

Gap Analysis and Need Assessment Report On Strengthening of Knowledge Products' on industrial waste water management at National & State (Uttarakhand) level to combat industrial wastewater pollution

Submitted to



**Deutsche Gesellschaft für Internationale Zusammenarbeit
(GIZ) GmbH**

Government of India

By



National Productivity Council
{Environment Management Group}
New Delhi
(November, 2019)

Table of Contents

1.	About the Project.....	1
1.1	Objectives of the Project:.....	2
	a) Output 4: At National Level	2
	b. Output 4: At State Level (Uttarakhand).....	4
1.2	Scope of Project: -	5
	a) Output 4: At National Level	5
	b. Output 4: At State Level (Uttarakhand).....	6
2.	Background of the project.....	8
3.	Tasks to be performed.....	11
3.1	Methodology Adopted by NPC.....	15
4.	Indicative Inventory of existing Knowledge products referred in India	16
4.1	Inventory of CPCB Knowledge products w.r.t. industrial wastewater management.....	18
	4.1.1 Software / ICT tools / web based platforms available with CPCB	19
	4.1.2 SWOT insights on KPs available from CPCB - Generic.....	20
4.2	International Knowledge Products referred in India	21
	4.2.1 Key Aspects addressed by selected international KPs for Operation & Maintenance in waste water treatment facility	21
	4.2.2 Key Aspects addressed by selected international KPs for Design in waste water treatment facility.....	22
	4.2.3 Key Aspects addressed by selected international KPs in the form of ICT tools / web based platforms.....	23
	4.2.4 Key Aspects addressed by selected international KPs in the form of mobile based applications	24
5	Mapping of stakeholders	28
5.1	Category of stakeholders	28
5.1	Identification of Various domains pertaining to industrial waste water management.....	28
6.	Questionnaire Survey and its analysis.....	30
6.1	Response of the questionnaire	30
6.2	Domain wise most commonly used knowledge products by stakeholders.....	32
	6.2.1 Most commonly used KP in the domain of design / engineering / technology of wastewater.....	33
	6.2.2 Most commonly used KP in the domain of Installation, testing and commissioning of wastewater treatment plants.....	33
	6.2.3 Most commonly used KP in the domain of Operation & maintenance and Sampling, analysis & monitoring of wastewater treatment plants.....	34

6.2.4 Most commonly used KP in the domain of Regulatory Compliance of wastewater treatment plants.....	34
6.2.5 Most commonly used KP in the domain of Tender/ bidding / business models of wastewater treatment plants.....	35
6.3 Effectiveness of most commonly used knowledge Products.....	35
6.4 Accessibility of most commonly used knowledge Products	36
7.Gaps and need assessment of the existing Knowledge products	39
7.1 General gaps identified:.....	39
7.2 Need assessment of new Knowledge products:.....	40
8. A few suggestions and way forward.....	43

1. About the Project

Under the Indo German Development Cooperation, a project on “Sustainable and Environment-friendly Industrial Production” (SEIP) was taken up during March 2015 to February 2019. SEIP project focused on finding solutions to industrial wastewater and water so as to reduce pollution, besides working on corresponding state level action plans and national level policy instruments.

The second phase of the Sustainable and Environment-friendly Industrial Production (SEIP) that will be implemented during March 2019 to February 2022 will be based on experiences from the preceding SEIP project, which ends in 02/2019. The second phase of SEIP will continue to have a focus on abatement of industrial wastewater pollution in the context of urban areas as well as the pollution of rivers and other water resources. The aim of the project is the promotion of sustainable industrial development in the urban sphere by reducing industrial wastewater pollution through strengthening of strategic and operational governance structures including framework conditions for regulating, implementing and monitoring. The Ministry of Environment, Forest and Climate Change of the Government of India will be the implementing partner.

The objective of SEIP phase 2 projects is, “The strategic and operational governance structures of the Indian Government to effectively combat water pollution from industrial wastewater are strengthened.”

The SEIP II phase works on the following main outputs:

- Output 1: Strengthening of Legal Framework
- Output 1: Strengthening of Organisational Procedures and Processes
- Output 3: Strengthening of Incentive Mechanisms
- **Output 4: Strengthening of Knowledge Products**

Each of the Outputs has an objective and a set of indicators to measure the outputs/results. National consultants have been appointed at the start of the project for

baseline assessments for each of the Outputs. Further, the following activities are to be undertaken:

- International consultants (long-term contracts) to be appointed to accompany each of the 4 Outputs.
- Multi stakeholder Technical Working Groups to be constituted for each Output.
- Process driven approach – intensive consultations within core groups and selected states and additional regular consultations with other States.

For undertaking baseline assessment for the Output 4 on Strengthening of “Knowledge Products”, GIZ has engaged National Productivity Council as the national consultant as per Terms of Reference described ahead.

1.1 Objectives of the Project:

The objective of the consultancy services is,

“An analysis of all the existing knowledge products at national level in the sector of industrial waste water management, including prevention and control of pollution, is available along with suggestions for strengthening such knowledge products.”

a) Output 4: At National Level

Under the framework of the SEIP II, the project aims to achieve certain outcome and output indicators. Output 4 (Strengthening of Knowledge Products) of SEIP II focuses on the strengthening of knowledge products to effectively combat industrial wastewater pollution.

Under the SEIP Phase II project, Output 4 on has the following objective and indicators.

• Objective of Output 4:

“Experiences of the strengthening of governance structures to effectively combat water pollution from industrial wastewater are disseminated to affected actors.”

The results to be achieved under Output 4 on ‘Strengthening of Knowledge Products’ are measured by one outcome indicator and two output indicators, as below.

Outcome Indicator:

“Two public agencies of the Indian government at national level (viz., MoEF&CC, CPCB) have designed their governance structure for effectively controlling industrial water pollution based on a well-defined process-oriented approach.”

Base: Inadequate process-oriented approaches in 2 public agencies of the Indian Government.

Goal: Governance structure based on a defined and process-oriented approach in 2 public agencies of the Indian government.

Output 4 Indicators:

Output 4, Indicator 4.1

8 knowledge products (4 Handbooks, 3 good practices document, 1 ICT portal) are nationwide available to public bodies, viz. MoEF&CC and CPCB.

» Base value: 1 handbook, 1 good practices documents, 1 ICT based system

» Target value: 4 Handbooks, 3 good practices document, 1 ICT based system

Output 4, Indicator 4.2

A symposium with 80 representatives of all states on the nationwide application of institutional improvements and measures took place.

» Base value: 0

» Target value: 1 Symposium **mit** 80 Representatives

As a first step, it is proposed to undertake baseline assessments of ‘Strengthening of Knowledge Products’ at national level on industrial waste water management and aspects of prevention and control of pollution, including undertaking gap analysis and come up with broad suggestions to fill these gaps.

b. Output 4: At State Level (Uttarakhand)

Under the framework of the SEIP II, the project aims to achieve certain outcome and output indicators in Uttarakhand. Output 4 (Strengthening of Knowledge Products) of SEIP II focuses on the strengthening of strengthening of knowledge products to effectively combat industrial waste water pollution.

Under the SEIP Phase II project, Output 4 on has the following objective and indicators.

• Objective of Output 4:

“Experiences of the strengthening of governance structures to effectively combat water pollution from industrial wastewater are disseminated to affected actors.”

The results to be achieved under Output 4 on ‘Strengthening of Knowledge Products’ are measured by one outcome indicator and two output indicators, as below.

• Outcome Indicator:

“Two public agencies of the State government in Uttarakhand (viz. SIIDCUL, SIDA) have designed their governance structure for effectively controlling industrial water pollution based on a well-defined process-oriented approach.”

» Base: Inadequate process-oriented approaches in the selected public agencies of the State government of Uttarakhand (SIIDCUL, SIDA).

» Goal: Governance structure based on a defined and process-oriented approach in upto selected 2 public agencies of the State Government of Uttarakhand.

• Output 4 Indicators:

Output 4, Indicator 4.1

4 knowledge products (2 Handbooks, 1 good practices document, 1 ICT portal) are nationwide available to public bodies in Uttarakhand, viz. SIIDCUL and SIDA.

» Base value: Zero

» Target value: 2 Handbooks, 1 good practices document, 1 ICT based system

Output 4, Indicator 4.2

A symposium with 40 representatives of various stakeholders from Uttarakhand on the State-wide application of institutional improvements and measures took place.

» Base value: 0

» Target value: 1 Symposium with 40 Representatives

As a first step, in order to achieve the Output 4 and the corresponding indicators, a baselinestudy of existing incentive mechanisms and knowledge products will be conducted.

1.2 Scope of Project: -

Under the objective of “Analysis of all the existing knowledge products at national level in the sector of industrial waste water management, including prevention and control of pollution, is available alongwith suggestions for strengthening such knowledge products”, the following are the scope of services:

a) Output 4: At National Level

- Consultancy services to cover the all the relevant knowledge products at national level inthe sector of industrial waste water management, including prevention and control ofpollution.
- Consultancy services should look closely into MoEF&CC, CPCB and other relevant nationalagencies.
- The baseline assessment shall address all relevant areas of industrial wastewatermanagement. These include, but not limited to, Common Effluent Treatment Plants(CETPs), Effluent Treatment Plants (ETPs) in individual industries, recycling and reuse ofindustrial wastewater/ZLD, pollution monitoring including online monitoring, skillsdevelopment of relevant personnel and infrastructure in industrial areas, such as stormwater drainage network, conveyance network, sewerage network, sludge, riverrejuvenation etc. Each industrial wastewater topic should be assessed in relevance tooutput 4 objective and indicators as detailed above.

- The knowledge products include handbooks, manuals, ICT based systems etc. that help in industrial waste water management, including prevention and control of pollution.

These include, for example,

- Handbooks
- Manuals/Guidelines
- Good practice documents
- ICT based systems / Online tools
- Web-based platforms
- Online courses/forums
- Training manuals, etc.

b. Output 4: At State Level (Uttarakhand)

- Consultancy services to cover all the relevant knowledge products as well as their structures and mechanisms at national level in the sector of industrial waste water management, including prevention and control of pollution.

- Consultancy services should look closely into SIIDCUL and SIDA and other relevant agencies.

- The baseline assessment shall address all relevant areas of industrial wastewater management. These include, but not limited to, Common Effluent Treatment Plants (CETPs), Effluent Treatment Plants (ETPs) in individual industries, recycling and reuse of industrial wastewater/ZLD, pollution monitoring including online monitoring, skills development of relevant personnel and infrastructure in industrial areas, such as stormwater drainage network, conveyance network, sewerage network, sludge, river rejuvenation etc. Each industrial wastewater topic should be assessed in relevance to output 4 objectives and indicators as detailed above.

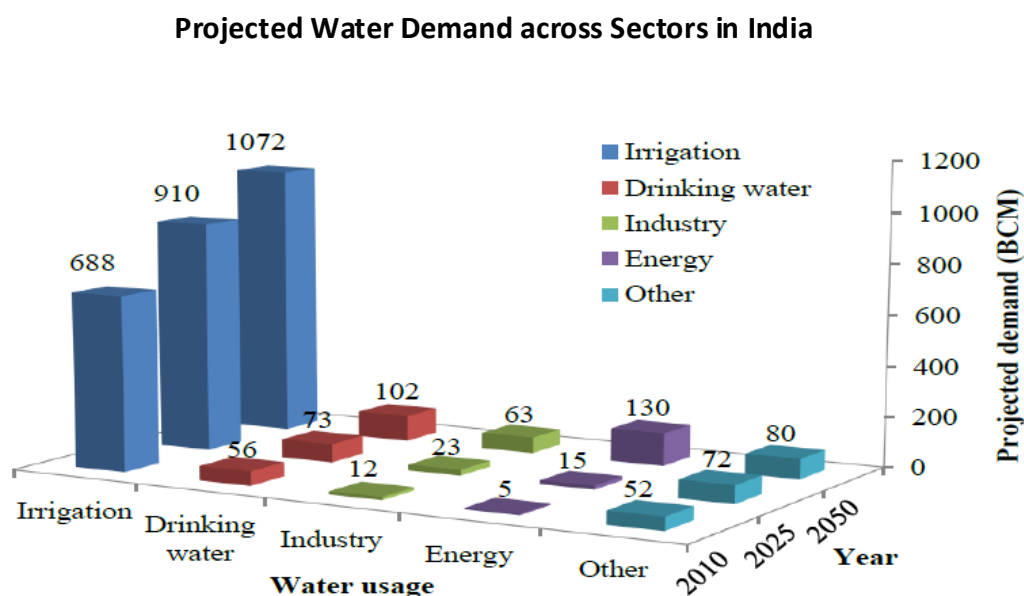
• The knowledge products include handbooks, manuals, ICT based systems etc. that help in industrial waste water management, including prevention and control of pollution.

