The Postmodern Sanitation: agro-sanitation business model as a new policy

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Abstract

This article proposes a Postmodern Sanitation concept, based on discussions such as what is necessary to solve the world’s current sanitation issues and what are the limitations of the current sanitation concept. The proposed policies of the Postmodern Sanitation concept are: (1) to discuss a sanitation value chain that creates and adds value to human excreta, and products made from human excreta, and build a sanitation business model to drive this sanitation value chain; (2) to design a sanitation business model focusing on incentives for individual toilet users; (3) to analyze current users' value chains to find available potential resources; (4) to connect these potential sanitation resources to the next value chain; (5) to make a financial plan based on market analysis of sanitation products; and (6) to find and organize facilitating organizations to support the individual toilet users' businesses. This concept was applied in the case of a rural area in Burkina Faso, and an agro-sanitation business model was designed based on material flow analysis and value chain analysis.

Keywords: Resource-oriented sanitation; Sanitation business model; Sub-Saharan Africa; Value chain

1. Introduction

The provision of appropriate water and sanitation is an urgent priority in the world. The Millennium Development Goals (MDGs), developed by the United Nations, included the water and sanitation goals to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and

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basic sanitation (UN, 2000). In 2008, coverage of safe drinking water had reached a world average of 87% but coverage of basic sanitation had reached only 52%. In the rural area of sub-Saharan Africa especially, the coverage of basic sanitation was only 24% in 2008 (UN, 2010). This was the lowest percentage in eight regions of the world. Although governments and related organizations including NGOs (non-governmental organizations) have been tackling sanitation issues, the UNDP (2006) estimated that sub-Saharan Africa would not achieve its sanitation goal until 2076. This suggests that the current concept and approach may not be adequate to provide mass sanitation supplies to those developing countries.

As another aspect, effective resource recycling is an inevitable issue for the world’s sustainable future. In both developed and developing countries, resource recycling from domestic wastewater including human excreta is an inevitable topic. Some resource recycling sanitation technologies have been proposed and tested over the last few decades (e.g. Lopez et al., 2001; Winblad & Simpson, 2004). These technologies are also promising as suitable solutions for developing countries with poverty, poor infrastructure, instability of government, and severe environmental conditions, because resource recycling sanitation technologies do not require expensive infrastructures such as pipe systems. In fact, many engineers and practitioners have been considering and trying to apply them to developing countries, including sub-Saharan Africa (e.g. Rüd & Münck, 2008; Matsebe & Osman, 2012).

Thus, the world’s situation demands a sanitation system that has higher sustainability and applicability to developing countries, and many studies and projects have been carried out to implement one. However large-scale success still cannot be found (Haq & Cambridge, 2012). The authors consider that the above-mentioned situations mean that the current sanitation concepts or schemes may not be sufficient to solve those stagnations in sanitation matters. This study aims to clarify the limitations of the current sanitation system concept and the features of the next-generation sanitation concept required for the future, and to discuss the sanitation business model as a suitable approach for this next generation of sanitation. This study also describes a sanitation business model for a rural area of Burkina Faso as a practical case model.

2. Nature of the conventional sanitation concept and required new policy

2.1. Three sanitation generations

This study categorizes sanitation systems into the following three generations or eras: Primitive Sanitation, Modern Sanitation, and Postmodern Sanitation. Systems that rely on only natural purification and natural material cycles are categorized as Primitive Sanitation, such as open defecation, toilets over the river, and open ditches. This sanitation system is quite simple, requiring little or no cost, however, the control of pollutants and pathogens is not adequate, especially in highly populated areas, owing to the incomplete separation of the human excreta from the human living environment.

The next phase, Modern Sanitation, is defined as sanitation aiming at the safe separation and disposal of human excreta from the human living environment. Urbanization and modernization made it difficult for people to continue Primitive Sanitation habits, as in highly populated areas it causes unsanitary conditions and makes it easy for a serous pandemic such as cholera to spread (Griffith et al., 2006). A sewer system, which separates human excreta by a piping network, was one of the critical solutions. Although it is known that some early historical cities, such as Rome, had primitive sewer systems, those
technologies did not continue after the Roman Empire collapsed, and people had to wait until the 18th century for the development of the modern sewer system (Lofrano & Brown, 2010).

