diffused. Japanese government or municipalities have been promoting the water flush toilet from the view point of hygiene issue (Maeda, 2008), however the percentage of water flush toilet did not increase so much. Only after rapid economic growth, that corresponds to 1960's to 1970's, coverage of sewerage and Johkasou show rapid increase (Fig.1). Current population coverage of centralized sewerage system and decentralized Johkasou are 75.1% and 8.7% respectively (Japan Sewage Works Association, 2012; Ministry of the Environment, 2012).

Sewage collected through sewerage pipe network is treated in treatment plant and treated water is discharged to river or sea. Johkasou is onsite treatment system therefore treated wastewater is directly discharged to river or sea. Both sewage treatment plant and Johkasou generate sludge. Sewage treatment plant has sludge treatment facility. Sludge from Johkasou is collected by septic truck and treated in Night soil treatment plant, which was originally established in order to treat human excreta collected from pit latrine.

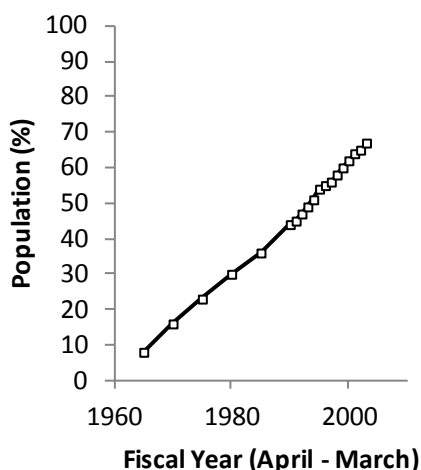


Fig.1 Sewerage coverage population from 1965 to 2003

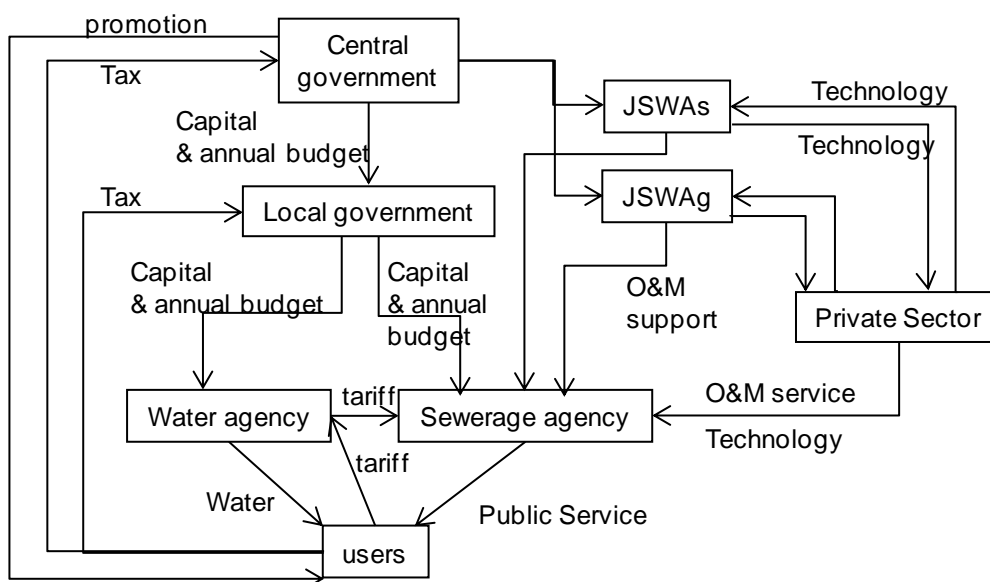


Fig.2 Value flow network of current centralized sewerage system

### Value network structure

The relationship between each stakeholder concerning sewerage system is able to be described by value flow network as Fig.2. Sewerage system is installed by each municipality or in some cases, by several concerning municipalities in same catchment area. Municipalities make a loan from national government in order to cover the construction cost. They have to establish sewerage agency to manage their sewage network system and treatment plant. People pay sewerage charge through water supply agency simultaneously with water supply charge, and sewerage part is transferred from water supply agency to sewerage agency.