These include, for example,

- Handbooks
- Manuals/Guidelines
- Good practice documents
- ICT based systems / Online tools
- Web-based platforms
- Online courses/forums
- Training manuals, etc.

2. Background of the project

The water demand in India has grown over the last decade and is expected to rise even more considering the existing pattern of consumption. The projected water demand across various sectors in India is summarized below:



Source : R. Kaur et al. Wastewater Production, Treatment and Use in India (Water Technology Centre, Indian Agricultural Institute India, New Delhi)

India is not a water deficit country, but due to severe neglect and lack of monitoring of water resources development projects, several regions in the country experience water stress from time to time. The annual rainfall received by India is unevenly distributed across its different parts, across different times of the year. As a result in spite of good annual rainfall, some river basins fall in the category of water scarce and water stressed regions.

India faces a critical water shortage due to government mismanagement, pollution, ground water depletion. A major challenge for India is its rising water demand coupled with economic development. India's increasing population and economic growth has put tremendous pressure on India's water resources. Water demand is steadily increasing across all markets, and will continue to do so. Balancing water demand with available supply will be crucial for future economic growth and development.

For India to meet its growing water demand, focused needs to be out on wastewater treatment and recycling and reuse of treated water into various secondary applications.

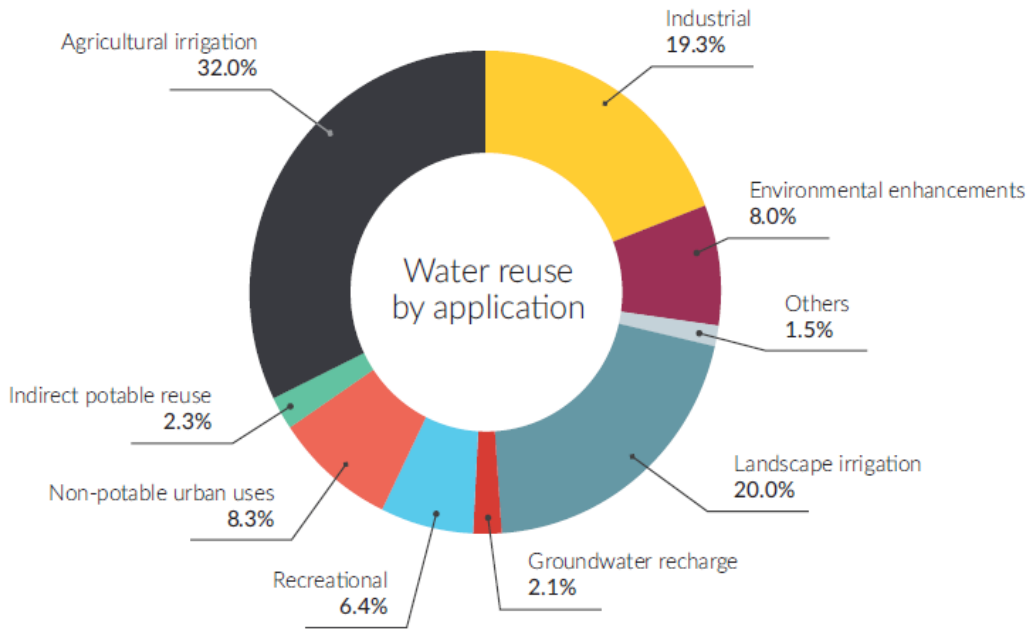
The Economics of Wastewater Treatment can be summarized as below:

The Economics of Wastewater Treatment (CPCB, 2007)

Particulars	Primary treatment system	Primary + ultra filtration system	Primary + ultra filtration system + reverse osmosis
Capital cost (Rs lakhs)	30.0	90.64	145
Annualized capital cost (@15% p.a. interest & depreciation)	5.79	18.06	29.69
Operation and maintenance cost (lakhs/annum)	5.88	7.04	12.63
Annual burden (Annualized cost +O&M cost) Rs. Lakhs	11.85	27.1	42.5
Treatment cost Rs./kl (Without interest and depreciation)	34.08	52.40	73.22

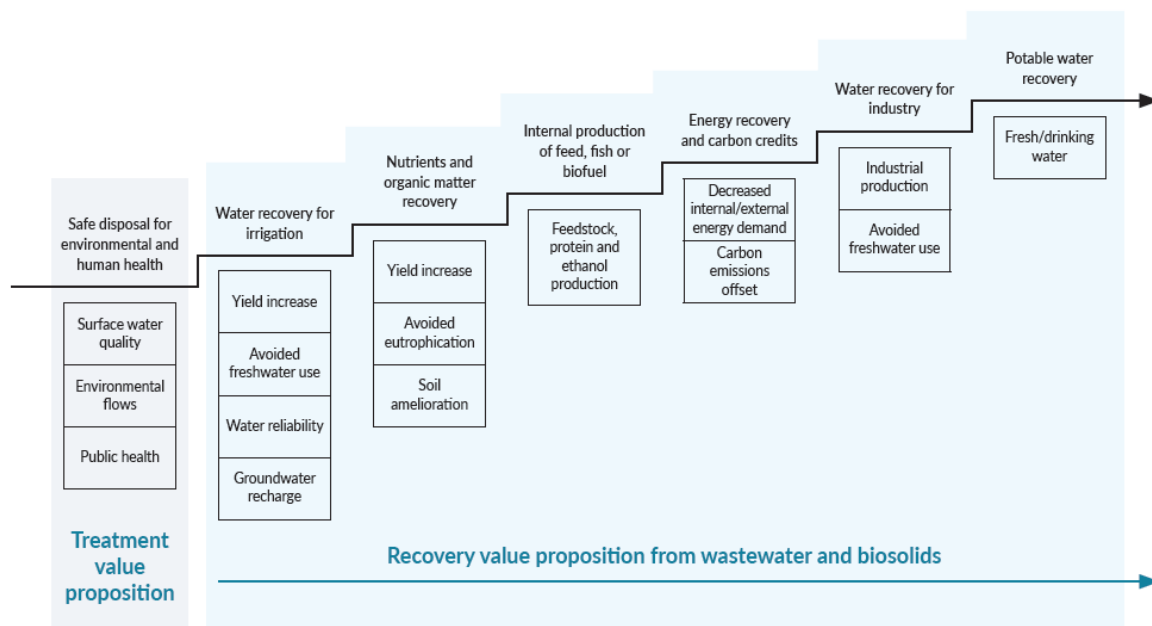
Source: CPCB.2007b.Advance methods for treatment of textile industry effluents,Resource Recycling Series : RERES/&/2007.Central Pollution Control Board,India

If we look into the statistics of the Global water reuse application, it can be stated that water can be reused for almost all the secondary applications like industrial, landscape, irrigation, indirect potable usage, ground water recharge etc.



Source: Lautze et al. (2014, Figure 2, p. 5, based on Global Water Intelligence data).

Ladder of increasing value propositions for reuse with increasing investments in water quality or the value chain



Source: Drechsel et al. (2015a, Fig. 1.2, p. 8).

3. Tasks to be performed

There are three main tasks defined under this project for both National and state level. The main tasks are further divided into subtasks. The details of various tasks/ subtasks and progress made against each task till 31stOctober 2019 has been summarized below:

<p>Main Task 1: Information/Data Collection</p>	<p>Sub Task 1: Collect required information for fulfilling the objectives and deliverables of the consultancy services including a detailed inventory of various available knowledge products in the area of industrial waste water management, including the following:</p> <ul style="list-style-type: none"> - Handbooks - Manuals/Guidelines - Good practice documents - ICT based systems / Online tools - Web-based platforms - Online courses/forums - Training manuals - Any other relevant products/instruments/tools <p>Information collection to include:</p> <ul style="list-style-type: none"> - Secondary information through sources e.g. websites, published documents, literature searches, and any information from any other reliable source. - Primary information through visits, one-to-one meetings, group meetings etc. <p>Sub Task 2: A ½ day kick-off workshop to be organised with CPCB, MoEF&CC and other stakeholders (with upto 15 participants) to discuss on the tasks and expected outputs/deliverables from the consultancy services so as to seek feedbacks on the tasks, information availability and various stages of consultancy services [Note: Organisational aspects of the workshop including venue, tea/coffee etc. will be the responsibility of GIZ]</p>
<p>Progress by NPC</p>	<ul style="list-style-type: none"> • Internet searches and KP downloads done for further SWOT analysis. • 5 meeting completed with CPCB for inputs / access on KPs sought. • Plan to communicate also with key publishers of suitably identified KPs being considered to obtain insights on popularity of identified KPs / copies sold / demand perceived / feedback received from users/ ongoing or future KP developments etc.

