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Chapter 5

Sanitation services

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Chapter objectives

The aim of this chapter is to describe the sanitation services value chains (SSVC) activities, services, benefits, and satisfaction that are offered for sale, and/or provided to enhance access to safely managed facilities for safe disposal of human waste (faeces and urine), as well as ensuring adequate hygienic conditions within and around sanitation infrastructure. Services differ from products (facilities) in many ways, but are inseparable (simultaneously delivery and consumption), intangible (can only be experienced), perishable (can't be stored) and heterogenous (variable in performance of the same service).

5.1 INTRODUCTION

Globally, millions of large and small private enterprises and public ventures including a combination of the two are involved in the provision of valuable sanitation services to millions of households and communities. Within both groups exist many 'sanitation entrepreneurs' who seek to grow their businesses in a sustainable manner by providing value addition services to their customers. Sanitation services are described as activities, benefits, or satisfaction which are offered for sale, or are provided, in conjunction with the sale of goods to enhance access to safely managed facilities for safe disposal of human waste (faeces and urine), as well as ensuring adequate hygienic conditions within and around the sanitation infrastructure (Hamilton, 2004). Sanitation services differ from products (facilities) in many ways but are inseparable (simultaneously delivery and consumption), intangible (can only be experienced), perishable (can't be stored) and heterogenous (variable in performance of the same service) (Bhadwal, 2015). When the service has been completely rendered to the end-user, this particular service becomes irreversible and the service provider must deliver the service at the exact time of service consumption.

The service is not manifested in a physical object that is independent of the provider and also service end-users are not inseparable from service delivery (Wikipedia contributors, 2021). For example, the end-user must sit in the toilet/latrine and the emptier must be

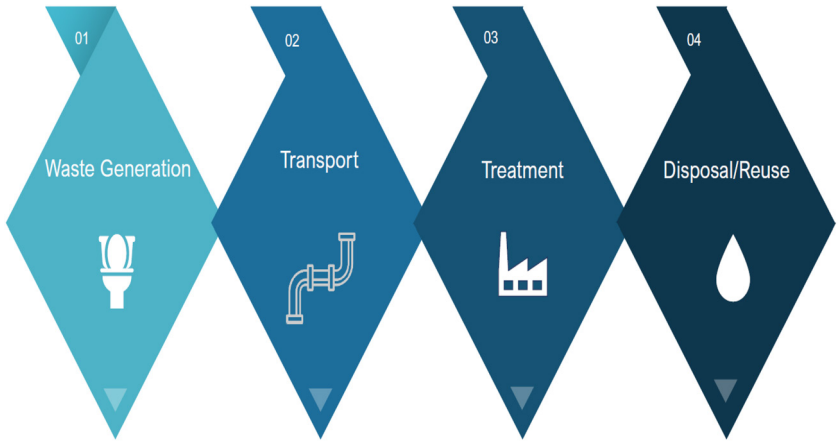

Figure 5.1 Conventional sanitation service chain. (Source: Frost & Sullivan (2021). Under CCA 4.0 license, © 2021 by authors.)

called upon to deliver their services of dislodging of the septic tank. Therefore, services include all sanitation value chain (SVC) activities where output are not a physical product or construction, and usually consumed when produced, and delivered as intangible value-added activities to end-users of the sanitation service chain (SSC) – for example emptying of toilets/latrines (Hamilton, 2004). Furthermore, sanitation services entail the payment of money for the provision of a technology or waste-related service, and overlooking the end-users' perspectives could lead to the development of inappropriate technologies and services (O'Keefe *et al.*, 2015). The sanitation services chain can be conceptualized in three different ways:

(I) Conventional sanitation services as shown in Figure 5.1, depicting sewered sanitation service provision with excreta flushed away using a fully waterborne sanitation system for transport via networks of sewage pipes connecting each toilet to a main link leading to a treatment facility; treated sewage results in sewage sludge and effluents that are then disposed of (Frost & Sullivan, 2021).

(II) Containerised sanitation services, as shown in Figure 5.2, which collect excreta in containerized systems that are basically dry systems. Urine diversion mechanisms are often installed to reduce the volume and weight of the faecal container; once the containers reach capacity, they are replaced with empty clean containers. Containerized faecal matter is collected from generation sites such as residential homes and schools, and the faecal matter is then transported to treatment facilities where resource recovery can take various forms to derive products such as compost, biogas, animal feed and briquettes (Frost & Sullivan, 2021).

(III) On-site and/or non-sewered sanitation services, as shown in Figure 5.3, provide management in which generated faecal matter is collected and contained in tanks below ground. The level of onsite treatment depends on the technology, which could range from pit latrines to septic tanks. Once the tanks have reached capacity, they are emptied using pumps to remove the faecal matter and load it to a vehicle for transport to a treatment facility where it undergoes further treatment and resource recovery, which can take various forms (Frost & Sullivan, 2021; TNUSSP, 2018).

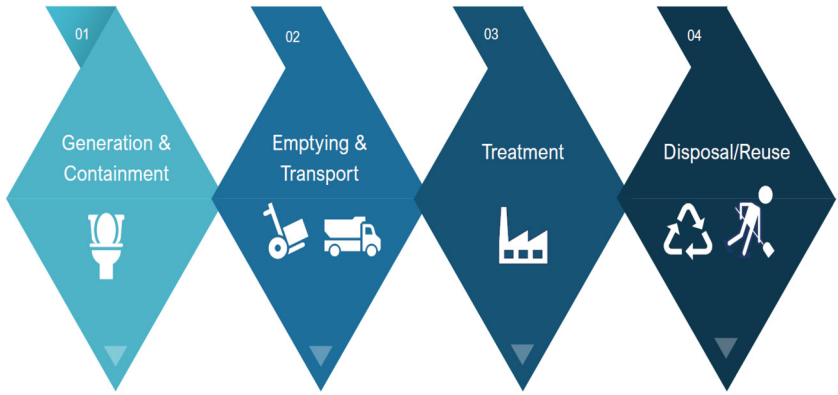

Figure 5.2 Containerized sanitation service chain. (Source: Frost & Sullivan (2021). Under CCA 4.0 license, © 2021 by authors.)

(IV) The service chain taps into the sanitation economy with smart sanitation incorporating technologies such as mobile applications to improve efficiencies in the sanitation service value chain (SSVC). These applications connect service providers and customers, facilitate remote payment, and track health data to prevent spread of diseases (Frost & Sullivan, 2021). SSVC also taps into the residential markets accounting for the majority of installed user interfaces, either connected to sewered sanitation systems or loosely connected to the non-sewered sanitation service chain. There is a vast commercial market for service provision, which includes the office and banking sectors, retail sectors and industrial establishments, warehousing spaces and public spaces such as schools, open spaces, markets, parks and gardens (Frost & Sullivan, 2021; Koottatep *et al.*, 2019c).

