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**1**. Public private partnerships (PPPs) are partnership between the public sector and the private sector for the purposes of designing, planning, financing, constructing and/or operating projects which would be regarded traditionally as falling within the remit of the public sector (Environmental financial center,2016). These happens because the government public sector might not be able to cope with the challenges the government faced in water supply and sanitation management

**Factors to be considered as a measure of success in Public private partnership water supply services**

* **Commitment of the partners**: this consist of four sub factors, strong commitment from project partners, strong and competent public partner, internal coordination within government, and flexible contracts with fair risk allocations.

Achieving contractual targets of a public private partnership projects is closely linked to a strong commitment of the project partners. commitment means a dedication and interest of key actors in a project, hence all project stakeholders ought to be willing to commit their best financial and human resources to the project throughout its lifecycle (Li et al,2005).

* **Strength and competence of the public partner**: this is an important factor in project success. The government should take part to capacity build the public private partnership staffs so that competent and experience public partners are realised. Capacity building is the only way to enhance public sector skills and knowledge to manage public private partnerships projects. However, engaging external professional advisors (legal, technical, financial and environmental advisors) to complement public sector expertise is crucial to the success of public private partnership:
* **Internal coordination within government**: Public Private Partnership is a complex procurement arrangement, and water supply projects involves multiple governmental ministries such as ministries for water resources, health, lands and natural resources and environment and anciencies including environmental protection agency, regulatory commissions. For any project to proceed smoothly, all these institutions must approve the suitability of relative issues. This process may be lengthy and frustrating and requires a healthy internal coordination among these relevant institutions. Effective coordination therefore requires strong leadership that calls for establishment of a leading body.
* **Strength of consortium**: This incorporates strong and competent private partner, effective regulatory and legal structures and profitable water supply projects. A project is likely to be constructed within time and cost or executed successfully by a consortium with a wealth of expertise and experience. In the other hands, a project is bound to fail when the award criteria are mainly based on the lowest tariff or fee rather than expertise.
* **Effective regulatory and legal structures**: These are very important to a successful implementation of water public private partnerships, especially in developing countries. A disappointing water private public partnership outcome, such as high incidence of opportunistic renegotiations, resulting from frail or non-existent regulatory and legal structures in many developing countries leads to failures. As the role of the government shifts to regulations under public private partnerships, a well-defined legal and regulatory frame work will improve public benefits by ensuring that contract operates efficiently and optimises available scarce resources in line with wider public objectives, and provides adequate protection to private investors (Pongsiri,2002). Many governments of developing countries need to equip their regulatory institutions with right skills to regulate these projects and address staffing problems.
* **Profitable water supply projects**: This is a prerequisite for a candidate project to be successfully executed as a public private partnership project. Thus, the private sector would not partake in social projects that offer no good return on investment. For good financial equilibrium, private sector is driven by profit incentives. Private sectors are more attracted with projects that has economic rational, bearing appropriate project identification. Apart from selecting the idle project, governments must commit to supporting affordable but cost-reflective tariffs, especially for revenue-based projects.
* Assets quality and social support: Quality water asset and workforce, public acceptance and support and adequate financing (Dorte,2019) plays a critical role in determining project success. Public private partnership project may not succeed in the absence of any or all of these (quality water asset, quality workforce, public acceptance and support and adequate financing)

**2.** (a) Water emergency (Exceptional water service, Nd) is any event that disrupts the normal supply of clean water to your home or to the entire community. These water emergencies can be caused by leaky pipes, frozen pipes, leaky appliances, chemical spills, broken water mains, power outages. failure of water storage tanks or other equipment, treatment plant breakdowns, water contamination, and

natural disasters (storms, floods, tomatoes, forest or bush fires, droughts, earthquakes, high winds)

**Natural causes of water Emergencies**

**Earthquakes**: This is a sudden movement of the earth caused by release of built-up stress within rocks along geologic faults or by the movement of magma volcanic areas. If the magnitude is high this can cause serious damaged to infrastructure like water supply systems and roads which calls for emergency attention. All existing water sources may be contaminated hence an emergency water supply from a safe source to the affected population will be necessary.