In the 18th century, the Industrial Revolution occurred in the United Kingdom, and the wave of industrialization spread all over the world between the 19th and 20th centuries. Industrialization enhanced the development of Modern Sanitation technology such as the water flush toilet and related plumbing technology (Maeda, 2008; Lofrano & Brown, 2010). On the other hand, industrialization also enhanced urbanization and serious environmental pollution (Lofrano & Brown, 2010). After this experience, people found that the disposal of human excreta required treatment before its discharge into the natural environment. Now, the same concept, safe separation, treatment and disposal of human excreta, is applied to decentralized systems such as community plants, Johkasou (JECES, 2009) and septic tanks. This article also considers such decentralized sanitation systems as Modern Sanitation.

The World Health Organization (WHO) noted ‘sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces’ (WHO, 2013a), and conventional approaches to sanitation projects including activities for MDGs are basically aimed at replacing Primitive Sanitation with Modern Sanitation.

2.2. Limitations of the Modern Sanitation concept

Basically Modern Sanitation systems are managed as public services, and the budget recovery rate is generally not good. For example, the Japanese centralized sewerage systems are managed by a sewerage agency that belongs to the municipality, and the sewer tariff is collected together with the water tariff. However, total annual budgets of sewerage systems are covered by sewerage tariffs of only 38% as a national average (MLIT, 2013) though few people decline to pay. The remaining parts of the budget are covered by municipal budgets on the basis of government tax.

The decentralized Johkasou system, which is one of the successful examples of a decentralized system in Japan, also depends on governmental support to a large extent even though the responsibility to manage the Johkasou belongs to individual users; up to 90% of the initial cost of the Johkasou system is subsidized by central or local government (JECES, 2009). Furthermore, the Johkasou requires periodic sludge removal, and the removed sludge is treated in a night soil treatment plant that is managed by local government, originally built for treating excreta from traditional Japanese pit latrines (JECES, 2009). Thus, the decentralized Johkasou system cannot function without governmental support and public services.

These two major successful Japanese cases basically work as public services, which aim for public benefit on the basis of an effectively designed social and administrative system; this system requires: (1) users’ positive participation through paying a tariff for the sewer system, and government tax, which supports the sanitation system costs in some part; (2) a high level of governance to realize the policy; (3) sophisticated organizations that support realization of the governmental policy; (4) a financial support system; (5) accountability and strategic advertising; (6) the economic background of the government to support this system; and (7) technologies.

Contrary examples can be seen in the urban slums of Southeast Asian countries. In such areas, the number of water flush toilets has been increased but many of them do not have a treatment facility (Ishikawa et al., 2002; Harada, 2007; Ushijima, 2007); they just discharge their toilet wastewater directly into the river. However, due to the nature of the river system, the direct discharge affects the living environment of downstream people in an adverse way, such as insanitary conditions with bad...
odors, while not directly affecting the people responsible for the discharge. Ushijima et al. (2013a) conclude that this situation is an inevitable result of people’s value judgments, because installing an individual treatment facility would give users only an obligation to pay for the management cost but with no clear benefit at an individual level.

The comparison between the Japanese case and the Southeast Asian urban slum case shows that with the Modern Sanitation system it appears difficult to give a sufficient incentive to invest in a treatment facility at the individual level because the return on the individual investment will not come back directly to the person who invested (Ushijima et al., 2013a). Therefore, it can be concluded that a well-designed public service aspect is necessary for the Modern Sanitation concept, at least in some part, otherwise unfavorable disposal might occur due to value judgments at an individual level. These value judgments are strongly influenced by the culture, habits, religion and economic capacities of communities (Sintawardani & Tri Astuti, 2008). If the situation does not provide a well-designed public service, some kind of clear and direct incentive to lead the individual to appropriate disposal is required.