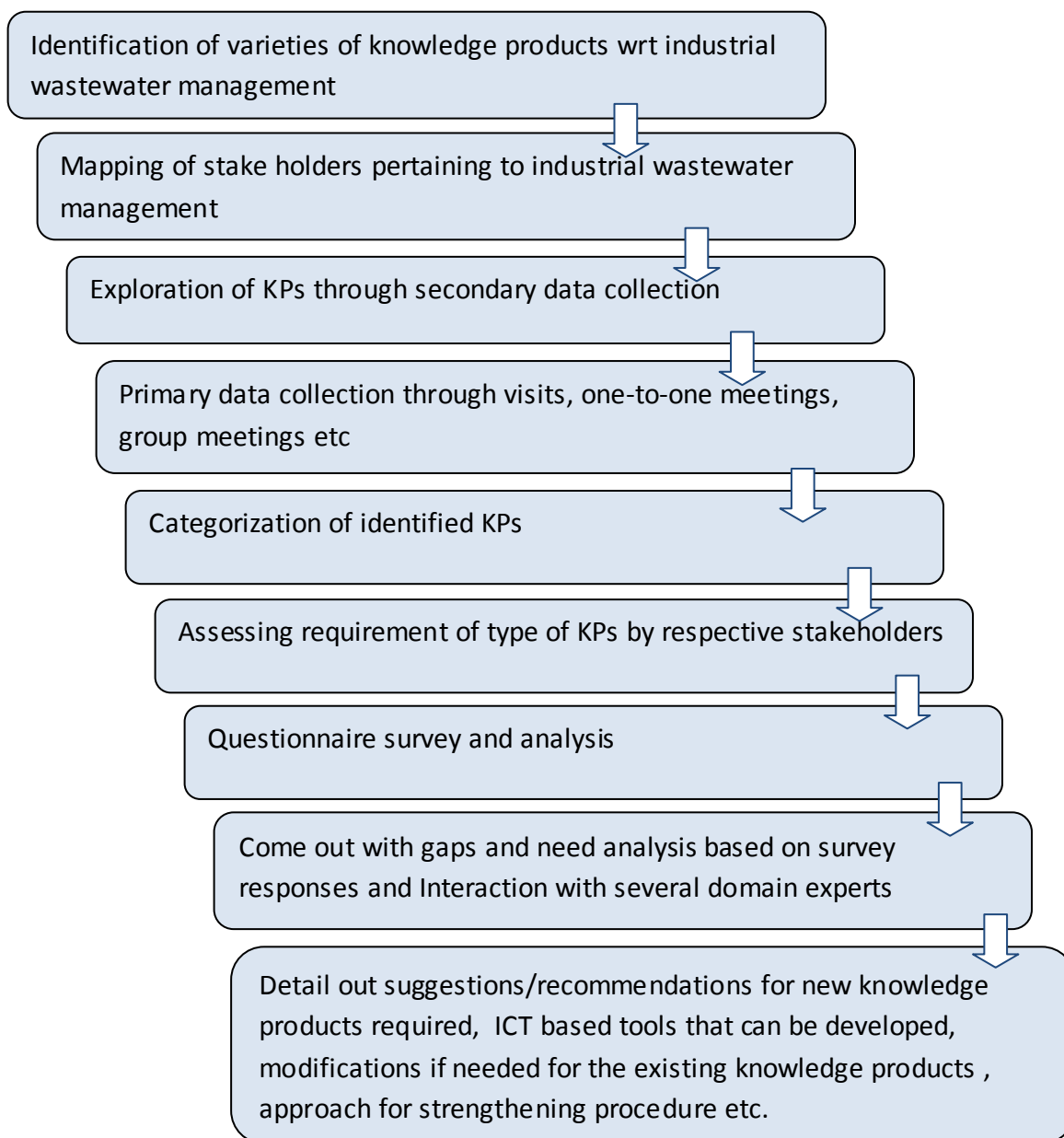
	<ul style="list-style-type: none"> • One indicative gap already identified as need for a Handbook or Guide for industrial process water quality perspectives for various sectors • Half day kick off workshop successfully conducted on 1st October 2019. <p>Framework perspective of KPs analysis (Focus on CETP / ETP Design documents and Texts reference):</p> <ul style="list-style-type: none"> • KP published year and age as on date • Copies sold (reflection on demand if possible trend available) • User variety / User base • User countries / regions • Citations received (where available) • Frequency indicator amongst usage by Users (including Professors / Consultants / Regulators etc) • Availability in libraries and / or accessibility online • Number of editions / versions published • Topics covered and range / spectrum of issues reflected on the subject of industrial wastewater management • Technologies enumerated and quality of insights provided to user (data / Numericals / Benchmarks etc) • New insights / knowledge offered to the field and its advancement • Feedback aspects as received by author / publisher from users and their sentiment regarding KP • Perspectives regarding the KPs from user response to questionnaires indicating any ranking / rating of the utility of the KP amongst their top 10 choices • Reflections of future expectations on the KPs being referred by Users etc.
<p>Main Task 2: Gap analysis/ needs analysis</p>	<p>Sub-task 1: List out briefly the availability and scope of the existing knowledge products in reference to the scope of services in 3.1 above.</p> <p>Sub-task 2: Identify and assess the adequacies of the existing knowledge products available for industrial wastewater management, including prevention and control of pollution.</p> <ul style="list-style-type: none"> • Mapping of the existing knowledge products. • SWOT analysis to identify the strengths and weaknesses, as well as opportunities and threats. • Gap analysis. • Needs analysis. <p>Sub-task 3: Assessment of effectiveness - map the stakeholders involved in application of the existing knowledge products and assess the usefulness of these products to them. Also, assess the effectiveness of these incentives in industrial wastewater</p>

	<p>management, including prevention and control of pollution.</p> <ul style="list-style-type: none"> • Stakeholder mapping. • Assessment of usefulness and effectiveness. • Gap analysis. • Needs analysis. <p>Sub-task 4: Identify the gaps and deficiencies, with adequate reasons, of the existing knowledge products related to industrial wastewater management, including prevention and control of pollution. Also, identify needs for new products. Prepare a draft Gap Analysis and Needs Assessment report.</p> <p>Sub-task 5: Present the gap analysis before the Technical Working Group constituted by GIZ/MoEF&CC/CPCB and any other stakeholder workshop organised by GIZ for seeking comments and suggestions (upto 2 meetings of TWG and upto one stakeholder workshop).</p> <p>Sub-task 6: Update the gap analysis accordingly. Prepare a final Gap Analysis and Needs Assessment report.</p>
<p>Progress by NPC</p>	<ul style="list-style-type: none"> • Exploration and access to different types of KPs begun and CPCB access also sought. • Mapping, SWOT, Gaps and Needs analysis focused questionnaire developed • Matrix developed for mapping of stakeholders and type of knowledge products required by them. • Framed Survey questionnaires to be send to Industry / Technology Providers • Identification of stakeholders for questionnaire survey • Questionnaires circulated to various stakeholders, more than 500 • Besides an initial set of stakeholder groups that was being deliberated, It is planned also to communicate with authors of the appropriately identified KPs ahead to strengthen the analysis on gaps and action plans to develop new KPs and additional versions / editions of the available KPs as well, based on feedback received by authors on existing products. • Gap analysis to be done on the basis of response to the questionnaire and on the feedback received during one on one interaction with selected stakeholders. • Field visits made to Dehradun for state level findings. • State level workshop attended on 22nd October 2019. The highlights of the workshop are placed as Annexure 2 • Highlights of state level workshop is mentioned in the report ahead. • Responses received from 54 stakeholders • Analysis of responses to be presented in the National

	workshop on 1 st November 2019.
<p>Main Task 3: Suggestions/recommendations</p>	<p>Sub-task 1: Detail out suggestions/recommendations in the form of a draft report based on the gap analysis and needs assessment undertaken in Main Task 2 above related to the topic of industrial wastewater management, including prevention and control of pollution:</p> <ul style="list-style-type: none"> • new knowledge products required • modifications if needed for the existing knowledge products • new ICT based tools that can be developed • approach for strengthening procedure and processes in developing such products • solutions for establishing regular feedback mechanisms to verify usefulness and effectiveness of such knowledge products • other aspects as may be relevant for strengthening knowledge products related to industrial wastewater management. <p>Sub-task 2: Present the suggestions/recommendations before the Technical Working Group constituted by GIZ/MoEF&CC/CPCB and any other stakeholder workshop organised by GIZ for seeking comments and suggestions (upto 2 meetings of TWG and upto one stakeholder workshop). Prepare workshop reports and MoM of the meetings.</p> <p>[Note: Organisational aspects of the workshop including venue, tea/coffee etc. will be the responsibility of GIZ]</p> <p>Sub-task 3: Prepare the final report.</p>
<p>Progress by NPC</p>	<ul style="list-style-type: none"> • Based on the 54 responses received against the circulated questionnaire, the most commonly used knowledge products in the domain of industrial wastewater management have been identified. • The gaps and requirement of new KPs have also been assessed from the responses as well as from interaction with various domain experts. • The suggestions and recommendations are being looked into.

3.1 Methodology Adopted by NPC

The methodology adopted by NPC for executing the main tasks 1, 2 and 3 is summarized below:



4. Indicative Inventory of existing Knowledge products referred in India

The anticipated inventory of existing knowledge products in the domain of industrial wastewater management has been extracted through secondary data available in public domain, online research and interaction with various domain experts. The probable inventory of existing National knowledge products (**other than CPCB documents**) is likely to be as indicated below:

S. No.	Particulars	Approx. numbers
1	Handbooks	30+
2	Textbooks	50
3	Manuals/ guidelines	60
4	Good practices document	7
5	ICT based systems / online tools	1 (Online consent management)
6	Web based platforms	8
7	Online courses/ forums	2 (e.g. NPTEL, JNTU)
8	Training manuals	5
9	Other relevant publications/ reports/ research papers	>50

A list of commonly used Knowledge Products in the form of text books, utilized by a wide variety of stakeholders in the domain of wastewater treatment is as follows:

Sl.No	Title	Author	Publication & Year	Frequency
1	Wastewater Engineering Treatment Disposal Reuse	Metcalf & Eddy	Tata McGraw Hill	17
2	Industrial Water Pollution Control	Eckenfelder W.W.	Tata McGraw Hill	10
3	Wastewater Treatment for Pollution Control	Arceivala, S.J.	Tata McGraw Hill	7

Sl.No	Title	Author	Publication & Year	Frequency
4	Water Supply and Sanitary Engineering	G.S.Birdie&J.S.Birdie	Dhanpat Rai & Sons	2
5	A Treatise on rural, municipal and industrial water management	KVSG Murali Krishna	Reem Publications	1
6	Environmental sanitation(social and preventive medicine)	Dr.P.V.Rama Raju & KVSG Mural Krishna	Environmental Protection Society	1
7	Municipal and Rural Sanitation	Ehlers,V.M. &Steel,E.W.	McGraw Hill book company,Inv 5 edition	1
8	Environmental sanitation	Ehlers,V.M. &Steel,E.W.	Mcgraw-HillBook Co.,Inc	1
9	Environmental Pollution and Toxicology	Meera Asthana and Asthana D.k.,	Alka Printers	1
10	Theories and practices of Industrial waste treatment	N.L.Nemerow	Addison Wesley publishing	4
11	Liquid waste from Industry-Theories,Practices and Treatment	N.L.Nemerow	Addison Wesley publishing	2
12	Industrial and Hazrdous Waste Treatment	N.L.Nemerow and Dasgupta A.	Van Nostarnd Reinhold New York	1
13	Zero Pollution for Industry:Waste minimization through industrial complexes	N.L.Nemerow	John Wiley & Sons	1
14	Fundamentals of Wastewater Treatment and Engineering	RumanaRiffat	CRC Press	1
15	Industrial water treatment handbook	Frank Woodard	Butterworth Heinemann	3
16	Biological Process Design for wastewater treatment	Benefield L.D. and Randall C.W.	Prentice Hall,New Jersey	4
17	Wastewater treatment	M.N.Rao and Dutta	Oxford and IBH Publishing Co.	6

Sl.No	Title	Author	Publication & Year	Frequency
			Pvt. Ltd.	
18	Water and wastewater technology	Hammer Sr.,Mark J	Pearson	2
19	Principles of industrial waste treatment	C.F. Gurnham	John Wiley and Son	3
20	Industrial wastewater management handbook	Hardam Singh Azad	McGraw-Hill Education	2
21	Industrial Pollution control handbook	Herbert F.Lund	McGraw-Hill	1
22	Water Recycling and Pollution control handbook	A.V.Bridgwater	Van Nostrand Reinhold	1
23	Pollution control in process industries	S.P.Mahajan	Tata McGraw-Hill Education	1
24	Water Supply Engineering	Dr.P.N.Modi	Standard book house	1

4.1 Inventory of CPCB Knowledge products w.r.t. industrial wastewater management

Following are the quantity and types of Knowledge Products to combat industrial waste water published by the Central Pollution Control Board from time to time

Sr. No	Particulars	Quantity
1	Publications related to Design	3
2	Guidelines related to water quality criteria	5
3	Publications related to performance evaluation of CETPs	2
4	Publications related to O&M	1
5	Publications related to Monitoring	5
6	COINDS	54
7	Web based platforms	3
8	ADSORBS (Assessment and development study of river basin series)	27

9	LATS (Laboratory & analytical techniques series)	19
10	MINARS (Monitoring of Indian national aquatic resources series)	29
11	RERES (Resource recycling series)	6
12	IRBM (Interstate river boundary monitoring)	1
13	Studies / reports on river water quality	6
14	PROBES (Programme objective series)	74
15	IMPACTS (Information manual on pollution abatement and cleaner technologies)	12

4.1.1 Software / ICT tools / web based platforms available with CPCB

There are a few ICT tools used by Central pollution control Board which are listed below. Most of the tools and web based platform are related to water quality monitoring for rivers, drains, ground water etc.

1. OLMS & OCEMS (Online monitoring of industrial emission and effluent and surface water quality regarding)
2. NWMP (National Water Quality Monitoring Programme)
3. GWQS (Ground Water Quality Series)
4. WQM related ports:
 - Suitability of river Ganga water / real time water quality monitoring of river ganga
 - Ganga E track GPI
 - Environmental water quality data entry system (EWQDES)

4.1.2 SWOT insights on KPs available from CPCB - Generic

Strength

- Widely recognized and acceptable by all category of stakeholders
- Existing KPs cover a wide range of WW domains including design, adequacy, water quality, O&M, monitoring, trouble shooting etc.
- The tools like OCEMS and real time monitoring of river water quality is one its kind and proving useful for regulatory bodies for remote monitoring

Weakness

- All KPs are not updated regularly
- Accessibility to these KPs is limited

There are a very few KPs in the form of online software/ web based in the domain of WW.