**Floods**: These are natural occurrences where an area or land that is normally dry abruptly becomes submerged in water. This is just an overflow of large quantities of water onto a normally dry land. Flooding happens in many ways due to overflow of streams, rivers, lakes or oceans or as a result of excessive rain.

In an event of flooding, there is the possibility of loss of life, hardship to people like displacement to another dry place. Floods destroys houses, crops, importance infrastructures.

In this situation, all water sources are contaminated or damaged. To save life WASH actors intervene by quick water supply of safe drinking water and other domestic uses to mitigate the spread of water related diseases and stop and outbreak of an epidemic.

**Droughts**: when there is no rain or precipitation over an extended period, resulting in water shortage, the rivers, swaps dry up. Animals and humans will not have water for basic needs and life. Ground water and soil moisture are depleted, and crops are damage, these leads to food insecurity crises and luck of drinking water.

When there is fresh water shortage during a drought, people may be forced to use unprotected water supplies, people and animals have to use the same water sources which increase the risk of contamination of the source as a result people are more expose to waterborne and water-washed diseases.

Emergency water supply will be an immediate alternative from area of surplus to the affected population for survival.

**Human causes of water emergencies**

**War:** when there is a conflict, the population be forced to migrate to a safer area or to another country. In South **Sudan**, two decades of sustained conflict and neglect have turned potable **water** into a precious and scarce resource. Limited access to **water** and sanitation has contributed to poor child health – a third of children under the age of five suffer from diarrhea.

When people migrate due to war, it happens in large numbers and where they settled might not have a safe and portable source of drinking water.it depends on the onset, it might be acute in the first weeks. Here emergency fair quantity of water must be supplied for survival. As the situation normalizes, quality consideration comes it and longer and sustainable sources of water are developed for the population.

**Landslides**: In fertile hilly sides of Uganda, occupants settle at the slopes of the mountains (Leonard,2019). The area is agricultural productive. Landslides occur due to heavy rains and all normal services are cut off as a result within after 14 days, respiratory/diarrhoea diseases increase since safe water supply were disrupted.

The ministry of environment and health intervened by supply portable water for drinking to rescue as an emergency and later the occupants are relocated to a safer site

)(Leonard,2019) **Leakage of dangerous chemical**: when a harmful chemical leak and it becomes uncontrolled it contaminates the water supply system. For example, 2000 people were displaced in South Sudan due to leakage of oil. The humanitarian organizations and WASH actors intervene by distribution of NFI item, Shelter item and emergency water supply, (Lasuba Memo,2019)

**(b**) From a technical point of view drinking water systems used in response to an emergencyy may not differ much from similar systems used in development situation, however in emergency, the below factors determine the choice of drinking water source to be used.

* Security situation regarding accessibility to the area for national/international organizations and people’s freedom of movement.
* Access to the area in terms of roads and topography
* Socio-political, legal and cultural constraints
* Availability of water sources and their characteristics
* Time required to develop the water sources
* Characteristics of the affected population (number of people, displaced or not, extent to which coping mechanisms are still in place)

**Methods of safe water supply during water emergency**

**SWATs**: This is a surface water treatment system, here the surface water is pump into a flexible onion tank, a calculated amount of coagulant is added, and flocculation takes place. When the water is clear and has settled for 6-hours, its is pump to a bladder, where a chlorine is added to leave a residual of 0.2-0.5mg/l. A pipe network is assembled, and consumers serve and collect water from the taps.

The setup of the systems and the capacity in litters depends on the number of people to be supplied and the objective of the water supply (number of litters per person per day)

The water quality is monitored once every month as a surveillance to monitor infections and

**Water Tankers (Water Tacking):** This is a solution for survival supply when time is very limited and other systems cannot be realised within the time limits. Water supply by tankers is planned and managed by specialised external agencies because of the complexity of its management and the high cost. This is not therefore a solution for a longer-term water supply. Water tankers are also often used to supplement other water services.