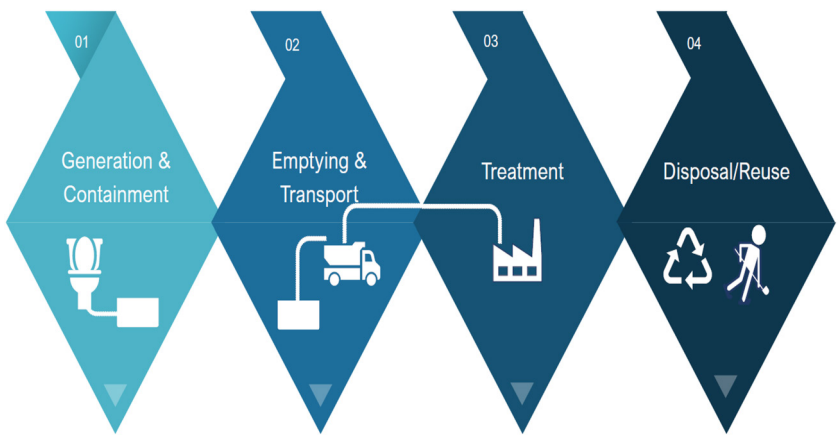

Figure 5.3 On-site and/or non-sewered sanitation service chain. (Source: Frost & Sullivan (2021). Under CCA 4.0 license, © 2021 by authors.)

5.2 SANITATION SERVICE ARRANGEMENT

Sanitation services entail the payment of money for the provision of technology or waste-related service. These services exist throughout the sanitation system, from households through the collection and transport of waste to treatment plants (O'Keefe *et al.*, 2015), see Figure 5.4. It aims to address both health and environmental issues. The stages of generation, capture and storage of excreta and or faecal sludge are primarily associated with improvement of household health levels, in order to collect and remove the excreta either through transportation or through networks of pipes.

Businesses/entrepreneurs need to provide toilets and/or latrines through improved designs that effectively capture and store the excreta and/or faecal sludge until it can be emptied or conveyed by networks of pipes. Faecal sludge and/or sewage can only be treated if it has been collected. The stages of transportation/conveyance, treatment and disposal or end-use have a wider environmental focus (Medland *et al.*, 2016). Sanitation services are delivered from sanitation infrastructure whether sewered (centralized or off-site) and/or non-sewered (decentralized or on-site) at public and private levels and must take into account all the technical aspects of the services, and all economic, social, organizational, institutional and environmental aspects (Koottatep *et al.*, 2019a,b,c; van Welie *et al.*, 2019).

Sanitation services cover series of businesses and entrepreneurs delivering value-added services to customers/users and relates to infrastructure operations and maintenance, collection, emptying, transport, treatment and disposal/reuse. It also includes value-added businesses that provide facilities and services for the safe management of human excreta from the toilet to containment and storage and treatment onsite or conveyance, treatment and eventual safe end use or disposal.

In addition, providers that offer sanitation services (e.g., building latrines, emptying pits) and those that sell sanitation products (e.g., manufacture of plastic toilets, making soap and other hygienic products) are part of this group. The off-site services are delivered with a sequence of several individual sanitation processes where each individual process represents a step of the sanitation service value chain (SSVC) that is mainly operated and/or delivered by public business/enterprise organizations. On the other hand, the

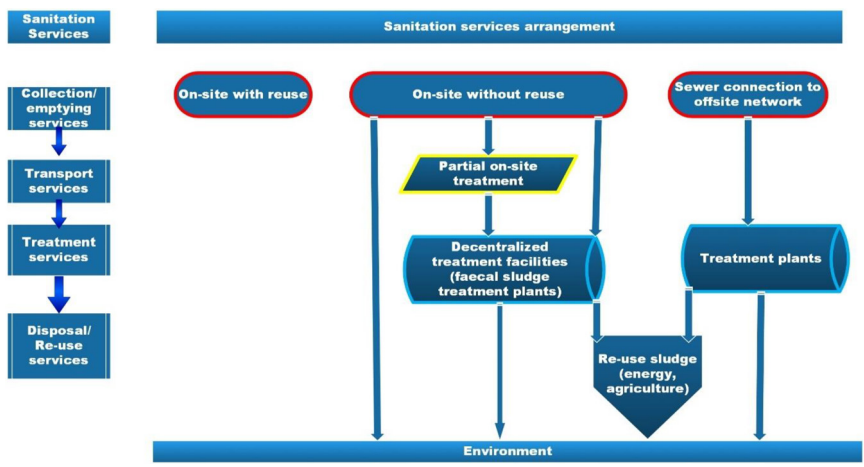

Figure 5.4 Sanitation service chain (Source: authors).

Box 5.1

Household expenditure on sanitation services in Nigeria (FMWR *et al.*, 2020). Access to sanitation indicators across Nigeria shows a slight improvement from 42% in 2018 to 44% in 2019, which is equivalent to a 6.6 million increase in the number of persons accessing basic sanitation services. Of the number of people using at least a basic sanitation facility, 21% use safely managed sanitation services, a two-percentage point increase from the 2018 findings (FMWR *et al.*, 2020). Households spent a total of ₦61 billion ($199 million) on sanitation services in 2018, whereby 38% was spent on bills and levies, 30% on toilet emptying and 21% on construction. In total, households spent the sum of ₦2 trillion ($6.6 bn) in 2018 on hygiene services. The bulk of the hygiene expenditure was on purchasing or replenishing bathing and laundry soaps (44%) and washing materials and equipment (23%) (FMWR *et al.*, 2020).

This is indicative that people are not just willing to, but actually do pay for sanitation services in Nigeria. The critical focus is on providing sufficient coverage and quality of on-site sanitation in order to improve the health and living conditions of the population and also reduce contamination of groundwater and water bodies. Continuous efforts are needed towards understanding and collapsing the barriers and drivers to adoption and usage of improved sanitation facilities and developing effective behaviour change interventions to curb open defecation.

Source: https://www.nigerianstat.gov.ng/pdfuploads/WASH%20NORM%20II%20Final%20Report%202019.pdf

on-site sanitation services are made up of several private businesses/enterprises, and in some cases public utilities (treatment plant operations), which usually synergistically combine to provide a complete sanitation services system to end-users (Koottatep *et al.*, 2019a), see Box 5.1. Services can be divided into two types: operational services and support services. Operational services directly support or perform outsourced business operations of sanitation enterprises. They are made up of the business models of the sanitation service value chain (SSVC). Support services in turn provide services that benefit groups of service value chain operators (Springer-Heinze, 2018b).