Opportunities

- KPs on advance treatment technologies are yet to be made (e.g. SBR, MBR, ZLD etc in Indian context)
- The new KPs can be ICT tools/ software or web-based platforms
- Sector specific KPs can be made

Threats

- A lot many international software and ICT tools are already available. Hence the acceptance for new KPs may take time.
- A lot of private firms are developing and maintaining copyrights or also patenting KPs developed on their own.

4.2 International Knowledge Products referred in India

There are several international benchmark knowledge products in the domain of industrial wastewater management which are being referred to in India. These knowledge products are in the form of Handbooks, manuals, guidelines as well as in the form of ICT tools, web based platforms and mobile applications.

Few international benchmark Knowledge products in specific waste water domains and its brief description is as follows:

4.2.1 Key Aspects addressed by selected international KPs for Operation & Maintenance in waste water treatment facility

S.No.	Name of Book	Type of Book	Publication	Yr. Of Publication	Brief
1	O & M Best Practices -A Guide to achieve Operational Efficiency	Manual	U.S. Department Of Energy	Dec-02	Its aim is to provide Operation and Maintenance (O&M)/Energy manager and practitioner, with useful information about O&M management, technologies, energyefficiency, and cost-reduction approaches.
2	Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector	Manual	European Commission	2016	1)Provide general information on waste water, including general information on management and treatment systems used within the chemical industry 2) Provide data and information concerning the environmental performance of waste water treatment plants (WWTPs) at chemical sites, and in operation. 3)The techniques to prevent or, where this is not practicable, to reduce the environmental impact of operating installations
3	Standard Methods for the Examination of Water and Wastewater	Manual	American Public Health Association(APHA)	1999	Standards for the examination of waters of a wide range of quality, including water suitable for domestic or industrial supplies, surface water, ground water, cooling or circulating water, boiler water, boiler feed water, treated and untreated municipal or industrial wastewater, and saline water.

4	Water and Wastewater Treatment Plant Operations	Handbook	CRC Press	2014	Assisting utility administrators, managers and directors; water and wastewater plant managers; plant operators; and maintenance operators manage or operate their treatment works in a successful and compliant manner. Aid and assist all personnel preparing for all levels of operator licensure.
5	Industrial Water Reuse	Guidelines	EPA Victoria	Oct-17	Guidance on how to assess and manage the health and environmental risks associated with reusing industrial waste water.

4.2.2 Key Aspects addressed by selected international KPs for Design in waste water treatment facility

S.No.	Name of Book	Type of Book	Publication	Yr. Of Publication	Brief
1	Wastewater Treatment and Reuse	Handbook	CRC Press	2018	To present briefly the theory involved in specific wastewater treatment processes; To define the important design parameters involved in the process, and provide typical design values of these parameters for ready reference; 3)To provide a design approach by providing numerical applications and step-by-step design calculation procedure
2	Principles of Design and Operations of Wastewater Treatment Pond Systems for Plant Operators,	Manual	U.S. EPA	2011	To include basic design recommendations, the innovations in design that have been made in new, expanded or modified systems, as well as the additional processes that have been added to address nutrient requirements.

	Engineers, and Managers				
3	Wastewater Treatment Technologies	Manual	ZHDC	2016	To close the knowledge gap on wastewater treatment technologies and thereby motivate fabric mills and other relevant facilities of the global apparel and footwear industry to implement the professional treatment systems necessary to meet the ZHDC Wastewater Guideline.

4.2.3 Key Aspects addressed by selected international KPs in the form of ICT tools / web based platforms

S.No.	Name	Features
1	Toxic Release Inventory Program	A resource for learning about toxic chemical releases and pollution prevention activities reported by industrial and federal facilities
2	Substance Registry Services	EPA's authoritative resource for information about chemicals, biological organisms and other substances tracked or regulated by EPA
3	The Permit Compliance System	The permit compliance system (PCS) and integrated compliance information system (ICIS) databases provide information on companies which have been issued permits to discharge wastewater into rivers.
4	European Pollutant Release and Transfer Register(E-PRTR)	A Europe-wide register that provides easily accessible key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland.
5	EMAS	A premium management instrument developed by the European Commission for companies and other organizations to evaluate, report and improve their environmental performance
6	eWater source	eWater source, Australia's National Hydrological Modelling platform (NHMP)

7	Burrlioz	Standard software used to derive water quality guideline values for toxicants in Australia and New Zealand
8	HowLeaky	Water Balance Model developed to assess the impacts of different land uses, soil types, management practices and climates on hydrology and water quality.

4.2.4 Key Aspects addressed by selected international KPs in the form of mobile based applications

S.No.	Name of Apps Used In Wastewater	Function	Type of App(Free/Paid)
1.	Wastewater Inflow Calculator	Wastewater operators can figure inflow and exceedence for reporting or recordkeeping.	Free
2.	Leak Loss Calculator	Calculates the amount of water lost based on the size of the leak and the pressure of the main, making reporting easier.	Free
3.	Sizing a Chemical Pump	Calculates the size of chemical pump needed for your specific application, depending on water flow, dosing requirements and strength of chemical needed.	Free
4.	Well Disinfection	Calculates the amount of chlorine bleach needed to disinfect a well.	Free
5.	Percent Efficiency Calculator	On Simply entering the influent and effluent lab results for any parameter, including BOD and TSS, the calculator will determine how efficiently the process removed the parameter. Within seconds, wastewater specialists can calculate the efficiency of the wastewater treatment facility or any of the individual process within the plant.	Free
6.	Disinfection Calculations	Gives us an easy way for water professionals to calculate tank and pipe disinfection amounts. Simply insert tank or pipe sizes along with the desired ppm, and allow the app to calculate the chlorine dosage	Free
7.	Well Drawdown	Water professionals can simply enter the pressure readings from the air line installed with the submersible pump to determine well drawdown and specific capacity.	Free
8.	Flushing Flows	Estimating flushing flows has never been easier.	Free

		This app helps estimate hydrant flushing and flushing devices made from pipe for various reasons when a gauge is not available and accurate calculations are not essential.	
9.	Wastewater Infiltration Calculator	Wastewater operators will find this tool invaluable for determining the amount of infiltration from various breaks and holes in the lines.	Free
10.	Dosage Calculations for Water Treatment	Water specialists can make on-the-spot calculations with this app. Various calculations allow you to make the necessary changes in treatment.	Free
11.	OpCalc –Wastewater	OpCalc is for Water/Waste Water field operators that need to perform calculations on the go, without an internet connection. This capability will help minimize error and maximize efficiency for calculation related tasks.	Free
12.	Rural Water Calculator	This calculator for the rural water community includes every formula and calculation needed for water and wastewater utility operators. Calculation categories include perimeter, area, volume, flow, detention, pressure, head, water loss and flow estimation, concentration, dosage, loading, temperature, weight, common conversions, horsepower, efficiency, F/M ratio, solids, wasting, sewer inflow estimation, chemical calculations, and process efficiency	Free
13.	AWWA Exam Prep.	Pass your water operator certification exam with the American Water Works Association (AWWA) Exam Prep study app. Study anywhere, anytime with 2,000+ practice questions and answers.	Free
14.	Waste Water Reclamation Plant	A simple and easy-to-use utility that calculates mixed liquor suspended solids (MLSS), return activated sludge (RAS), and waste activated sludge (WAS) for those who work at water reclamation facilities.	Free
15.	Env Calcs	This app is designed for engineers, operators, and students to perform calculations such as pipe velocity, pipe diameter, friction head loss, mixer horse power, chemical consumption, chemical dose, residence time, blending concentration and much more. Feature allows users to select from imperial or metric unit	Free

		system.	
16.	Hydraulics and Waterworks Calc	Hydraulics Calculator contains 94 calculators and converters that can quickly, and easily, calculate and convert different hydraulics, water works, and civil engineering parameters.	Free
17.	Wateropolis	Wateropolis is designed to provide fast and accurate results in any demanding situation. Download their 5 free formulas to have access to key formulas, convertors, and look-up tables. Users can use their email feature to share their results with their colleagues, co-workers, or to save for use later.	Free
18.	PlutoCalc Water & Wastewater	Plutocalc is the most complete and popular problem solver suite for water treatment, wastewater, hydraulics, environmental chemistry, and unit conversions.	Paid
19.	Water Treatment 1900 Flashcard	This app is designed to make your study life easier to manage. Learn & educate yourself as much as you can with exam questions and study notes .	Paid
20.	Water Treatment Plant Process	This interactive app is designed to help students learn the properties of water, water treatment plants, water purification, water contamination, and sources of water in an innovative learning method.	Paid
21.	Wastewater Manager	Wastewater Manager app is designed for wastewater operators, engineers, or anyone else who has a need for easy-to-use mathematical formulas relating to wastewater. The formulas are organized by processes and can be used to assist in daily lab work, process troubleshooting, and more.	Paid
22.	Sewer Design Calculator	This app is designed for those involved in building or maintaining sewer infrastructure. The app uses “The Manning Equation” to calculate the necessary pipe diameter and slope for a given project. The user inputs the desired flow, length, initial ground elevation, and final ground elevation, and the app uses this data to calculate the slope, diameter, depth, and tractive force needed. The user has the option of working in U.S. units or SI units.	Paid
23.	Tank Level Monitor	Keeps track of critical tank levels with this app.	Paid

		Simply input starting levels and feed rate, and the app will calculate the current tank level every 60 seconds. The app is designed to monitor a variety of chemicals including peroxide, caustic soda, fluoride, hypochlorite, sulfuric acid, and ethylene, and will display both starting level and current level for each substance. A low level alert will appear when any tank is at or below low level setpoint and allow the user to update the levels when a tank is filled. The app can be used to monitor multiple tanks. Each tank's level can be emailed to anyone directly from the app. Designed for large and small water and wastewater treatment plants.	
24.	SAM-1 Smart Aqua Meter	This app turns smart devices into pH, oxidation-reduction potential (ORP), conductivity/ total dissolved solids (TDS), and temperature measuring meters that not only measure, but also communicate collected data via instant and error-free email. Users can simply plug the SAM-1 into the audio jack of their smartphone or tablet then plug in the smart sensor to take accurate readings. Samples can be measured in the lab, field, or plant and the readings can be shared via email.	Free
25.	Process Water Products	This app makes it easy to find the product that matches each individual application need, including pure water analysis, power plant water analysis, drinking water analysis, wastewater analysis, pulp and paper manufacturing, and general processing.	Free

5 Mapping of stakeholders

5.1 Category of stakeholders

The domain of industrial wastewater management caters to a wide variety of stakeholders ranging from the end users like Industries, ETP/ CETP, technology providers, Academia to Regulatory bodies, Judiciary etc. The broad identification of stakeholders in the domain of industrial wastewater management is as follows:

Category of Stakeholders under domain of industrial wastewater management

End users	Service provider	Academia	Regulatory bodies	Consultant / Third party	Investors	Publisher
Industry / ETP/ CETP	Turnkey service providers	Professor / Teachers	Judiciary / NGT	MEP (Mechanical, engineering, Plumbing) Consultant	Financial institution / Banks	Authors
Plant Manager/ supervisor	Technology providers	PHD scholars / researchers	MoEF&CC	Third party auditors	Government bodies	writers
Plant operator/ technician	Equipment suppliers	Institutes	CPCB / SPCB	PMC (Project management) consultant	Industrial development authorities	-
Lab analyst	O&M providing agency	students	NMCG	NGOs	Industrial associations	-

5.1 Identification of Various domains pertaining to industrial waste water management

The several domains under industrial wastewater management have been categorized majorly under five categories as summarized below:

Matrix for types of Knowledge products in industrial wastewater management					
i. Guidelines/ Manuals, ii. Handbook, iii. Good practice documents, iv. ICT based online Tool/ software, v. Web based platforms vi.) Online courses/ forums, vii.) Training Manuals viii) Any other relevant products/ instruments/ tools					
S.no.	1) Design/ engineering/ technology	2) Installation	3) Operation & maintenance	4) Regulatory compliance	5) Bid processing documents
a)	unit operations/ Pre treatment / Primary / secondary/ tertiary treatment / ZLD / technologies/ equipment sizing/ design vetting / feasibility	Supply	SOPs for each unit processes / equipment	Statutory requirement / EIA/ EC/ CTE/ CTO	Contractual requirement
b)	Process engineering & bio kinetics , Sludge generation / management	erection	Trouble shooting / Prevention and control	Discharge / Reuse standards	Finances / Available funding schemes
c)	Wastewater characterization and treatment process selection	testing / trial run	Laboratory Sampling & Analysis / analytic procedures	Plant adequacy	Evaluation Process
d)	Conveyance / storm water drain/ piping network	Dry run / wet run	Accidental discharge plan	Environment Laws / regulation / rules/ Govt. notification	Life cycle assessment/cost assessment
e)	Land & area requirement	Pilot plant	Monitoring (Manual, online, real time, remote)/ Record keeping	certification & accreditation : MoEF / PCB/ NABL/ ISO etc.	Funding Model are EPC, BOOT, CoD
f)	Costing , capital cost & operating cost	commissioning	Safety & Health Aspects	-	Investors
g)	Retrofit / capacity augmentaion / system upgradation	stablization	Best Practices / skill development	-	-
h)	Pollution prevention and control at source / Resource recovery at source	List of service / technology providers	Energy conservation & efficiency	-	-
i)	Rejectmanagement	List of equipment providers	List of chemical providers	-	-

Based on the categories of stakeholders identified and various domains of industrial waste water management, the requirement of knowledge products shall be assessed.

6. Questionnaire Survey and its analysis

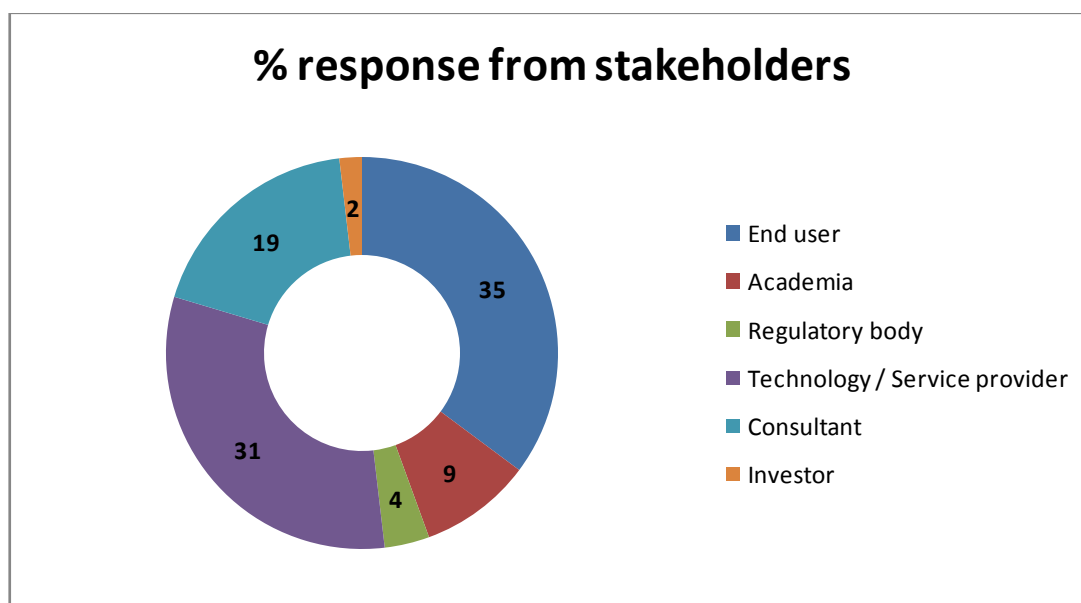
A questionnaire was prepared based on internal brain storming and interaction with various stakeholders. The copy of questionnaire is attached at Annexure 1. The questionnaire was circulated to over 400 stakeholders across India in the following sectors:

S.No.	Particulars
1	ETP/ CETP
2	Industries
3	Technology / service / equipment providers
4	Academia
5	Regulatory bodies
6	Experts in the domains of wastewater
7	Consultants etc.

A total of 54 responses were received by NPC. The several aspects of the questionnaire survey have been analysed by NPC and is summarized ahead.

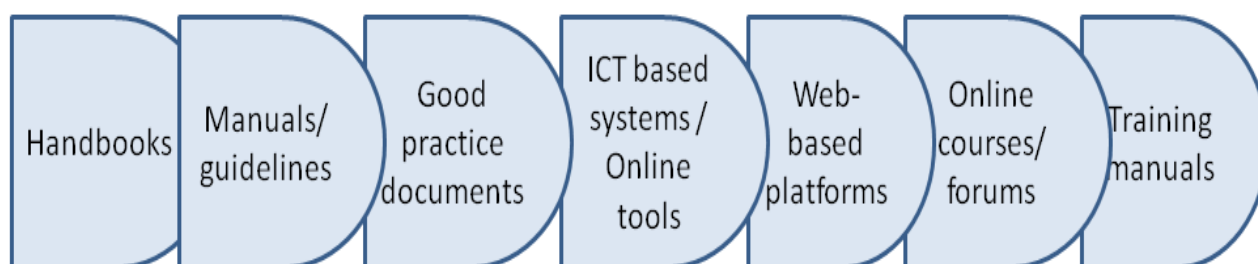
6.1 Response of the questionnaire

The 54 responses received were from various sectors and domains as indicated in the chart below:

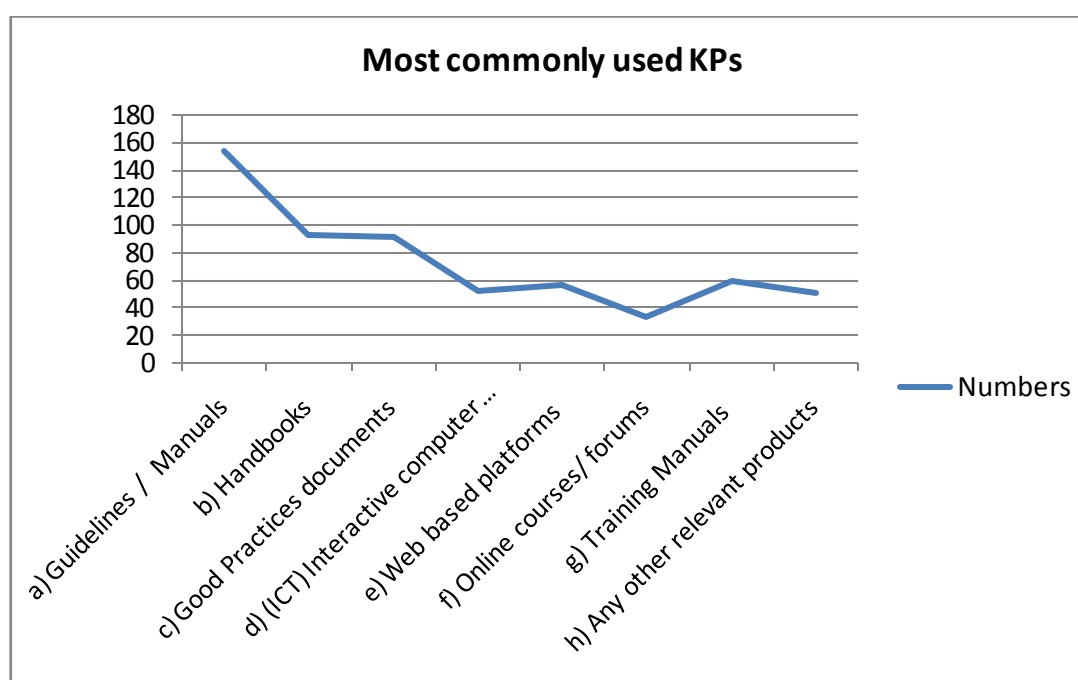


The maximum numbers of responses received were from End users like industries or ETP/ CETP owners/ operators etc. and from technology / service providers in the domain of wastewater management.

The categories of knowledge products covered in the survey are:

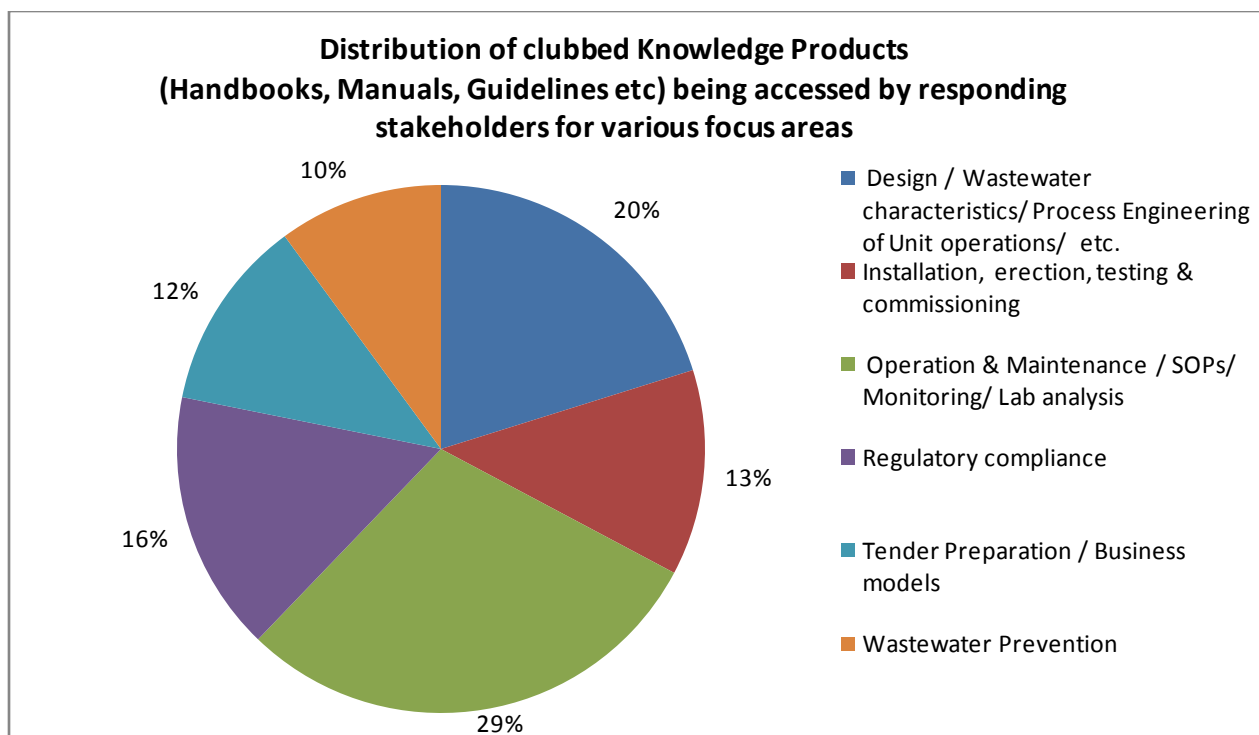


Amongst the 54 responses the most widely used knowledge products to be used by these stakeholders is indicated as below:



Guidelines and manuals were observed to be most sought knowledge products by all categories of stakeholders. While web based platforms and ICT tools are gaining popularity but they are very limited in numbers and have limited accessibility.