2.3. Resource-oriented sanitation

Generally, most humans urinate and defecate as a daily activity, and human excreta contains rich nutrients such as nitrogen and phosphorus (Lopez et al., 2002; Maksimovic & Tejada-Guibert, 2003). It is clear that human excreta represents a massive potential resource for world agriculture. The total amount of nitrogen and phosphorus in the world’s human excreta represents 40% of the nitrogen and 19% of the phosphorus of the world’s fertilizer consumption (calculation based on FAO (2012) and Maksimovic & Tejada-Guibert (2003)). Furthermore, an important feature is that the resource of human excreta is almost equally distributed according to population and originally it belongs to the people, rather than a specific private company or government. Therefore, if an appropriate value chain was prepared for human excreta and the products from human excreta, namely, agro-sanitation products such as vegetables grown with treated human excreta, people could start their own business based on their own resources. This idea gives the opportunity for people to overcome issues of poverty and poor sanitation by themselves.

Concepts and technologies to recycle human excreta have been proposed and tested in the last few decades and summarized information is available (e.g. GTZ, 2010). These are regarded as promising concepts and technologies to provide a sustainable way of sanitation, and to provide low cost, low energy-consuming sanitation. Economic evaluations have also been conducted by some researchers (summarized by Mara (2008)). However, most of the current studies discuss the subject from the sanitation technology side. Only a few studies have discussed systems to create and add value from human excreta (Fogelberg et al., 2010; Hijikata et al., 2012, Ushijima et al., 2013a). Resource recycling technology itself is just a tool that has the potential to increase the value of human excreta. What brings benefit to individuals is the sanitation value chain, and therefore the discussion should start with the value chain of sanitation products.

The reason why the current discussion does not include the value chain seems to be the nature of the Modern Sanitation concept. Basically this concept does not require discussion on the value chain because Modern Sanitation is usually designed as a public service on the basis of tariffs and government tax. Therefore, the main task is to treat harmful or unpleasant materials and to dispose of them into the natural environment. Thus, the Modern Sanitation concept is not concerned with creating a sanitation value chain to add value and connect it to the market. In fact, the difficulty of the current resource
recycling sanitation practice is the exit design of the sanitation products (Fogelberg et al., 2010; Ushijima et al., 2011). In order to manage human excreta or agro-sanitation products as resources, the product should be treated in a business manner, including quality control, marketing, and a distribution network, otherwise the agro-sanitation products will not have sufficient value in the market. If the agro-sanitation products do not have sufficient value, material flow will not work and human excreta will not have anywhere to go as a business proposition.

One interesting and important example is the old Japanese model, known as the Edo period sanitation model (Watanabe, 1983; Onjo, 2004; Mitsumata, 2008). In Japan, human excreta has been used in agriculture since around the 10th century. In the Edo period (1603–1869) particularly, human excreta was traded with a monetary value, and this system was managed under the market system, not by the government. This system was still functioning up until the early 20th century. However, the Edo model is not able to separate human excreta completely, so it should be categorized as Primitive Sanitation. However, its value chain system and material balance provide a number of useful ideas, and, interestingly, the Edo model system was automatically optimized under the market (Ushijima et al., 2012b).

2.4. Basic policy of Postmodern Sanitation

On the basis of the discussion of the current sanitation system described in Sections 2.2 and 2.3, a new sanitation concept seems necessary to achieve breakthrough, considering the limitations of the current modern system and concept. The new concept, enhancing independent development by people on low incomes living in slums or traditional rural areas, will be the key to solving both the poverty and sanitation issues. Thus, this article proposes the Postmodern Sanitation concept, which has the following basic policies.