If sanitation services are not well developed and are inadequate and unsustainable, service providers will find it difficult to deliver the right services in terms of quantity, quality and price to service end-users. Service market failure means that service costs will be too high and capable of limiting economic and technical efficiency (Springer-Heinze, 2018b) and negatively impact service arrangements. Sanitation services are conceived of as a system of at least three elements (Albert, 2000): service end-users demanding, paying and receiving service; service providers delivering the service products; and service arrangements defining the organization of service delivery often including third parties providing regulatory and funding functions (Springer-Heinze, 2018a, 2018b). It, therefore, becomes imperative that players on the SSVC should not downplay consumer demand and desire for functionality, practicality, aesthetics and affordability.

Figure 5.5 shows service conceptualization dominated by private enterprises providing services to end-users of non-sewered sanitation systems. These service arrangements in many locations, are handled by the informal and private sectors or a mix of public and private operators. In many settings, the service falls outside regulatory frameworks,

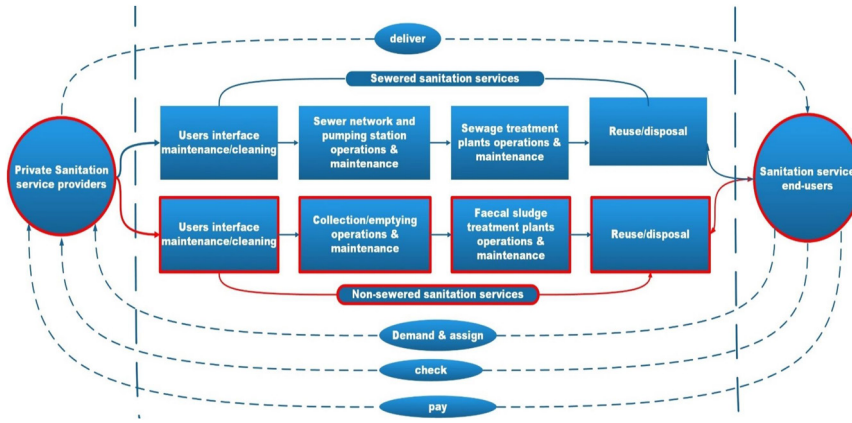

Figure 5.5 Concept of private enterprises' sanitation service arrangement (Source: authors).

policies or utility jurisdictions (Rao *et al.*, 2017). The elements in the service concept are closely interlinked. Essentially, the sanitation service value chain interactions has two parties : the service providers and the end-users (customers). The verbs placed into the arrows (in Figures 5.5 and 5.6) denote the main functions taken by either side. The relationship is a closed cycle in which service providers get clear incentives and clients have control over the service process. The service delivery system works only when both sides (private service providers and service end-users) take their role seriously. In reality, this is not always the case. Government and/or international donor agencies sometimes tend to subsidize particular operational services (Springer-Heinze, 2018b). For example, private emptying enterprises will not expand their offer until and unless potential service end-users express their demand effectively (Springer-Heinze, 2018b). In the same vein, if service end-users are not satisfied with the quality of the service provided or are not

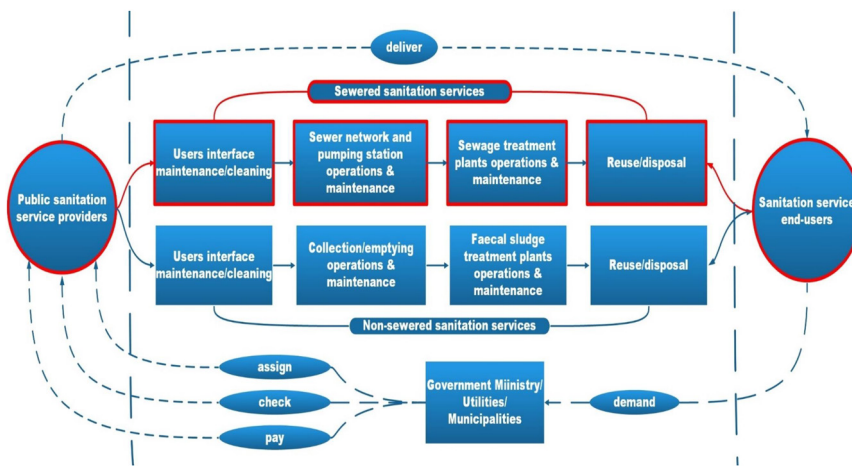

Figure 5.6 Concept of public services' sanitation arrangement (Source: authors).

convinced that they need such services, they will not demand and/or be willing to pay for such services. This service arrangement is common in Africa and South Asia where a larger proportion of faecal waste is handled by non-sewerage systems and highly problematic because businesses *lack the necessary information* to make faecal sludge management a functional component of the sanitation value chain (Rao *et al.*, 2017).

In Figure 5.6 the role is split between three parties which can either be the government, ministries/utilities and/or municipalities providing sanitation services to end-users (Huppert & Urban, 1998) and it is a much more complex form of organizing service delivery. The final recipients of the service have little influence on the service provided and their expectations might differ from those of the public service providers. Hence, there is a gap in the service system because the incentives are impaired (Huppert & Urban, 1998; Springer-Heinze, 2018b). In Figure 5.6, sewerage systems are mostly provided by government agencies that act as public operators (i.e. an organization mainly owned and controlled by the government) who also regulate or operate wastewater treatment plants and establish policies on environmental sanitation (BMGF, 2012; Rao *et al.*, 2017).

5.3 SANITATION SERVICES VALUE CHAIN (SSVC) MAPPING

From environmental and operational perspectives, it is important to assess sanitation services through the full value chain starting with access at household or property level and on to final disposal/reuse. From the generation of excreta to its final disposal or reuse, the journey flows through functional groups including conveyance, treatment, disposal and reuse. This approach helps to see the value chain of sanitation services from functional grouping perspectives of user-interface, collection and storage, conveyance, treatment and disposal/reuse for non-sewered sanitation (BMGF, 2011; Mehta & Mehta, 2013). On the other hand, sewered sanitation services examine the value chain of sanitation services from wastewater collection, treatment of wastewater, disposal and recovery of resources (Chofreh *et al.*, 2019) as shown in Figure 5.7.