Per capita total budget for sewerage system construction, which is estimated by dividing total annual budget for sewerage project by increased sewerage covered population, is approximately 1.5 million JPY in Japan, which corresponds to 13,500 USD (Japan Sewage



by effective media, (4) good financial system effectively support each stakeholder, (5) users' commitment to be involved in this system and to pay required charge or cost, and (6) technology. Regarding (5) users' commitment, however, current system requires large amount of initial and maintenance cost, therefore high economic level, which affords both people and government to pay these costs is necessary as a background requirement.

## **EDO PERIOD MODEL**

### **Overview of the Edo model**

The oldest literature which clearly mentions to agricultural use of human excreta is "Engishiki" published on 972 (Kusumoto 1981). However, in the "Kojiki" (Miura, 2002) published on 712 which describes myths and history of Japanese imperial family, there is a story which implies agricultural use of human excreta; "Toyoyuke-no-ohkami" who is the god of crop, is a daughter of "Wakumusubi-no-kami" who was born from urine of "Izanami-no-Mikoto" who is a god of creation. From this story, Japanese people seem to know the value of excreta at that time.

It is considered that Japanese population reached 4,000,000 at 8<sup>th</sup> century (Kitou, 2000) therefore increase of food productivity was important task (Kusumoto, 1981). Central government encouraged double-crop farming and fertilizer demand was increased (Kusumoto, 1981). Probably agricultural use of human excreta was widely spread upon this situation. In the Edo period (1603 – 1869), Japanese population again rapidly increased from 12.2 million to 30 million (Kitou, 2000). Fertilizer demand was increased especially around urban area such as Edo, or Kyoto. In the Edo period, human excreta were regarded as commodity to trade. There were excreta broker, and some of them established big company to trade excreta. They collected excreta from urban area and transported then to suburban area by horse car, boat, or foot. According to historical literature survey (Watanabe 1983) excreta transportations were conducted in 20 km. Important asset of excreta trading business was only transportation facility including horse, boat, buckets, and so on. This excreta market had been existed until early to middle of 20<sup>th</sup> century, the period low priced synthetic fertilizer was emerging.

### **Value network structure**

The relationship between each stakeholder concerning Edo model is able to be described by value flow network as Fig.4. In the Edo period, there were many apartment and excreta of residents were regarded as asset of apartment owner. Apartment owner can sell the excreta and this income enables apartment owner to discount a rent. Owners built a toilet in their apartment, and they made contract with excreta trader. Excreta trader paid money to apartment owner as a consideration of excrement, and they dug out the feces and transport it from each apartment to suburban. They sold excreta to suburban farmers. Suburban farmers produce foods for urban area.

National government officially recommended to use human excreta and showed the technique of excreta use in agriculture. However, above mentioned system was not built by national government but by private sector. In some cases, local government mediated between farmers and apartment owner or trader because the price of excreta became too high in some period, but they never controlled this system.