(1) Put a sanitation value chain at the center of the discussion, and prepare a sanitation business model to drive this value chain.
(2) Design the sanitation business model focusing on incentives for individual toilet users.
(3) Analyze the current users’ value chain including food, sanitation and agriculture, and find available potential resources in and around the sanitation material flow.
(4) Find an effective way to connect the potential sanitation resources to the next value chain, which in most cases would be agriculture.
(5) Make a financial system plan based on a market analysis of the sanitation product, and use that financial system to support individual users as sanitation resource providers.
(6) Find and mobilize facilitating organizations to support the individual toilet users’ businesses as resource providers.

3. Sanitation business model: the case of a rural area in Burkina Faso

3.1. Case field

The approach and concept of Postmodern Sanitation were applied in the case of a rural area in Oubritenga province, Burkina Faso. According to the law of public sanitation in Burkina Faso (No. 022-2005/AN),
house owners have a responsibility to construct wastewater treatment facilities on their land and manage them appropriately. However, there are no clear strategies, detailed supporting systems or technologies mentioned in the law. The reality of the situation is that the proportion of the population who have access to basic sanitation facilities is only 6% in the rural areas of Burkina Faso (UN, 2010). Although urination is done in a shower space, open defecation is still common (Ushijima et al., 2012a). The under-five mortality rate in Burkina Faso is 169 per 1,000 live births, and this mortality rate is the eleventh-highest in the world, with 19% of these deaths caused by diarrhea (WHO, 2010). Water and sanitation are clearly urgent issues in Burkina Faso.

However, the application of a Modern Sanitation system, which requires a high level of governance and economic background, seems difficult in the short term. GDP is only 1,149 USD capita\(^{-1}\) yr\(^{-1}\) (in Purchasing Power Parity (PPP) 2005 according to WHO (2013b)), and the Human Development Indicator (HDI) is the fifth-worst in Burkina Faso, out of 186 countries (UNDP, 2013).

Burkina Faso is essentially an agricultural country. More than 90% of the population live on agricultural activity (FAO, 2012), and 33.8% of the GDP is produced by agriculture (World Bank, 2013). However, the environment for agriculture is severe. Burkina Faso is located in the sub-Saharan region and its climate belongs to the semi-arid type, which means low precipitation, and, furthermore, irrigation facilities are very rare in rural areas. The main soil type is lixisols, which require frequent fertilization and careful erosion control (Driessen & Deckers, 2001).

The case field is two rural villages in the Ziniaré commune, Oubritenga province in Burkina Faso. Ushijima et al. (2012a) observed and described daily life in the light of material and value flows relating to water, sanitation and agriculture in and around rural households in the target area.

### 3.2. Current value chain in and around rural households

According to Ushijima et al. (2012a), the features of daily life in the target villages can be described as follows. The main activity is crop cultivation to make food for self-consumption. However, crop cultivation is possible only in the short rainy season, which generally corresponds to June–September. One of the major income sources is vegetable production. They have two types of vegetable garden, which are different from crop fields. One is a small garden (e.g. 10 m\(^2\)) located near to the house. Products from this garden are vegetables for self-consumption but extra produce is sold in the market. This type of small garden is generally available only in the rainy season because there are no irrigation facilities near the house. The other type is a comparatively large garden (e.g. 1,000 m\(^2\)) located alongside reservoirs or shallow wells. This type of large garden is available even in the dry season. Products from these gardens are vegetables for selling. Generally, people put most of their working effort into crop production in the rainy season, and vegetable production in the dry season. People use synthetic fertilizers only for the vegetable gardens, but the amount available is limited by their individual economy. Generally, fertilizer use is at a low level (Crawford et al., 2006).

People’s main water source is a deep well, of which there exist 3–5 in a single village. Water from the deep well is used for drinking, cooking, bathing and dishwashing. Some also use this water for laundry, but others use water from the reservoir or shallow well for laundry. All wastewater is disposed of in the ground, except for some of the dishwashing wastewater that is given to livestock.