The value addition of sanitation services includes sanitation logistics and transportation services, treatment plant maintenance, faecal and sewage sludge collection, emptying and treatment, cleaning and hygiene services, laboratory/analytical services, mobile toilet services, local artisans like plumbers, masons, and so on. Therefore, sanitation service providers range from the masons that build household

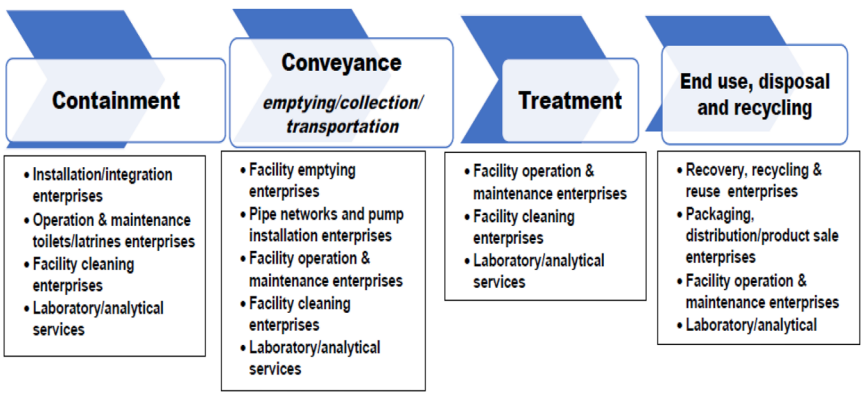

Figure 5.7 Sanitation services value chain. (Source: adapted by authors from Chofreh *et al.* 2019)

latrines to the entrepreneurs that build and run public/communal toilet blocks and from manual pit-emptiers to privately run emptying vacuum trucks to large public utilities providing networks of sewerage infrastructure along with sewage treatment and faecal sludge treatment services.

The key stakeholders that engage in the sanitation service value chain can be categorised across the stages of the chain as presented in Figure 5.7.

(I) *Containment*, including the user-interface, which is the starting point for the delivery of sanitation services. The key stakeholders involved in the provision of these services that come with access to toilet/latrines services are householders, businesses and institutions (public and private) (UNEP/IWMI, 2020). The operations and maintenance services for the containment systems are provided by local masons, plumbers, construction and installation enterprises. Cleaning services are carried out by different private enterprises, while in households these services are carried out by members of the household. Lavatory cleaning enterprises in some cases may be mechanized systems that automatically clean the user interfaces providing more hygienic conditions to users and cleaning service operators.

(II) *Conveyance services*, (emptying, collection and transportation) differ depending on the sanitation service arrangement. For sewered systems the networks of pipes and pumps convey sewage from the user interfaces directly to the treatment plants. In most regions, it is the responsibility of the municipality/public utilities. The non-sewered systems, however, have municipalities and/or specialized agencies providing emptying and transportation services. In some cases, public institutions and private companies provide sanitation services including collection and disposal of faecal sludge. Also, private companies may sometimes be contracted by municipalities/public utilities to carry out desludging services, depending on the region. In addition, private companies operate independently in areas where public entities are unable to provide reliable timely services (Blackett & Hawkins, 2017; Parkinson *et al.*, 2014; Rao *et al.*, 2017). Also, households may be difficult to access by trucks, so the sludge is disposed of manually by operators. Community Based Organizations (CBOs) or Non-Governmental Organizations (NGOs) also play a key role in providing emptying services and transportation in underserved communities (Blackett & Hawkins, 2017; Opel & Bashar, 2013; Rao *et al.*, 2017; Strande *et al.*, 2014; UN-HABITAT, 1995; WASH PLUS, 2011).

(III) The *treatment and end-use, disposal and recycling services* are provided by either the municipality or public utility. In a very few cases, the municipality/public utility contracts operations to a private company (Rao *et al.*, 2017). Meanwhile, reuse involves stakeholders, depending on the type of resource to be recovered – energy or nutrient (Bolomey, 2003; Rao *et al.*, 2017; Takouleu, 2020).

5.4 ECONOMIC ANALYSIS OF SANITATION SERVICES VALUE CHAIN

Value chain is short for 'value added chain', which points to the fact that the value chain is a system that adds value at every stage (Springer-Heinze, 2018a). The subject of the economic analysis is the creation of value and its distribution along the SSVC and the assessment of parameters of chain competitiveness and efficiency. The economic analysis of a value chain includes: calculation of total value added; composition of value added along the SSVC; and the assessment of parameters of chain competitiveness and efficiency (Springer-Heinze, 2018a). Economic analysis means attaching numbers to the

elements of the value chain map – end markets, service providers and business linkages (Springer-Heinze, 2018a). This analysis requires very important and sensitive financial data that is not always easy to collect from value chain operators.

The calculation *of total value added (total value generated)* is based on the sales price and volume sold. The formula to calculate total value of SSVC is set as the total volume of services sold to the end-users' market multiplied by the price paid by the end-user of sanitation services. The total value generated (or value added) is the single most important number in the economic analysis of the SSVCs:

$$(\text{Total value generated}) = (\text{end price of service per unit}) \times (\text{number of units sold}) \quad (5.1)$$

Another SSVC economic indicator is the estimation of the *composition of the value generated* in each stage of the SSVC, which is indicative of the actual value captured by the chain operators at each stage of the SSVC. For instance, a large share of the value generated from service providers is often transferred from retailers to internal and external suppliers. Therefore, the total value generated at each stage of the SSVC includes the value of intermediate products delivered by the service providers at preceding stages of the value chain or by external companies. The value actually captured by chain service providers at each stage of the SSVC can be obtained by deducting total value generated from the cost of bought-in materials used in the service delivery and components of equipment deployed for service delivery (Springer-Heinze, 2018a). The value added is then calculated by equation (5.2):

$$\begin{aligned}(\text{Value added}) = (\text{Value generated}) &- (\text{value of intermediate products} \\ &- (\text{value of other inputs and services})\end{aligned} \quad (5.2)$$

The third indicator of economic analysis parameter is the *assessment of chain competitiveness and efficiency* to determine the specific strategies used by the SSVC service provider that enable them to gain more clients. Cost, quality, availability and innovation are very important variables used in assessing the competitiveness of the SSVC.

Table 5.1 shows the composition of the value generated in visual form. The value generated is composed of the value of the intermediate services that the service providers at one stage of the value chain obtain from their suppliers, the value of other inputs and

Table 5.1 Components of SSCV (adapted from Springer-Heinze, 2018a).

VALUE GENERATED by SSCV or by each stages At each stage of the SSCV the value generated must take into account the value added by the operator of each of the stages, the intermediate products and other input products and services used for operation. Value generated will be the sum of the three parameters. For all SSCV the total value generated can be determined by multiplying the unit price by the quantity of the service sold.	**Value added** • Wages • Interests and rents • Depreciation • Direct taxes • Profits and so on. **Intermediate products** Transferred to the operator by the previous SSCV stage operator: • Fresh or transported/semi-transformed faecal sludge **Other input products and services** Transferred to the SSCV operator by external suppliers: • Equipment • Transportation • Energy consumption • Water consumption and so on.

services they utilize, and the value added. The value added by service providers includes wages, interests and rents, depreciation, direct taxes, profits, and so on. As a result, high value added does not necessarily imply high profits for the service providers. The value added is used to pay for the production factors labour, land and capital as well as for the owners and management of the enterprise – in the form of profits (Springer-Heinze, 2018a).