Based on the identified domains of wastewater, the domain wise knowledge product accessed by the stakeholders is indicated below:



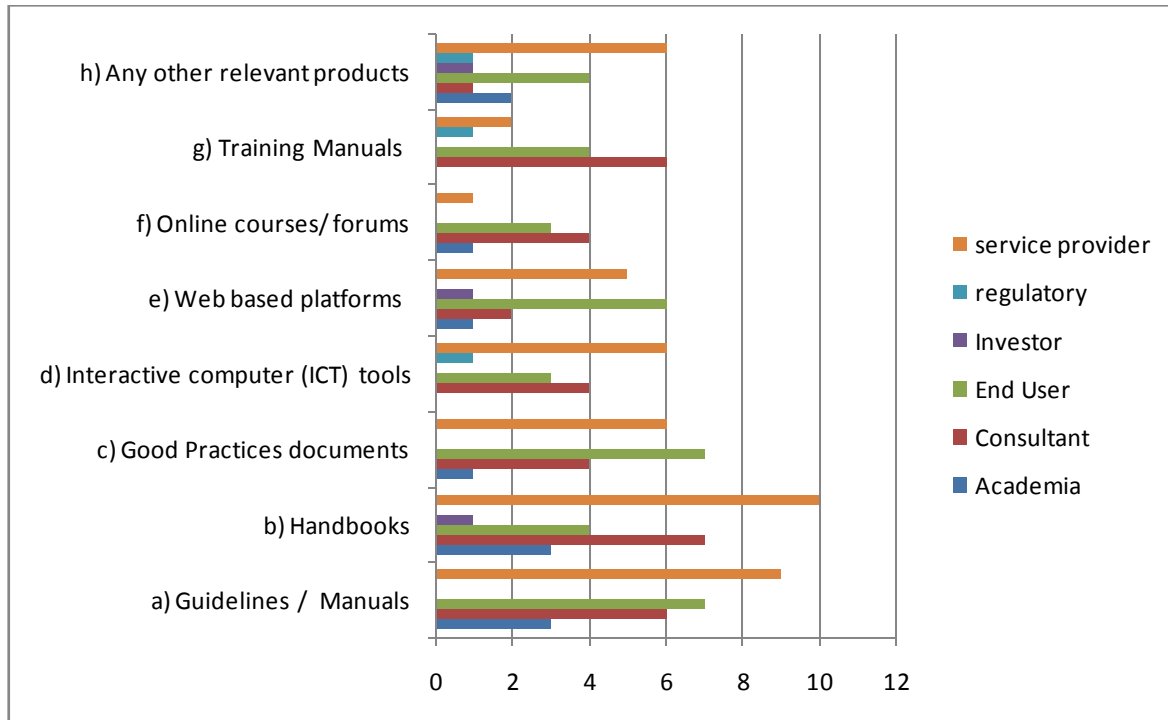
6.2 Domain wise most commonly used knowledge products by stakeholders

On the basis of the questionnaire survey, the respondents were broadly classified into 6 categories of Academia, End users, technology providers, Consultants, Regulatory bodies and investors. Based on the various domains of wastewater mapped in chapter 5 of this report, the most commonly sought knowledge products have been derived.

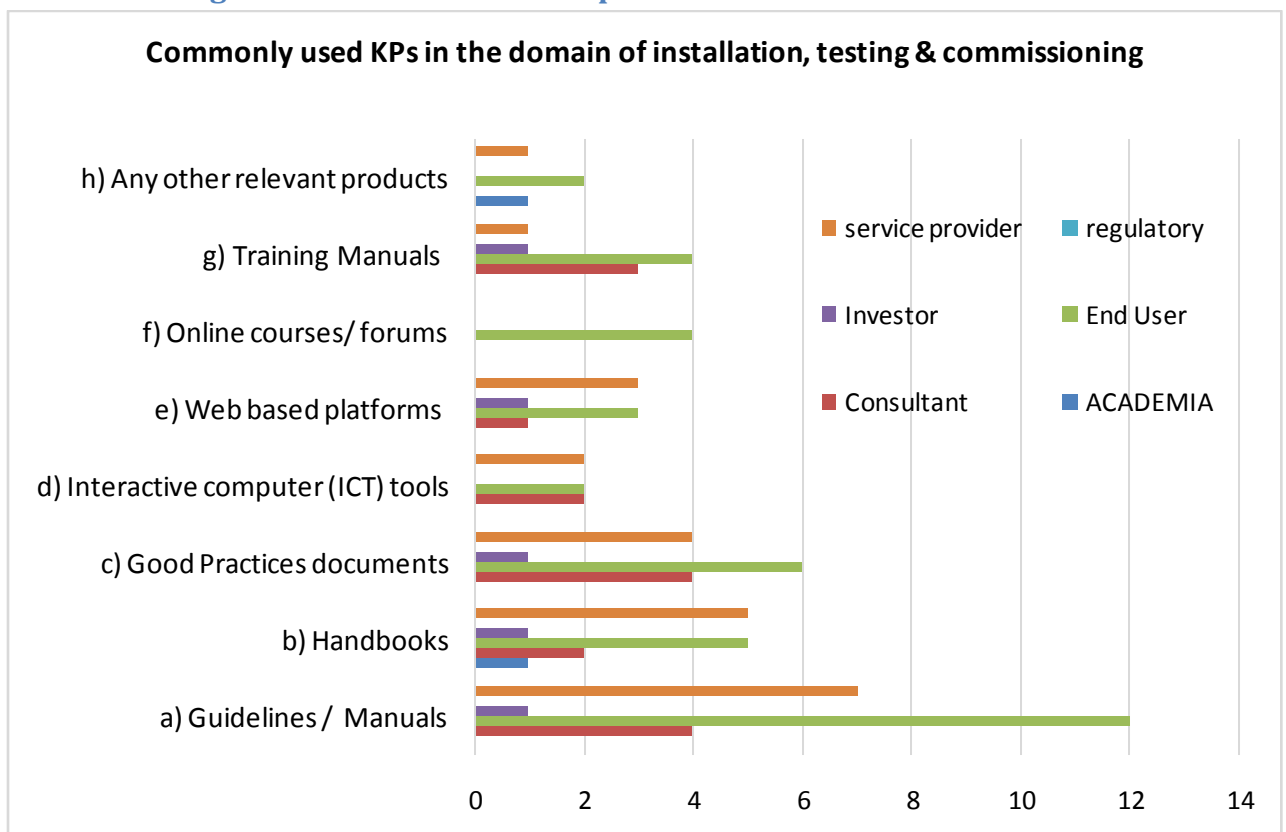
The identified domains of wastewater management are:

1. Design/ engineering / technology of wastewater
2. Installation, testing and commissioning
3. Operation & maintenance and Sampling, analysis & monitoring
4. Regulatory Compliance
5. Tender/ bidding / business models

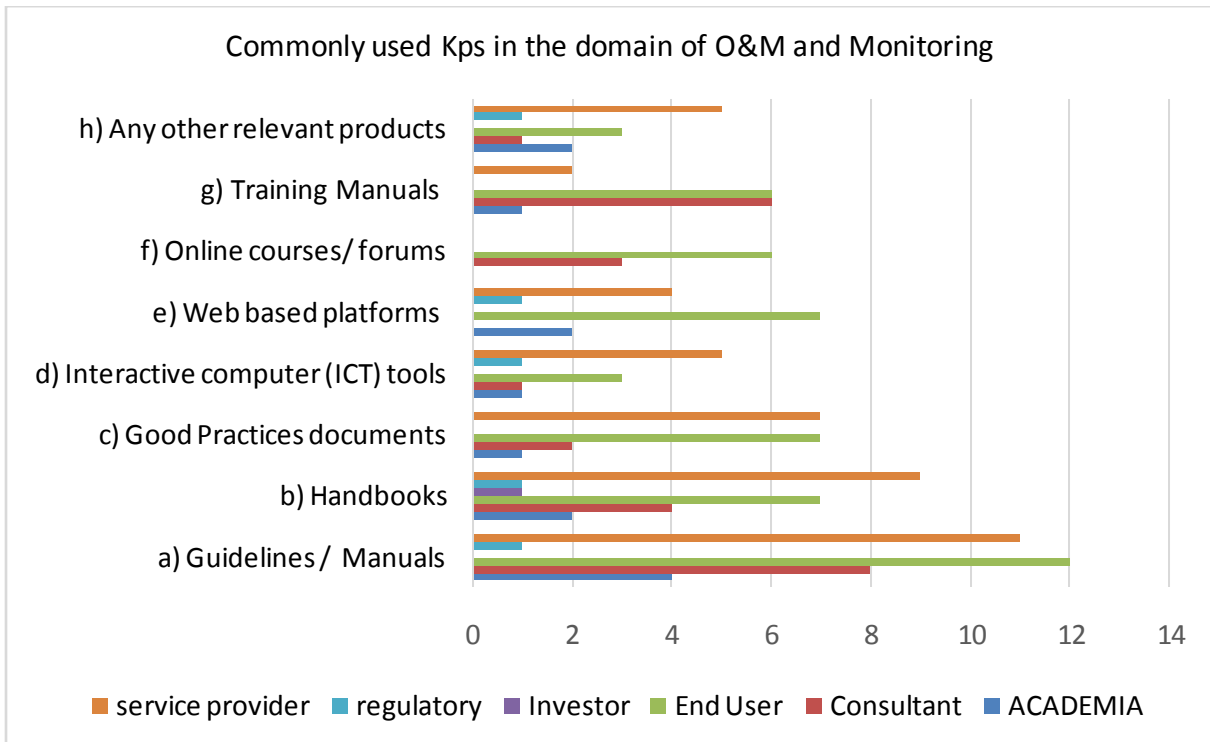
6.2.1 Most commonly used KP in the domain of design / engineering / technology of wastewater



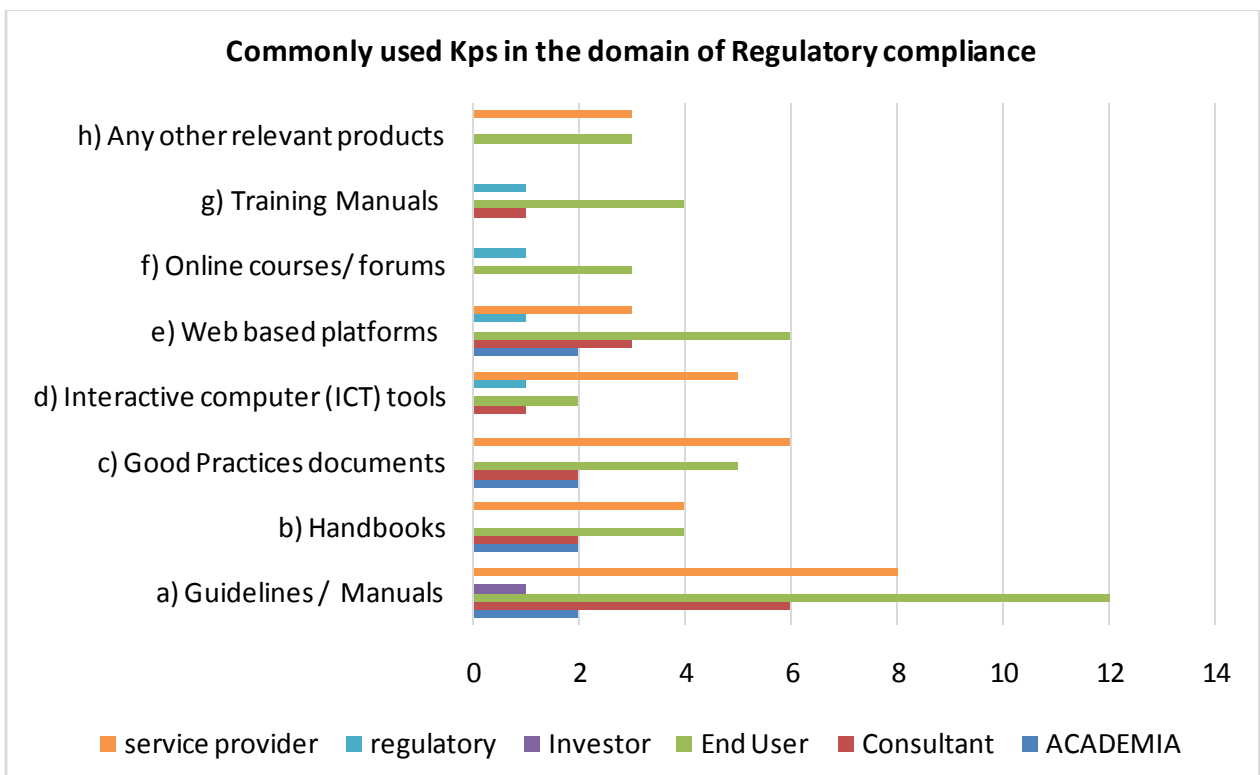
6.2.2 Most commonly used KP in the domain of Installation, testing and commissioning of wastewater treatment plants