Figure 1 shows a schematic diagram of the current material flow and value chain in and around rural households, based on the field data of Ushijima et al. (2012a). This shows four important value flows, as follows. (1) People put a large part of their working effort into crop fields in order to obtain their food.
Fig. 1. Current material flow and value chain in and around rural households.
Water for crops is a critically important resource but it depends on natural precipitation, and therefore it is not controllable. (2) A clear monetary income flow is vegetable production. However, this requires the cost of fertilizer and seeds. The location of the garden is also a limiting factor. (3) People put in a lot of work to obtain their daily water from deep wells. However, after using the water, the household’s wastewater is just disposed of, without any treatment. (4) Human excreta is also just disposed of, although it contains nutrients for crop production.

3.3. Framework of the sanitation business model for rural households in Burkina Faso

A direct way to connect the sanitation value chain appears to be as shown in Figure 2. In order to create value in the market and obtain sufficient compensation, the essential points are: finding good channels to the market; producing a high quality and quantity of the agricultural product from currently available resources; obtaining sufficient quality and quantity of fertilizer; and avoiding contamination of products and resource materials in each process. In addition to these four points, it is clear that additional resources for this single value chain are necessary for each process. For example, farming needs good quality of irrigation water, seeds, a workforce, well-managed soil, and so on.

In this context, Figure 1 suggests that (1) the vegetable garden is currently the existing channel to the market, (2) the current small vegetable garden near the house lacks sufficient fertilizer and irrigation water, especially in the dry season, (3) human excreta is a potential fertilizer source, (4) disinfection of sanitation products must be optimized for agricultural use, and (5) gray water is a potential water source for supplementary irrigation water. As a result, a promising new sanitation value chain network can be proposed as shown in Figure 3. In this value chain, farmers will increase their income through vegetable cultivation, especially in the dry season, by using treated gray water as irrigation water, and human excreta as fertilizer. In this sense, composting toilet and gray water treatment facilities function not only as sanitation facilities but also as assets to increase agricultural products, which can be called ‘agro-sanitation assets’. In this model, farmers invest in agro-sanitation assets in order to increase their income from the vegetable garden. If this value chain functions well, the income increase becomes a good incentive for individual toilet users to invest in and manage those agro-sanitation assets, which also function as sanitation facilities.

Fig. 2. Single sanitation value chain.
Fig. 3. Proposed sanitation value chain network in and around rural households.
Ushijima et al. (2013b) quantitatively estimated available agricultural resources in the material flow of rural households, and found that irrigation water is a strong limiting factor (Figure 4). Thus, in this target area, obtaining an irrigation water source is a key factor for the effective use of excreta resources. Hijikata et al. (2012) proposed an example of crop rotation for a small vegetable garden based on the same concept as this study, and estimated an optimum income increase of about 40–100 USD yr\(^{-1}\) person\(^{-1}\). This increased income can be considerable for farmers when compared with the average GDP in Burkina Faso of 1,149 USD capita\(^{-1}\) yr\(^{-1}\) (converted in PPP 2005 (WHO, 2013b)).

In order to realize the value chain shown in Figure 3, a more detailed business model should be proposed. Figure 5 shows a schematic diagram of a practical business model for this concept. In order to support this system, the facilitating organization becomes a key actor who provides three main functions. The first is providing micro-finance, because generally farmers do not have the capital to invest in assets. The second key function is technical support for vegetable farming, because their farming techniques need to be upgraded in order to maximize the production. The third key function is marketing support, because farmers also need to upgrade their marketing ability to sell the agro-sanitation products at a good price. In this business model, the farmers are not only the providers of the vegetables but are also consumers of the agro-sanitation assets.

4. Discussion

4.1. Advantages of the Postmodern Sanitation concept

It is clear that the Postmodern Sanitation system, which is based on the resource-oriented concept, has higher sustainability in terms of resource management. But the most important feature of Postmodern Sanitation, which is based on the value chain of agro-sanitation resources, is that sanitation resources belong to the individual toilet user, as mentioned in Section 2.3. The sanitation resources in the concept of Postmodern Sanitation are recognized not only as agricultural resources but also as business resources for individual toilet users. People who do not have access to basic sanitation usually live in low-income conditions and many of them are excluded from the market economy. Designing the sanitation value chain and agro-sanitation business model, in order to increase the value of sanitation resources, gives a big opportunity for those on low incomes to gain the benefits from their own resources. The expectation of clear benefits by the people becomes the internal driving force for sustaining the sanitation

Fig. 4. Expected cultivatable area using composting toilets, a urine collection system, and a gray water reclamation system.
system and also for spreading basic sanitation all over the world. Thus, in order to maximize the advantage of the Postmodern Sanitation concept, the system must be designed with the priority of increasing the value of the sanitation resources, and providing direct benefit to the users.