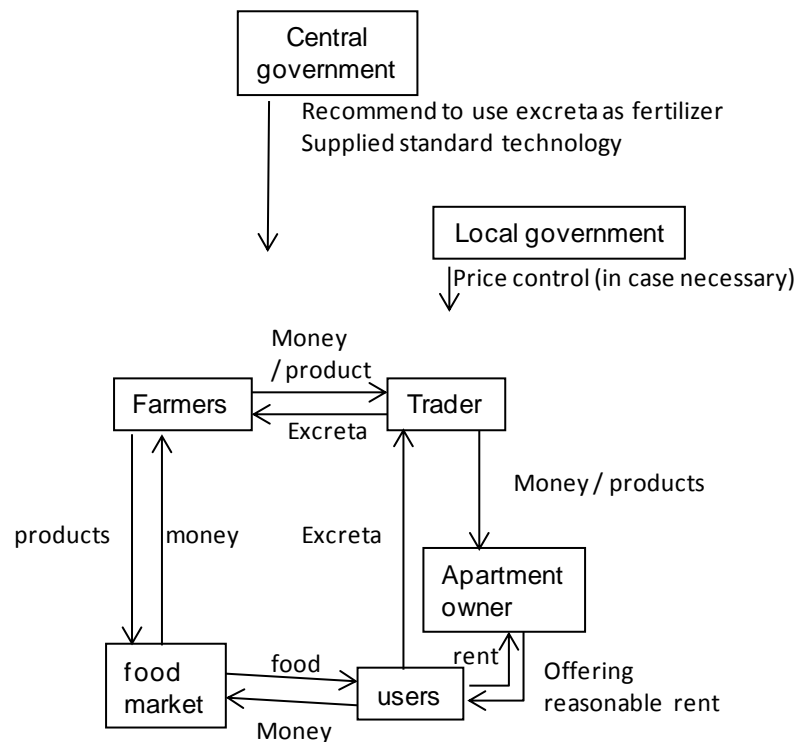


Fig.4 Value flow network of Edo-model

This value flow network based on excreta market had been continued until early 20<sup>th</sup> century, however after this period, cash flow turned to opposite direction, because farmers were able to buy synthetic fertilizer in lower cost than excreta. Due to this situation, human excreta market disappeared around middle of 20<sup>th</sup> century. Excreta collection had changed from business to public service after this period. Collected excreta were not used anymore, therefore treated in night soil treatment plants.

### Lessons from the Edo model

Lessons from the Edo model can be described under comparison with 6 key points of current model as follows. Japanese government stated (1) clear policy to use human excreta for agriculture due to food security, and (6) provided technical instruction of how to use human excreta. The big difference from current system was that system was not built by central government but (2) private sector realized this policy, and (3) clear benefit was provided to people, (5) it was easy for people to commit this system, (4) each stakeholder could manage their investment and asset by business manner. Thus, Edo-model was not public service but completely market economy.

Thus excreta trading system is not so particular system but just following market economy manner. Because value of excreta was higher than that of other alternative fertilizer in this system, and because supporting business infra including agricultural technique was available, this system was able to exist. Because this system was market economy, it was sustainable for long time, and easily destroyed by innovation of synthetic fertilizer.

## DISCUSSION

Japan experienced completely different but well managed 2 type of excreta management system. Although the system concept was completely different, both satisfied common 6 important factors; (1) clear policy, (2) appropriate actor who realize the policy, (3) effective information, (4) financial system, (5) people's participation, and (6) technology. When considering application to developing countries, current centralized system requires too large amount of budget to both users and government. Economic background is necessary for both user level and government level.

On the other hand, Edo-model does not require high economic level. In this system, needs (= fertilizer demand) and seeds (=excreta) matched, and the balance of value and price was sufficiently reasonable compared to other alternative. The framework of Edo-model, which can be regarded as business model, seems more reasonable in developing countries. If we apply this framework to current developing countries, issues would be two points; one is value-cost balance, and other is people's acceptance.

Regarding value-cost balance, well designed value chain network between all stakeholders have to be prepared. In the Edo-model, excreta market emerged without any market design, and this model could not adjust to synthetic fertilizer diffusion. Regarding people's acceptance, it requires driving force to change the people's mind. In Japan, central government recommended people to use excreta for long time in Japan, because of food crisis. Now the world are facing food crisis, and therefore it is clear that human excreta generated in each county is important asset for that country. This asset is constantly generated regardless to economic level, jus according to population. National government especially in low economic leveled country will have to manage this asset strategically. However there are psychological barrier for ordinary citizens to use excreta, therefore some technology which changes the face of excreta would be important. Technology development of this context is desired.

## CONCLUSION

Two sanitation models in Japan were analyzed in the light of value flow network. Both systems satisfied common 6 important factors; (1) clear policy, (2) appropriate actor who realizes that policy, (3) effective information, (4) financial system, (5) people's participation, and (6) technology.

Current Japanese model succeeded under central government's great initiative based on rapid economic growth. It is difficult to apply to developing countries. On the other hand, Edo period model was market economy system, which was driven by value flow network therefore this system was economically independent. Expected issue when this concept was applied for current developing countries is driving force which enables us to overcome the value-cost balance of excreta and people's acceptance.

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