5.5 ENVIRONMENTAL AND SOCIAL ANALYSIS

The economic performance of the value chain is the basis for its success, but that success may not last long if it is detrimental to the natural environment. Unsafe sanitation management harms overall human health and child health and also damages the quality of air, soil, surface water and groundwater (Hyun *et al.*, 2019; UN WATER, 2021). While the economic objective is the primary focus of the SSVC, it is not sufficient on its own to report on SSVC's environmental sustainability. In fact, all sanitation value chain activities must meet sustainability criteria. The environmental analysis places the SSVC into an ecosystem context to identify negative environmental impacts of the value chain on the environment and vice versa; and the impact of natural resource scarcity and climate change on business operations (Springer-Heinze, 2018a). The main elements that make up the environmental analyses are material consumption, energy consumption, water consumption, greenhouse gas emissions, land erosion/pollution, air pollution, water pollution, waste and biodiversity. The climatic parameters to be taken into account are in particular the change in temperature, the weather, changes in rainfall patterns and climate variability. Studies in Dakar have estimated the consumption of a vacuum truck at 15 litres of fuel for a distance of 20 km (Gning *et al.*, 2017). Tricycles consume an average of 4.5 litres over a distance of 100 km (Huanghe Motors, 2020). CO_2 emissions are estimated at 2 kg of CO_2/km for vacuum trucks and 0.1 kg of CO_2/km for tricycles (Ecoscore, 2020).

Environmental pollution caused by the disposal of faecal sludge into the natural environment affects the usability of ground and surface water leading to serious disruption of environmental processes and the destruction of ecosystems. In some areas, along rivers and streams, upstream residents normally enjoy better quality water, while downstream users are often obliged to take water with the properties of "diluted sewage" (UN WATER, 2021). In South-East Asia, 13 million tonnes of faeces are emitted into inland waters every year, as well as 122 million cubic metres of urine and 11 billion cubic metres of grey water. Water pollution costs Southeast Asia more than $2 bn per year. In Indonesia and Vietnam, it creates environmental costs of more than $200 m per year; mainly due to the loss of productive land (UN WATER, 2021).

The promotion of SSVC is only justified if it generates social benefits and contributes to reducing poverty. SSVC development should seek to support market-driven economic development that is inclusive of the poor and other vulnerable social groups as well as addressing gender gaps and providing better income opportunities (Springer-Heinze, 2018a). It is this social character that makes it easier for the public sector to promote a certain sector of private activity. The parameters used for social analysis are general working conditions, social security, training and education, workers' health and safety, human rights, living wages, consumer health and safety, product quality, and gender involvement in the SSC. For instance, a study was conducted in nine countries – Bangladesh, Bolivia, Burkina Faso, Haiti, India, Kenya, Senegal, South Africa and Uganda – on sanitation workers' conditions (health, safety and dignity) and it was found that:

(I) sanitation workers are exposed to multiple occupational and environmental hazards;

(II) sanitation workers have weak legal protection resulting from working informally, a lack of occupational and health standards, and weak agency to demand their rights;
(III) financial insecurity is a great concern because typically, informal and temporary sanitation workers are poorly paid, and income can be unpredictable – some sanitation workers report being only paid in food;
(IV) social stigma and discrimination exist, and in some cases, are experienced as total and intergenerational exclusion (Ren, 2019).

These working conditions are not necessarily applied to all sanitation workers. A minority of these sanitation workers do, however, enjoy good social, economic or both conditions. These include the best organized entrepreneurs in the sector who often manage to hire workers for services.

5.6 SANITATION SERVICE VALUE CHAIN CASES

5.6.1 Non-sewered sanitation service value chain, Ouagadougou (Burkina Faso)

Ouagadougou is the capital city of Burkina Faso with approximately 2.5 million inhabitants, and it accounts for about 14 percent of the nation's population with a growth rate of 3 percent per annum (INSD, 2013; UNEP/IWMI, 2020; WSUP, 2014). Less than 2 percent of the population are connected to a sewer network. The remaining 73 percent use pit latrines and 15 percent use septic tanks for faecal sludge *containment* (ONEA, 2015). The case illustration in Ouagadougou (Burkina Faso) is designed to provide a better understanding of the sanitation service value chain (SSVC) activities and their enterprises (Figure 5.8). There are about 36 cleaning enterprises providing *containment*

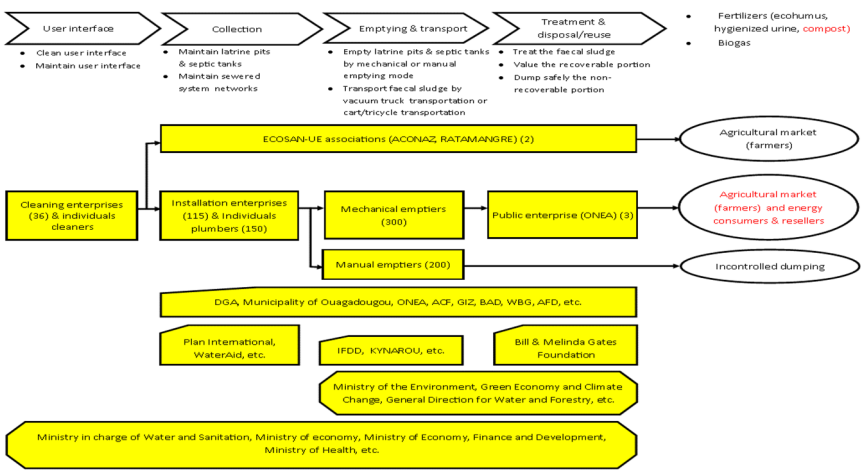

Figure 5.8 SSC mapping in Ouagadougou, adapted from structural analysis – value chain mapping. (Source: authors). *Note*: ONEA – Office National de l'Eau et de l'Assainissement, ACF - Action Contre la Faim, GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit, BAD – Banque Africaine pouur le Développement, WBG - Word Bank Group, DGA –' Direction Générale de l'Assainissement, ACONAZ - Association Communautaire Namanebg-Zanga, RATAMANGRE - association specialised in ECOSAN, IFDD - Institut de la Francophonie pour le Développement Durable.

services in Ouagadougou. Some of these services include: cleaning & maintenance services, collection (facility maintenance) services, emptying, treatment and disposal/reuse services.