The Postmodern Sanitation concept also has an advantage in the cost aspect. Whereas the Modern Sanitation system requires continuous input of a budget to install and manage the system, the Postmodern Sanitation system, for example as in the case study (Figure 5), just requires an initial investment for the facilitating organization to manage the micro-finance, and this capital is reusable unless the sanitation business fails. This means that the Postmodern Sanitation system has high sustainability in economic terms also.

In the Postmodern Sanitation system, the central government does not have to manage the whole project as it does with a sewerage system, and it does not have to prepare a huge budget. The governance issue in the Postmodern Sanitation concept becomes more localized and market-based, like the Edo period model (Ushijima et al., 2012b). In developing countries particularly, the local community based on ethnicity or traditional groups sometimes has greater importance for people (e.g. Nakanishi, 1991), and sometimes the local community is in conflict with the central government (Hyden, 1980, 2006; Nabeshima, 2011). Thus, in terms of the management unit, locally based management of Postmodern Sanitation seems realistic in developing countries.

The Postmodern Sanitation concept also has an advantage in the system design procedure. Because the main purpose is to increase the value of the sanitation resources, the system optimization proceeds by considering the required additional resources and supporting systems; for example, in the case study
of Burkina Faso, not only the urine and feces but also the water and workforce were taken into account. Furthermore, the destination of excess urine and compost should also be discussed, because the crude value chain concept (Figure 2) has already implied that water or the workforce may be a limiting factor. Thus, designing the system by considering the value chain gives an idea of related important factors, and a more comprehensive and practical point of view for the system designer or planner.

A practical system designing process based on the value chain also gives a clear policy and the requirements for each technology selection; for example, in the case of Burkina Faso, the proposed business model focused on a small vegetable garden, therefore the technological policy and requirements for gray water reclamation were to minimize the loss of gray water collection with minimum treatment in order to use it for irrigation. In this context, targeted factors can just focus on detergents, pathogens and biodegradable dissolved organic carbon (BDOC) (Ushijima et al., 2013c).

4.2. Effective approach for Postmodern Sanitation

On the basis of the six policies outlined in Section 2.4, this study has designed a feasible Postmodern Sanitation model for the rural area of Burkina Faso. In the designing process, material flow analysis (MFA) and value chain analysis (VCA) were important tools to analyze the current value chain, finding available potential resources (policy 3 in Section 2.4.) and an effective way to connect to the agricultural value chain (policy 4 in Section 2.4.). MFA and VCA were also useful in understanding the structure of the value and benefit exchange in and around households, which was necessary for designing the sanitation business model to focus on incentives for individual toilet users (policy 2 in Section 2.4). VCA also helped in designing the financial plans required for the sanitation system (policy 5 in Section 2.4.), because VCA includes cash flow information. Furthermore, the assessment of the exit capacity, that is, the market size for the sanitation products, is critically important for the success of the sanitation business. If the capacity were overestimated, excess sanitation products would not have an outlet and the sanitation system would stop immediately. Quantitative market size assessment based on MFA and VCA increases the likelihood of succeeding.

In the Modern Sanitation system, which is a disposal system, material flow and value flow are basically a single line from the household to the natural environment, through the collection and treatment system. Branch flow only occurs if valuable by-products are isolated. Therefore, the system is simple enough to design without MFA and VCA. On the other hand, in the Postmodern Sanitation system, which is a producing system, material flow and value flow are multiple mechanisms because all the required resources to make the agro-sanitation products have to be taken into account. Thus, MFA and VCA appear to be necessary processes in designing the Postmodern Sanitation system.