**Water intake, storage, treatment and distribution systems**: For surface water source, a temporary intake is created by building a small weir made of sand bags. A mesh is fitted to filter the water from bigger debris and position in the river directly upstream of the weir. A floating object is place at the point to signal to water transport users to avoid damage. A pump is assembled a high ground to prevent flooding and an operative is hired to manage the system. Simple and cheap pumps are usually used for sustainability purposes.

The catchment area should be protected to minimise the risks of pollution. Human settlement, agricultural and livestock activities should be prevented as much as possible anywhere near upstream of the intake.

**Pipes:** This is quick and efficient means to supply water to the affected community and it can be achieved by using pipes that are locally available even if they are not a perfect solution. For emergency water supply, two types of pipe are recommended namely flexible hoses and polyethylene (PE) pipes.

**Flexible hoses**, usually they have to be brought in from abroad but can be flown in and are easily transported over land, can be installed on site very quickly (rolled out) and connect easily to other types of pipe.

**PE** pipes are suitable for survival supply due to the ease of jointing and the flexibility of the pipe. Jointing can be done through fusion welding or push-fit or mechanical couplings. These jointing options are easy and quick and give very strong joints that can withstand end loading, they therefore do not need thrust blocks at points where the direction of the pipeline changes.

**Water tanks**: A typical tank for emergency situations should be easily and quickly installed, be suitable for quick transportation to the site (so light and easy to pack materials are needed) and should be easy and quick to dismantle at the end of the operation. Majorly the two types used are OXFAM and collapsible tanks

OXFAM tanks, this is made from corrugated steel sheets that can be bolted together to form the round casing for the tank. A synthetic rubber lining is hung inside, and plastic sheet can be put on top to form a roof. The tank can easily be transported in parts and erected on site. The main uses are water storage and treatment in both survival and longer-term supply systems.

**Collapsible tanks** are made of collapsible fabric, without any supporting framework. They have a low packed volume and easy to handle. The tanks are light hence fits air transport. Main uses are in situations where very quick action is required (within hours/days) and where no other tank materials are available. These tanks can be supplied in contingency plan, incase of an emergency they should be at reach at the nearest store.

**Springs:** In the even of any disaster that causes an emergency and the affected population is relocated, available springs should immediately be protected, and with hygiene promotion messages, people should not defecate in or near the water sources. These springs can be used as emergency water sources. The flow rate and the status have to be assessed that it has the capacity to supply the required volume of water to be supplied and it should not dry during the dry season.

**Other possible sources** (rain water collection, open wells, boreholes)

**3. (**a)**Sanitary inspection** is the assessments carried out by a WASH technician to assess a water source to determine all possible sources of contaminant to ascertain the visibility that the source can be used for a drinking water supply.

**Purpose of Sanitaryy inspection**

* When new water sources are being developed, to assess the water quality and any treatment needs.
* When comparing water sources for potential development.
* When contamination is suspected, to identify the likely cause
* When there is an epidemic of a water-borne illness to identify the likely cause
* To interpret results from water-quality analysis, to establish how the water become contaminated.
* As a routine exercise, to monitor sanitary conditions
* When there are significant changes (such as heavy rain or construction activity) which could affect water sources.

**To ascertain the above, it can be done by observation and carrying test by the following tools: -**

1. Color, this is a physical property which might result from presence of minerals like iron, this can be observe by the eye. Its implication is that the users will not accept the quality. Color tests indicate the effectiveness of the water treatment system.
2. Odour and taste, are associated with the presence of living microscopic organisms, or decaying organic matter. Here HS test and observation are also used to check the quality of the water.
3. Turbidity tube: Turbidity in water is caused because of suspended solids and colloidal matter. It may be due to eroded soil. turbid water increases the cost of treatment, in a situation where the cost if high, another source must be found of fair turbidity.
4. PH Meter: PH is a measure of hydrogen ion concentration. It is an indicator or relative acidity or alkalinity of water. Low PH and high PH affects the treatment process. Drinking water should have a PH between 6.5 and 8.5.
5. Thermometer: For a drinking water to be accepted by the community, it has to be palatable and sweet (accepted) by the community.so the temperature of the source has tp be moderate to be accepted and for proper chemical reaction to take place during treatment process, for example aluminum does not work well in high and low temperature.
6. Sample cup, bottle and box: Total coliform of the source has to be determine, when E.coli are noted this shows faecal matter contamination. This sample are collected and transported to the main laboratory for testing. The box has to be packed with ice to keep the pathogens alive until analysis time is done, the sample has to be analyzed within 6-hours from the time of collection and had to be incubated for 24-hours.