The major players in the sector are ECONAF enterprises, BZ and Service d'Hygiène du Faso (SHF). Cleaning and maintenance enterprises provide services to establishments, institutions, commercial enterprises and some households and are one of the main sanitation services at this stage of the value chain. In most cases, households' user-interface cleaning and maintenance services are carried out by members of the household. Other value stage players are construction and installation enterprises. Local masons and plumbers are also contracted for maintenance services when the need arises. For on-site sanitation systems, the *conveyance services* which include provisions of services such as emptying, collection, transportation and maintenance services, are carried out by construction enterprises and other private business concerns. The emptying of onsite sanitation systems is either manually or mechanically done. Users choose based on what they can pay for and/or their location or the availability of emptiers. A formal SSVC for Ouagadougou is presented in Figure 5.8. There are about 250 manual emptiers throughout the city of Ouagadougou, and more than 300 vacuum trucks involved in emptying and transportation of faecal sludge. For the sewered sanitation system, maintenance and upkeep (of the only existing sewerage system in Ouagadougou) is managed by the technicians in the Office National de l'Eau et de l'Assainissement (ONEA). To present a strong front for favourable bargain the emptiers (mechanical and manual) have joined forces to form two associations: Association des Vidangeurs du Faso (AVIF) and Association Burkinabé pour l'Assainissement et la Sauvegarde de l'Environnement (ABASE) for mechanical and manual emptiers respectively.

Faecal sludge emptied are transported to one of the three *treatment plants* for treatment/reuse/disposal at Zagtouli, Sourgoubila and Kossodo. The treatment plants are equipped with drying beds to separate liquids and solids and ponds to treat liquids. The three plants are managed by ONEA (see Figures 5.7 and 5.8). The Kossodo faecal sludge treatment plant has a biogas production unit of 400 m^3/d of sludge with a production of electricity expected to reach 2 160 MWh per year. Unfortunately, no valorization is yet applied to this sludge to allow its *reuse* (except during the pilot phase when it produced electricity).

The SSCV enablers in Ouagadougou are generally the ministries. The core ministries are the Ministry of Environment, Green Economy and Climate Change and they are responsible for developing policies and regulations for environmental protection. They ensure that ONEA and emptiers comply with the General Direction of Water and Forestry, which deploys its agents in the field for monitoring missions. The Ministry of Water, Sanitation and Hydro-agricultural Installations, the Ministry of Economy, Finance and Development and the Ministry of Health are also enablers who intervene at all stages of the SSC.

5.6.1.1 Economic analysis of SSCV in Ouagadougou

The economic analysis of SSCV in Ouagadougou was carried out to determine the value addition of each service provider and total value generation in the entire SSCV. This analysis was based on each service provider (enterprises and entrepreneurs) at each stage of the SSVC delivery services such as cleaning, maintenance, emptying, (manual and mechanical emptiers) and ONEA treatment facilities providing treatment and disposal/reuse services. The *cleaning services* are directly related to the user interfaces and so without intermediate services contributing any value addition, rather they create value themselves. Cleaning enterprises are able to deliver services to multiple clients at a time (about eight or more) because of the number of employees engaged which depends

on the size of the firm as well as their market coverage. They earned an average of $163 per client per month.

On the other hand, the *maintenance service* providers such as plumbers and installation enterprises are able to deliver services to about 12 and 35 clients in a month at an average price of $6 and $10 per client respectively. *Emptying services* are provided mechanically and/or manually. In the case of mechanical emptiers, the most common vacuum trucks used in Ouagadougou have a capacity of 8 m^3. The cost for mechanical emptying is fixed at $37 which is for filling of 4m^3 of the truck and they empty an average of 3 pits per day. Hence, the cost can increase if the volume of emptied faecal sludge decreases, but not up to 4m^3. In the case of manual emptiers, the estimated cost of emptying takes into account several parameters such as the volume of sludge emptied, the depth of the pits and also the customers' ability to negotiate. In any case, they charge an average of $47 per client and are available every day to provide services to their customers and undertake emptying of an average of 3 pits in a week. *Treatment services* are provided at ONEA's treatment plants and the volume of faecal sludge received at ONEA's treatment plants per day varies from 250 m^3 (Sourgoubila's faecal sludge treatment plant) to 800 m^3 (Kossodo's faecal sludge treatment plant), which averages about 500 m^3 for each plant. For each cubic metre deposited, the emptiers pay an average of $0.55 which is $2.2 for 4 m^3 (Table 5.2).

Also, households that benefit from the ECOSAN pit-emptying and urine canister collection services provided by the ECOSAN-UE associations are charged a monthly fee of $0.95. There is no rigorous follow-up and households unfortunately do not pay these charges. Biofertilizer is sold to the farmers in 50 kg bags at a price of $5 and 20 litres of treated urine at a price of $0.5. The total added value created by the whole SSCV in Ouagadougou is currently put at $ 12 97 811. The best value-addition is derived from the mechanical and manual emptying (Figure 5.9).

5.6.1.2 Environmental analyss

In the case of SSCV, direct utilization of natural resources is very low and can be minimised. Nevertheless, faecal sludge transportation to the treatment plant using vacuum trucks and tricycles consume fuel. Studies in Dakar have estimated that vacuum trucks use 15 litres of fuel for a distance of 20 km (Gning *et al.*, 2017). Tricycles consume an average of 4.5 litres over a distance of 100 km (Huanghe Motors, 2020). CO_2 emissions are estimated at 2 kg of CO_2/km for vacuum trucks and 0.1 kg of CO_2/km for tricycles (Ecoscore, 2020). Operationalization of the SSCV in Ouagadougou releases annual CO_2 emissions from vacuum estimated at 120 kg per day for an average distance of 60 km. These emissions are not to be ignored because of the negative impacts they can have on the climate. In addition, the faecal sludge treatment plants' open system makes them another major source of air pollution in the city because of the odour nuisance. The environment also influences the activities of the SSCV as the demand for emptying services by users becomes more frequent during the rainy season. Also, high rainfall leads to flooding which affects the operation of sanitation systems such as the treatment plants.

5.6.2 Sewered sanitation service value chain, Khuzestan (Iran)

To reduce wastewater management problems and to provide better value for end-users, the sewage industry requires the transformation of conventional system into sustainable sewage management systems (Wei *et al.*, 2017). In this process operators of sewage companies need to re-analyse their value chain to create sustainable value for customers (Chofreh *et al.*, 2019). Sanitation service value chain analysis enables sewage companies to evaluate business processes so that they can provide the greatest opportunities to

Table 5.2 SSCV total value generated and value-added determination in Ouagadougou.