Regarding the business model designing process, there are many methods and tools to build it. For example, the business model canvas proposed by Osterwalder & Pigneur (2010) gives a simple but comprehensive way to build a business model. However, the relationship between the provider and consumer is not so simple in the Postmodern Sanitation business model. So far, the authors have not found effective methods and tools for these multiple relationships of provider and consumer. Even if the system designer has no choice about using simple methods and tools, the above-mentioned multiple relationships of providers and consumers should be carefully analyzed and considered.

From the organizational aspect, some kind of facilitating organization seems to be necessary. In the case study on Burkina Faso, the authors found that the facilitating organization should have functions of micro-credit for initial investment, marketing support to sell the agro-sanitation products in better
conditions, and agricultural technical support for the farmers to increase productivity and marketability. Potential candidates for this actor are NGOs, private companies, farmers’ unions, and so on. This aspect is very practical and therefore it makes sense to contact and collaborate with those practitioners.

4.3. Topics requiring further accumulation of knowledge and know-how

The Postmodern Sanitation concept discussed in this article still has many areas that need further knowledge and know-how. Major topics for further discussion are quality control, risk management systems, marketing systems, and individual value judgment systems.

Because the agro-sanitation model is a business, quality control is required throughout the process in order to keep sales stable. Although the Postmodern Sanitation system contains a motivating function for individual toilet users, it does not seem to be sufficient. Quality control needs to cover all of the sanitation value chain, therefore the whole package of the method and technology for quality control of the sanitation products has to be developed.

The Postmodern Sanitation system also has the risk of failure of the business. If it were a general industrial product, it would mean just the failure of one company; however, the failure of the sanitation business also means the collapse of the sanitation system, and the social damage is much larger. In fact, the Edo model, which was managed as a market, collapsed due to the emergence of low-priced synthetic fertilizer, and the Japanese government had to take on the role of human excreta management from that period (Onjo, 2004; Mitsumata, 2008). Some kind of risk management system that absorbs the fluctuations and uncertainty of market-based systems seems necessary.

Other points of uncertainty are the actual market capacity, acceptability of agro-sanitation products, and the value judgment systems of individual toilet users. There have been some studies on psychological resistance or acceptability of sanitation systems (Wilke, 2003; Rosenquist, 2005); however, it is still difficult to definitely predict people’s acceptability given the incentive of an income increase.

5. Conclusions

This study has aimed to describe the features of the Postmodern Sanitation concept that is desirable as a next-generation sanitation concept. The conclusions are as follows:

- Human excreta is a massive potential resource for agriculture in the world, and this resource is originally distributed to people equally. Therefore, it can be an important business resource especially for people with low income in developing countries.
- If an appropriate value chain for sanitation resources and products is provided, it can be the solution for both poverty and sanitation issues.
- The Postmodern Sanitation concept was proposed with the following policies:
  1. Put a sanitation value chain at the center of the discussion, and prepare a sanitation business model to drive this value chain.
  2. Design the sanitation business model focusing on incentives for individual toilet users.
  3. Analyze the current users’ value chain including food, sanitation and agriculture, and find available potential resources in and around the sanitation material flow.
(4) Find an effective way to connect these potential sanitation resources to the next value chain, which in most cases would be agriculture.

(5) Make a financial plan based on market analysis of the sanitation products, and use it to support individual users as sanitation resource providers.

(6) Find and mobilize a facilitating organization to support the individual toilet users’ businesses as resource providers.

- Because the material flow and value chain are complex mechanisms in the Postmodern Sanitation system, which is a producing system, MFA and VCA seem to be the fundamental analysis tools for designing the Postmodern Sanitation system.
- An accumulation of knowledge and know-how is required for the method and technology package of quality control for sanitation products, development of a risk management system to stabilize the sanitation business, agricultural marketing based on agro-sanitation products, and an effective incentive or motivating scheme for individual toilet users.

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