(b)

**Human settlement upstream**: Human settlement that have access to waste water collection systems without water treatment facilities and which discharges directly into the river generate urban wastewaters, and these contains mostly suspended matters, organic substances, nutrients but also heavy metals, detergents. All activities within human habitation upstream of the obstruction point is a threat to the quality of water downstream. All categories of pollution sources exist with the settlement (point sources, nonpoint and diffuse sources) (WHO,2004). All types and sources of pollutants are taken to account during sanitary survey then strategies are laid out as prevention measures. In the even where the pollution is unavoidable, another location is likely to be sited for the obstruction point.

**Possible occurrence of landslide**: Landslides cause property damage, injury, and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams, and roadways can be affected for years after a slide event.  
  
The negative economic effects of landslides include the cost to repair structures, loss of property value, disruption of transportation routes, medical costs in the event of injury, and indirect costs, such as lost timber and fish stocks. Water availability, quantity, and quality can be affected by landslides.

**Presence of animals upstream**: A common hazard of household water is contamination by potentially harmful bacteria and other microorganisms. ... The microorganisms which find their way into a water supply can come from a variety of sources including sewage, animal wastes, or dead and decaying animals. Under this point, presence of animals upstream of obstruction point is a priority which need to be assessed and accounted.

**Fence around the obstruction point**. obstruction point must be fenced to restrict an authorized person in accessing the point including animals which are agents for contamination. Human should be allowed to go there except an operative to avoid poisoning the water source, therefore fence is a priority to maintain the water quality.

**4**. Drinking water usually gets contaminated from different angle with a contaminant posing a risk and a public health concern. To mitigate the above to happen, a water safety plan has to be developed to ensure the safety of drinking water through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer.

**Key components**

* Health based targets (based on an evaluation of health concerns)
* System assessment (to determine whether the water supply chain from source through treatment to the point of consumption) as a whole can deliver water of a quality that meets the health-based targets
* Operational monitoring of the control measures in the supply chain, which are of particular importance in securing drinking-water safety.
* Management plans (documenting the system assessment and monitoring ;describing actions to be taken in normal operation and incident conditions-including upgrade and improvement), documentation and communication
* A system of independent surveillance that verifies that the above are operating properly (WHO,2014)

A water safety plan, therefore, comprises system assessments and design, operational monitoring and management plan (including documentation and communication)

The purpose of water safety plan is to protect human health and ensuring good water supply practice to minimize contamination of source waters, reduction or removal of contamination through appropriate treatment process and the prevention of contamination in the distribution network and the domestic distribution system (WHO,2008)

**5.**Water supply system operation is timely and daily operation of the components such as headworks, treatment plant, machinery and equipment, transmission mains, pumps, service reservoirs and distribution system.

**MAINTENANCE** of water supply system is the art of keeping the structures, plants, machinery and equipment and other facilities in an optimum working order and proper functioning without and interruption. These involves all planned technical activities or activities carried out in response to a breakdown, to ensure that assets are functioning effectively, and require skills, tools and spare parts

**TYPES OF MAINTENANCE**

**Preventive Maintenance**: Constitutes routine works and precautions to be taken periodically to prevent the systems from mal-functioning by mechanical adjustments, repairs, corrective action and planned maintenance. Examples of preventive maintenance would include servicing of equipment for wear and tear and replacing as necessary items that have a limited lifespan.

**Corrective Maintenance**: Involves carrying out works related to break down, which has actually occurred by replacements, correction of defects. Breakdown is common in many Utilities and it occurs as a result of poor preventive maintenance.

To meet customer demand and continues supply, preventive maintenance is more economical than corrective maintenance.it ensures that that the asset fulfils its service life. It also prevents crises occurring and costly repairs (time/money) being needed.

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