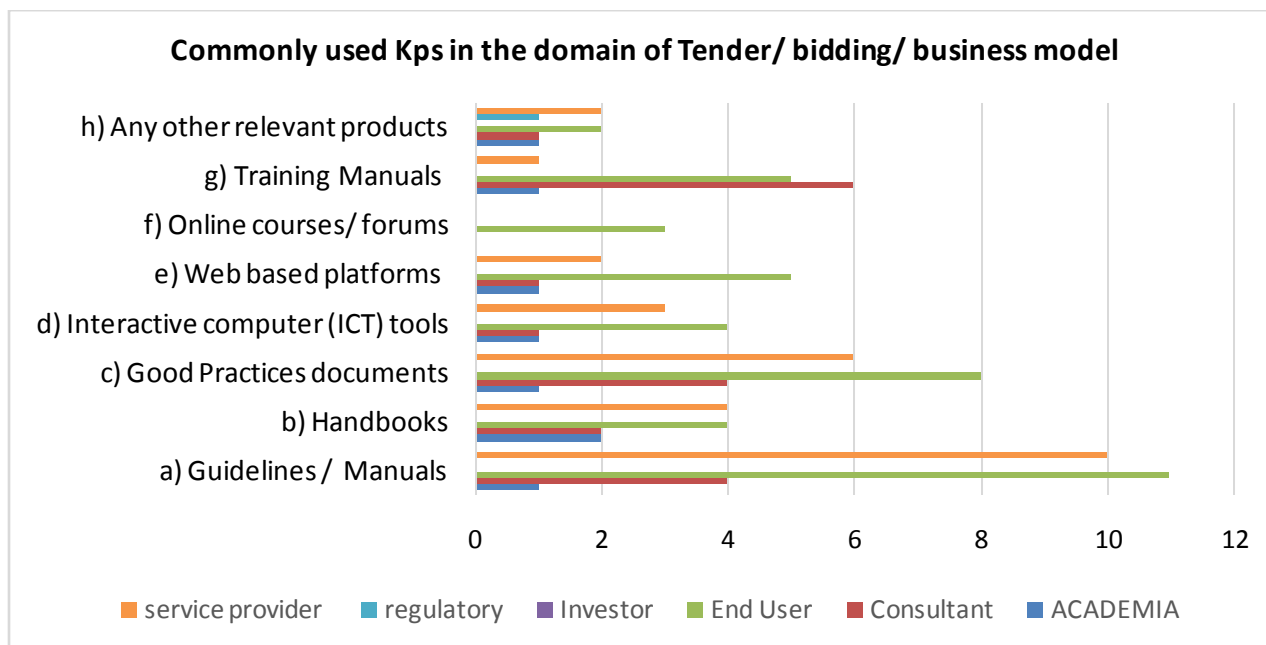
6.2.3 Most commonly used KP in the domain of Operation & maintenance and Sampling, analysis & monitoring of wastewater treatment plants



6.2.4 Most commonly used KP in the domain of Regulatory Compliance of wastewater treatment plants

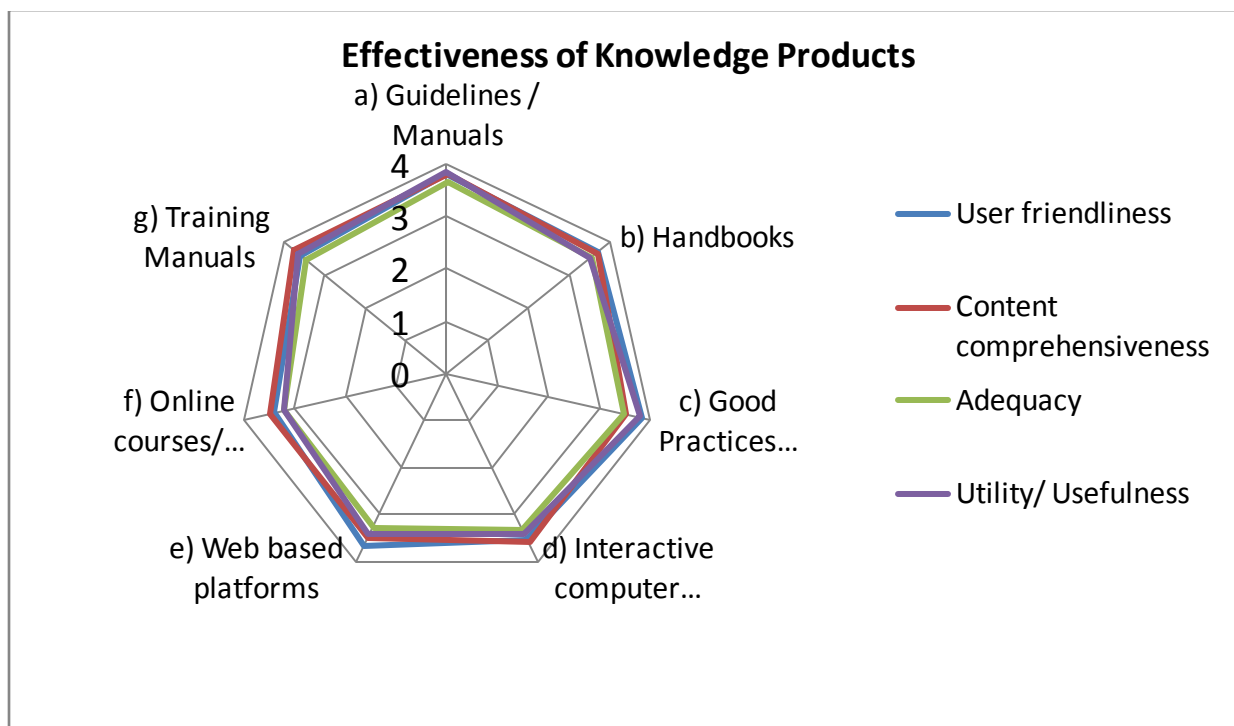


6.2.5 Most commonly used KP in the domain of Tender/ bidding / business models of wastewater treatment plants



6.3 Effectiveness of most commonly used knowledge Products

The effectiveness of most commonly used knowledge products has been obtained based on the marks and feedback given by the respondents on the user friendliness, content comprehensiveness adequacy and utility of the knowledge products used by them.

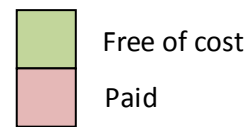


For the effectiveness of all categories of knowledge products used by various stakeholders, most of the respondents have given an average marks ranging between 3 to 4, on a scale of 1 to 5. Hence the effectiveness of the existing Knowledge products may be considered as adequate.

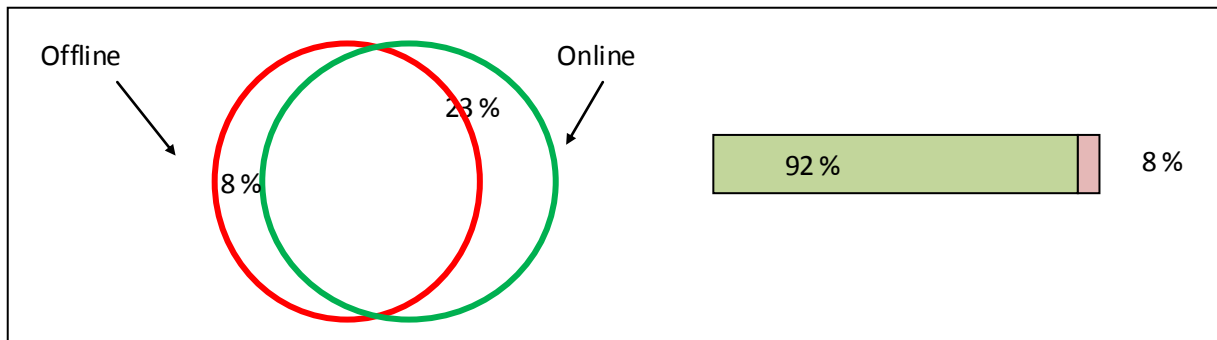
6.4 Accessibility of most commonly used knowledge Products

The accessibility of KPs as offline and Online and availability of KPs as Free of cost or paid has been assessed. Based on the responses it can be inferred that most of the knowledge products are available both offline & online and on approx 35% of knowledge products available are paid and 65% are available for free. The accessibility and availability of knowledge products as per responses received is indicated below:

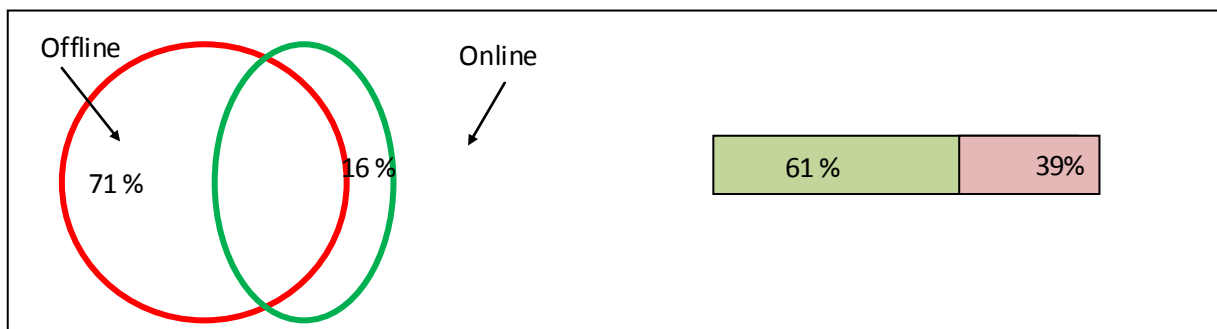
Legends:



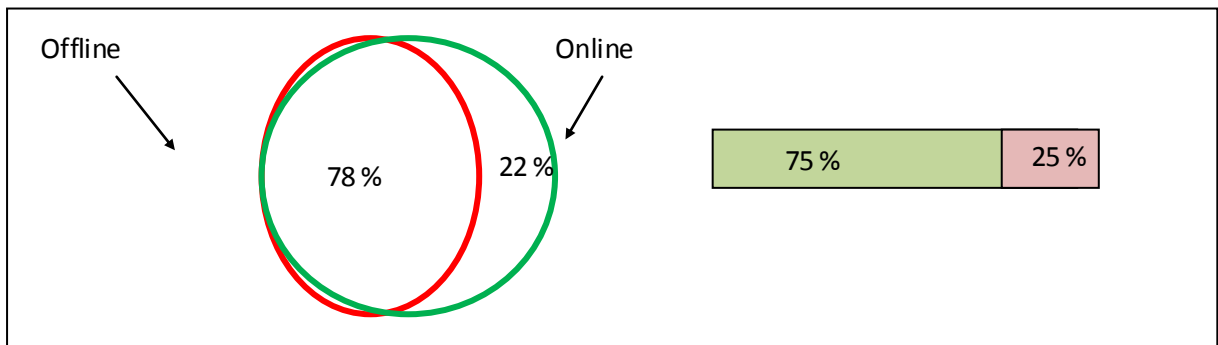
1. Guidelines / Manuals



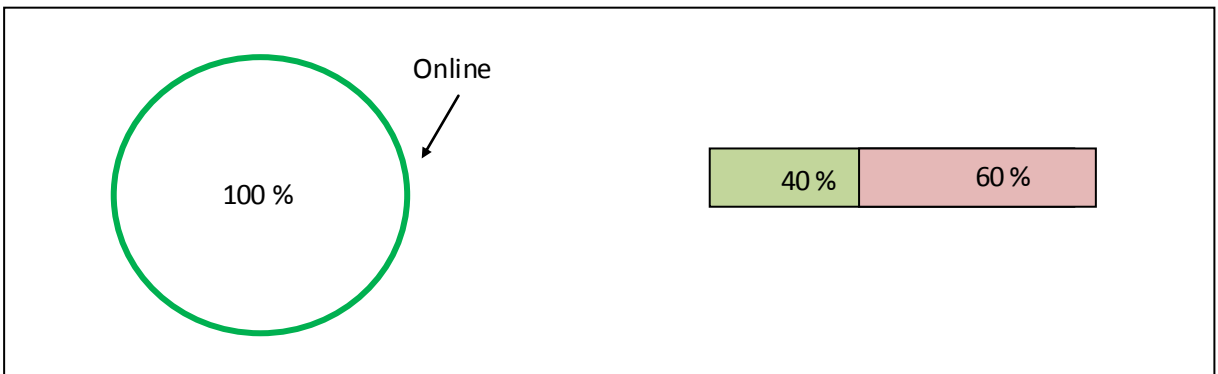
2. Handbooks



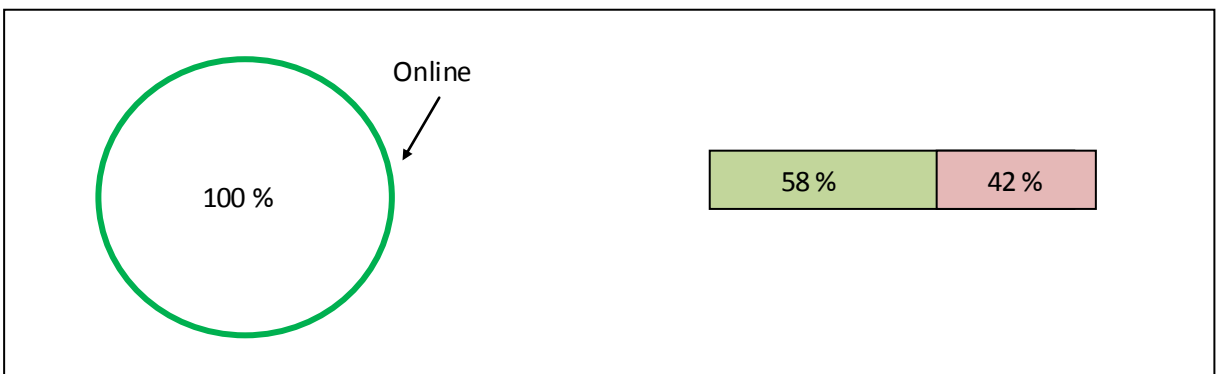
3. Good practices documents



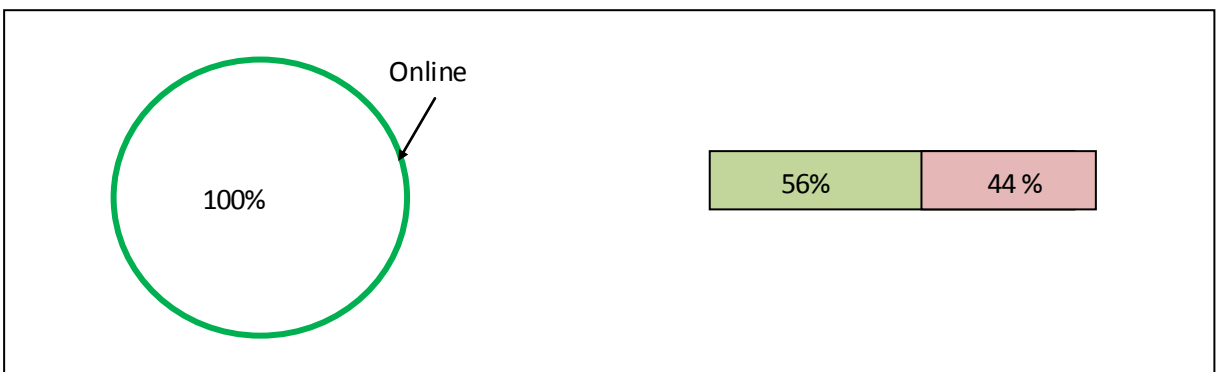
4. Interactive computer tools



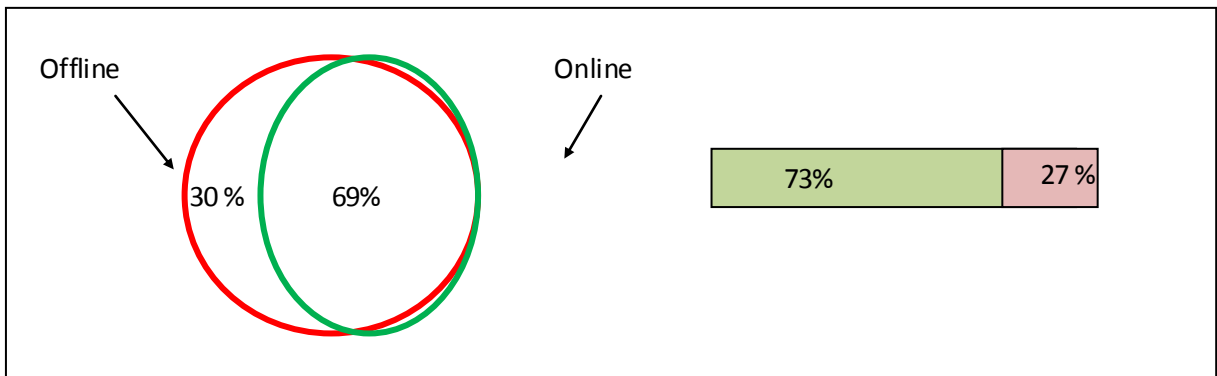
5. Web based platforms



6. Online courses and forums



7. Training manuals



7.Gaps and need assessment of the existing Knowledge products

The gaps and need assessment was carried out based on the responses of 54 stakeholder, one on one interaction with various domain experts/ stakeholders and on the basis of internal brain storming.

The gaps identified in the existing knowledge products are as follows:

7.1 General gaps identified:

1. Most KPs are on conventional technologies.
2. Generally, KPs cater to operational level activities and design aspects are moderately treated
3. Very few KPs are contextualized to Indian situation
4. Most KPs are aimed at aerobic treatment systems. Other types of treatment systems do not have much resources
5. KPs on combined WW treatment are very few
6. KPs on combined wastewater treatment, design of packaged treatment systems, tertiary treatment of wastewater and its reuse, Troubleshooting of WWTP are required
7. Inadequate / insufficient SOPs/Guidelines for Troubleshooting Problems with ETPs.
8. Inadequate / insufficient Guidelines / Books for RO/FO & MEE Operations and Maintenance
9. The New Concept developed by regulator is ZLD but No Specialised Programme at Online Portal is available to make effective implementation with respect to technology, costing etc.
10. Good practice documents are mostly international and country specific and adaptation process need to be guided or India specific Best Practice Documents needed and with better access / ready availability
11. User friendliness limited to already knowledgeable personnel
12. Guidelines for vetting of design /installation of ETPs / CETPs needed etc.
13. State specific Guidelines and Suitable Act / Rules for CETPs establishment and User fee charges formulae and industry responsibility aspects, besides Business Models and funding pattern / O&M aspects related applicability issues are needed to be addressed and benchmarks for service life etc of Civil structures and Electro-Mechanical Equipment needed

14. No common platform where design / features on WWTPs could be shared
15. Operator Qualifications not standardized and KPs specific or customized to various stakeholders needed
16. Simplified KPs and in Local language in respective States of India are not available.
17. Sector specific model tender documents for design / development / installation of ETPs/CETPs with suitable detailing of technical requirements beyond treated wastewater discharge norms specifications as well are not available.

7.2 Need assessment of new Knowledge products:

Based on the interaction with several stakeholders, domain experts and analysis of responses, the following need of new knowledge products have been listed:

1. Detailed Case studies on River pollution scenarios, pollution monitoring, river cleaning, rejuvenation and recovery / revitalization
2. Development and advancing of India specific Water Quality Index as a framework and methodology for implementation across regions covering surface and ground water regimes
3. Sustainable Portals / websites / Transportals etc., with deeper integration of possibly Artificial Intelligence application and Machine learning / data mining algorithms for comprehensively generating Technology options, addressing industry and stakeholder needs on specific range of wastewater management issues, addressing and providing end to end solutions via an open platform for bringing in multi-country inputs on technology options/guidance, reflecting India specific needs and indicators etc. The economics and relevance of such platforms should be driven by the beneficiaries and their business model structures
4. Self certification platforms for engineers and operators and wastewater professionals and availability of their databases for engagement by industry and regulatory bodies
5. Real time incidence response frameworks building on online monitoring networks concerning wastewater related emergencies in the context of chemicals and toxics releases, pollutant load factors, floods and disaster impacts assessments and related

recovery systems including mechanisms of strengthening additional real time data needs incorporation etc.

6. Training module for induction of fresh appointees with a Identified training Institute
7. Costing elements and indexations with respect to design of ETPs / CETPs
8. Comparison amongst alternatives based on site specific conditions (with range of conditions and parameters accounted for)
9. Electromechanical detailing and equipment descriptions and alternatives
10. O&M Manuals and worksheets and usage features
11. Models with respect to revenue and cost benefits (enterprise / society level)
12. Sector specific features / key differentiators or focus elements highlighting unit specific and cluster specific treatment approaches, design and outcomes
13. Comparison of influent characteristics and treated effluent characteristics across sectors and any justifications thereto with respect to emission norms
14. Quantum of input for construction personnel towards prevention and control, detailing water auditing procedures.
15. EIA requirements / Environmental Clearance aspects and modeling, including for river and sea water discharges of treated effluents
16. Solved numericals and Question / Answer banks for designers of different stages of knowledge building
17. Case examples and case studies focused KPs : (regarding successes / failures / upgrades and redesign and also covering tendering elements and cross references) .
18. Industry / Sector specific KPs and guidelines are required. Sector specific features / key differentiators or focus elements highlighting unit specific and cluster specific treatment approaches, design and outcomes
19. Advanced Treatment Focused Manuals (e.g. MBR, SBR – Sequential Batch Reactor System; MBBR – Moving Bed Bio-Reactor)

20. KPs on instrumentation and Metering of Equipment in ETPs / CETPs along with compendium of applicable IS Codes in the domain of WWT equipment and operations
21. Models with respect to revenue and cost benefits (enterprise / society level)
22. Establishment of Pilot Plants and Demonstration Units for different technologies in WWT and Training Plans related KPs
23. Softwares required for the range of the domain (e.g. for drainage there is WaterCad / Watergem / SewerCadetc being made by Bentley but access is inadequate and very few trainers in this domain).
24. RO/FO/MEE Operation and troubleshooting
25. Standards Development (Linking to Output 1 – Legislative or norms perspectives) and Load based standards
26. Guidelines towards prevention and control and detailing water auditing procedures
27. Energy efficient Treatment Systems
28. Specific treatments like Ammonia removal, Cyanide removal, heavy metals removal: Standardized Methods needed.
29. Utilization of Solar power in effluent / sludge treatment
30. Comprehensive Water Quality Index integrating various parameters (to also include linkage with GIS systems and geo – referencing and GIS based Governance) or Geo-Mapping on different parameters (by Physical monitoring for surface and ground water as well as Satellite imagery e.g. for Rivers)
31. Heavy Metal Pollution Index Development related KP

8. A few suggestions and way forward

- Create a web based centralized database for all the existing and upcoming KPs wrt industrial wastewater management
- Categorize all the KPs under various identified domains of industrial wastewater management.
- The centralized database may have the provision of membership fee (one time / annual) for accessing all the KPs and eventually making it sustainable.
- A networking portal for all stakeholders may be developed for knowledge and experience sharing amongst all wrt to pollution prevention / mitigation, trouble shooting of wastewater treatment plants etc.