Operators	Quantity/ Month/ Operator	Unit	Price Per Unit ($)	Operator's Number	Value Generated/ Month ($)	Intermediate Product ($)	Other input Products/ Services ($)	Added Value/ Month ($)
Cleaning enterprises	8	contracts (clients)	163	36	46 933	–	–	46 933
Individual plumbers	12	clients	6	150	10 000	–	–	10 000
Installation enterprises	35	clients	10	115	37 269	–	–	37 269
Manual emptiers	12	clients	47	250	1 94 444	–	215	1 94 230
Mechanical emptiers	89	clients	37	300	9 90 476		460	9 90 016
ONEA's treatment plant	12 276	m^3 of sludge	0.55	3	20 461	–	1 086	19 375
ECOSAN-UE associations (RATAMANGRE)	2	50 kg of Birg-koenga	5	2	19	–	47	– 12
	17	20 litres of Birg-koom	0.5		16			
Total value generated/month					12 99 617	Total added value/month		12 97 811

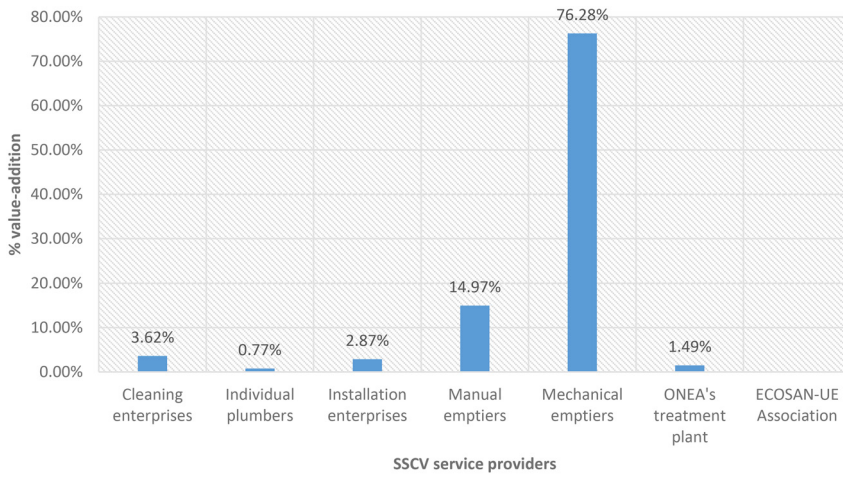

Figure 5.9 Contribution of the value-addition of each SSCV service provider to the total value generated in Ouagadougou. (Source: authors).

reduce operational costs, optimise efforts, eliminate waste, improve health and safety, and increase profitability (Reese *et al.*, 2016).

The Khuzestan Urban Water and Sewage utility companies is one of the largest water and wastewater companies in Iran and provides water and sewage services in the Khuzestan Province. The company was established in Ahvaz in 1992 and has 57 branches spread throughout the cities in Khuzestan (Khuzestan Water and Sewage, 2018). The company manages water and wastewater systems in Khuzestan's urban area with a population of approximately 2 180 301 people in 57 cities of the Khuzestan Province. The main activity of Khuzestan Urban Water and Sewage is to distribute clean water to households and industries, monitor and control water treatment and purification, and manage wastewater systems in households and industries. Operation and maintenance of water supply and distribution facilities include catchment basins, underground utilities, refineries, pumping stations, transmission lines, water supply networks, control systems, and distribution networks. All municipalities in Khuzestan except Ahvaz have similar water supply and wastewater systems (Chofreh *et al.*, 2019), see Figure 5.10.

Wastewater from households and industries are transferred using sewage pipelines and collected into the central wastewater tanks. The wastewater is then directed to the treatment plants using an underground drainage system for the screening stage. The process consists of several stages including a screening process to remove large objects that can damage equipment, primary, secondary treatment, and final treatment (Chofreh *et al.*, 2019). The main stakeholders of sanitation services value chain in Khuzestan Urban Water and Sewage include consultants and contractors who design wastewater treatment systems and provide equipment to the project operators and the end-users.

The water and wastewater agency are also involved in the enforcement of local government policies, rules and regulations on sewage and urban water management. The systems and equipment design process is conducted by developers and contractors who have agreements with the water and wastewater company (Figure 5.6). According to Chofreh *et al.* (2019), the value chain mapping results of Khuzestan Urban Water and Sewage utility company, indicate a need to effectively embed sustainability initiatives

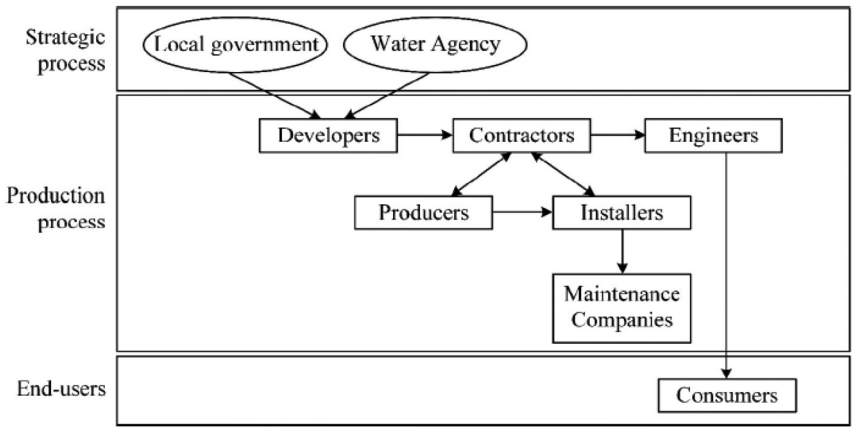

Figure 5.10 Main actors involved in the Khuzestan sewered sanitation service value chain. (Source: Chofreh, *et al.* (2019) with permission from Elsevier Ltd.)

into the business processes of the company, since water production and wastewater systems are not sustainably managed by the operators.

5.6.3 Container-based sanitation service value chain

Container-based sanitation (CBS) consists of an end-to-end service in which toilets collect excreta in sealable, removable containers (also called cartridges). The containers are regularly collected and transported to treatment facilities when full (Russel *et al.*, 2019), see Figure 5.11.

CBS services are typically provided by social enterprises or NGOs (e.g., Sanergy, Nairobi, Kenya; Clean Team Ghana Ltd, Kumasi, Ghana; Loowatt Ltd, London, United

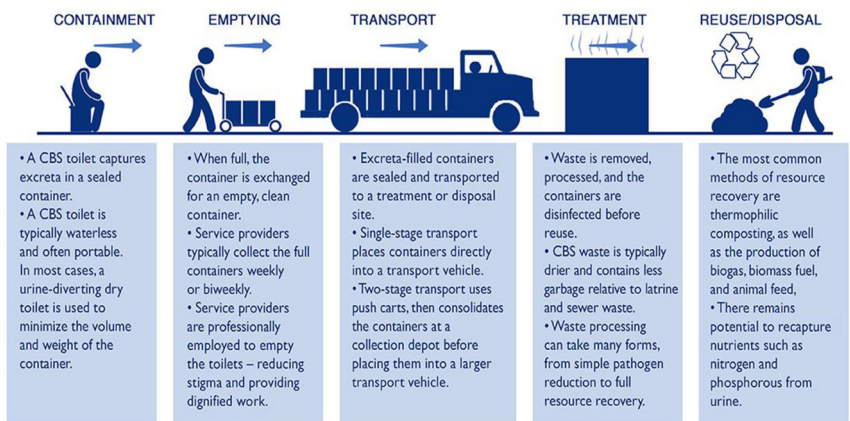

Figure 5.11 CBS sanitation value chain. (Source: Russel *et al.* (2019), under CCA 4.0 license, © 2019 by the authors.)

Box 5.2: Some CBS service providers

Sanergy, Nairobi, Kenya
Sanergy builds affordable CBS products designed specifically for urban slums, and franchises them to community members to serve all residents. The toilets are high-quality, low-cost sanitation units. With a urine-diverting squat plate, they source-separate solid and liquid waste, making collection and conversion safe and easy. For the comfort and convenience of owners and users, amenities include a handwashing station with soap, water and a bin for feminine hygiene products. They also professionally collect sanitation waste from the community by handcarts and trucks. Handcarts ensure that toilets are installed deep in slums. The company also converts the waste at a centralized facility into valuable end-products such as organic fertilizer and insect-based animal feed. So far, the company serves 123 768 residents per day in Kenya (http://www.sanergy.com/)

Clean Team Ghana Ltd, Kumasi, Ghana
Clean Team Ghana Ltd provides CBS that are safe, affordable in-home toilets for low-income families. End-users pay a small weekly fee for the service and are provided with toilets and wastes are collected from end-user homes weekly in sealed containers and taken away for safe disposal (https://www.cleanteamtoilets.com/)

Loowatt Ltd, London, United Kingdom
Loowatt's patented toilet integrates revolutionary waterless flush technology with a 360-degree waste processing system to deliver hygienic and safe toilets for both domestic and commercial installations around the world. From the manual flush Home toilet, designed for domestic use, to the electric flush Pro toilet for commercial applications, there is a Loowatt solution designed to fit. The company has already served over a quarter of a million people with waterless flush toilets from the U.K to Madagascar, delighting customers and sustainably generating energy (https://www.loowatt.com/)

X-Runner, Lima, Peru
X-runner offers a sustainable sanitation solution that provides urban households with a portable dry toilet and a responsible service that removes and converts a human waste into compost, thus improving the daily lives, health and environment of thousands of individuals. The non-conventional sanitation solution consists of a Container-Based Sanitation (CBS) system which provides homes with a dry toilet of high technology and also includes the collection and responsible treatment of the generated waste and a continuous customer service support. Once a week we pick up the faeces from every household or respective collection point and bring them to the treatment plant, where they are transformed into compost, an ecological fertilizer. After successful implementation of a pilot project with 40 families in 2012, X-Runner extended their operations to serve currently over 900 families in three districts in Lima (https://www.x-runner.org/)

Kingdom; X-Runner, Lima, Peru), and several city utilities (such as Cape Town and Manila) are adopting CBS as part of their approach to citywide inclusive sanitation (CWIS), see Box 5.2. Revenue comes from customer service fees and the sale of waste treatment by-products, such as compost, protein (for animal feed), and energy (Foote *et al.*, 2017; Preneta *et al.*, 2013; Russel *et al.*, 2019).

The main target market for CBS services are the urban poor, who typically live in rented accommodation in densely packed settlements or with no formal land title. The portable nature of CBS as a sanitation approach makes it appealing in these contexts, as it requires little space and limited or no in-house construction (World Bank, 2019). CBS has typically been used where it is infeasible or inappropriate to install sewerage systems, such as in densely populated urban neighbourhoods, informal settlements, displaced person camps, or areas with high water tables or risk of frequent flooding (Russel *et al.*, 2019). The CBS service providers operate across the whole sanitation service chain, treating the faeces for reuse, whereas others focus on collection and emptying. Also, CBS approaches can be deployed with different types of toilets (seated or squat, shared or private) to respond to customer preferences (World Bank, 2019). Most CBS toilets are seated portable units that are placed inside the household. Sanergy's service involves shared squat toilets, and Loowatt has solutions for use in homes and in external superstructures. CBS service providers have to adapt their businesses to the limited and fragile cash flows of the urban poor, so they have developed a variety of payment plans to smooth out sanitation payments over time (World Bank, 2019).

5.7 WAY FORWARD FOR SANITATION SERVICES

Improving sanitation services requires huge capital investment, and government, private sector and development agencies finances are not sufficient. Therefore, promotion of the sanitation service value chain (SSVC) is the necessary step to take towards large-scale comprehensive private sector involvement in delivering quality sanitation services. This would require proper coordination of the actors in the SSVC as well as the introduction of innovative tools for effective and efficient service delivery such as the introduction of digital tools, including GPS tracking conveyance systems and technologies, mapping of operators and operation of call centre services (UNEP/IWMI, 2020). Special attention must be paid to performance improvement and sustainability of the treatment stage of the SSVC through the adoption of the circular economy approach and low-cost biological methods for faecal sludge management that will contribute to the end-value satisfaction. Treatment plants can generate revenue and value-addition/creation to sustain its operations by implementing appropriate business models in collaboration with the private sector, which can add value to the by-products generated (UNEP/IWMI, 2020).

From a citywide sanitation perspective, improving the SSVC will depend on extending the partnerships between the public and private sector as well as the penetration to more aspects of the SSVC. While the state could have a direct involvement in service delivery through public entities, it could also engage indirect provisions by delegating the service provision to non-state (or private) providers. Thus, a dimension involving the degree of 'state penetration' is deemed necessary for SSVC improvement and promotion (ADB Institute, 2020). Thus, significant improvement in the SSVC will require more investments in all stages of the value chain and mechanisms should be created to direct more investments to the poor and vulnerable segments of the population. In addition, the state will need to address the various bottlenecks and inefficiencies inherent in the SSVC.

5.8 Take Action

(I) Visit your municipality office and find out registered sanitation services enterprises in your area and how they operate.
(II) Assess the competitive advantage between public and private sanitation services delivery actors.

5.9 Journal Entry

(I) Identify and review existing sanitation services and delivery formal guidelines and standards as well as regulations at your local, regional and national levels.
(II) What are the economic indicators of the sanitation services value chain and how useful are such information in a value chain analysis?

5.10 Reflection

What is the level of quality and standards of sanitation service delivery in your area and how does it affect the sanitation landscape of your locality?

5.11 Guiding Questions

(I) What are sanitation services and what are the difference between sanitation products and sanitation services?
(II) What are the three ways sanitation services value chain can be conceptualized?
(III) Define a sanitation service arrangement?
(IV) Differentiate between private enterprises and public service sanitation arrangements?
(V) Describe the sanitation service value chain with a sample value chain overview map.

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