Journal of Engineering Education Transformations ,
Volume 30 , No. 1, July 2016, ISSN 2349-2473, eISSN 2394-1707

Clean Village and Project Based Learning

Dr. Milind Kulkarni
Group Director & Professor, Engineering Institutes,
ITM Group of Institutions, Vashi, Navi Mumbai
drmkulkarni@itm.edu

Abstract : The industry complains that fresh Engineering graduates are not employable. They lack practical and hands on experience. ITM Group has four Engineering colleges located at Vizag, Nagpur, Raipur and Vadodara in India. The group has already introduced project based learning in all Engineering colleges. Many of these projects are executed in the campus. This concept will be now introduced at village level in the vicinity of Engineering Colleges so that students will be exposed to broader level of experience. Students will gain practical technical knowledge, hands on experience, skills to work in a team, skills to interact with different stakeholders in society. Students will become employable and at the same time this will help in achieving the mission of clean village. There are different aspects of clean village such as: water supply, sanitation, indoor air quality, solid waste management etc. The paper discusses all these aspects with reference to Maharashtra State and India. This paper plans to propose a participatory role for Engineering College in the efforts of government to achieve the missions of clean village and skill development. This can be achieved by Project Based Learning in the identified areas.

Dr. Milind Kulkarni
Group Director & Professor, Engineering Institutes,
ITM Group of Institutions, Vashi, Navi Mumbai
drmkulkarni@itm.edu

Keywords : clean village; water supply; sanitation; skill development; project based learning

1. Introduction

ITM Group Engineering Colleges are young. Chairman Dr. P.V. Ramana is keen to integrate project based learning in Engineering Education. ITM College of Engineering, Nagpur adopted village Ghorpad in the vicinity and conducted a survey by involving students and faculty. Based on the survey it was decided to implement projects in the areas of water supply, sanitation, solid waste management and indoor air pollution. The paper discusses the present status in the state of Maharashtra and India in these areas and identifies the projects which can be undertaken in these areas in the village Ghorpad based on the survey conducted by the students.

2. Water Supply

Countries such as Brazil, Russia and Canada have the largest supply of fresh water in the world. Relative to these countries, the per capita availability of fresh water in India is meager- 1197 cubic meters per year in 2009, according to World Bank report, published in 20101.

At present about 50% of the rural households in Maharashtra have access to tap water and about 37% have access to improved domestic toilets. (Census 2011)2 Improving access to water and sanitation services therefore remains a priority for the state

where water scarcity and water quality, and sustainability of sanitation coverage are still critical challenges. The government of India, the government of Maharashtra and the World Bank signed a $165 million credit agreement in May 2014 to help Maharashtra achieve its visionof ensuring safe drinking water and improved sanitation services for rural communities at an affordable cost and in an environmentally safe manner under Jalswarajya II. The program will help improve the quality of water and sanitation services in about 40 peri-urban villages and increase access to safe drinking water in about 580 water-stressed and water quality-affected villages, covering about one million people in 12 selected districts. In addition, the entire rural population in the state is expected to benefit from efforts to improve the capacity of its various RWSS institutions. The World Bank's earlier Jalswarajya-I Project (2003-2009) benefited 6.7 million people with improved water services, and about 61% of the gram panchayats in the project area have become Open Defecation Free (ODF)3.

Jalawarajya_II project will support the state's ongoing Medium Term Rural Water Supply and Sanitation (RWSS) program (2012-2022) of increasing water connections for households, improving service levels and ensuring that 100% of the rural population has access to safe water and improved sanitation especially in peri-urban and water quality-affected and water-stressed areas. This is fully aligned with the government of India's National Rural Drinking Water Program and the Nirmal Bharat Abhiyan (Clean India Campaign) for sanitation.

Jalswarajya-II will be implemented over a six-year period between 2014 and 2020. It is the first Program-for-Results (PforR) operation in India, wherein the World Bank funds will be disbursed on achievement of agreed key results, which are called Disbursement-Linked-Indicators.

In semi-urban areas, a water supply scheme of 5 to 10 MLD typically serves a group of towns/villages. Typical components of water supply scheme are: intake well, raw water pumping main, water treatment plant (WTP), Master Balancing Reservoir, treated water main, elevated service reservoir and distribution network. A laboratory is also needed at the site of water treatment plant. Level of automation and digital design is increasing day by day.

After water supply scheme is constructed, operation and maintenance is handed over to Local Self Governments. The 73rd and 74th Amendments of the Constitution of India confer upon the local bodies the powers and responsibilities of water supply and sanitation services. The role of the State is limited to giving advisories to the Local Self Governments and using the State and Finance Commission funds to leverage good management practices. The Government of India supported JNURMM and UIDSSMT programs for urban areas do not specifically reward sector reforms. The focus of government departments and agencies responsible for municipal water has largely been restricted to aspects of water supply and tends to ignore the larger canvas of integrated water management that includes prudence in financial management, operational efficiencies, water quality issues, and sewage and solid waste management. 4

A study undertaken by the Water Supply and Sanitation Department in Maharashtra revealed that while the coverage of urban water supply services in the State was fairly high (78% within premises), the quality of service was "inadequate, limited and irregular". The existing service level benchmarks do not meet the standards (Table 1).

Table 1: Service Level Benchmarks – Existing and Expected

Key Performance Indicator	Existing	Standard
Coverage of Water Supply Connections	50 to 76%	100%
Per Capita Supply of Water (LPCD)	41 to 132	75 or 135
Extent of Metering of Water Connections	14% (average)	100%
Extent of Non-Revenue Water	37 to 76%	17 to 20%
Continuity of Water Supply (hours per day)	2 to 6	24
Cost Recovery in Water Supply Services (WSS)	19 to 93%	100%
Efficiency of Collection in WSS Related Charges	60 to 95%	100%

The findings suggest that there is a need for strong governance model for establishing and maintaining water supply infrastructure. 4

The Government of Maharashtra resolved to implement a demand driven urban water supply and sanitation programme that is based on reforms. The Maharashtra Sujal and NirmanAbhiyan (MSNA) was thus launched in October 2008. 5 The MSNA places

thrust on a series of reform measures with the ultimate objective of achieving continuous and quality water supply alongside a sustainable institutional arrangement that will optimize water management.

The MSNA was framed in a phase-wise manner (Table 2) which allows the Local Self Governments to graduate up the ladder of reforms through identified milestones.

Table 2: Phasing of Reforms under MSNA

Phase – I	Phase – II	Phase – III
Consumer Survey, Detection of illegal connections	24 x 7 pilot project	Achieving 100% of Benchmark
Bulk Flow Meters	Sustainable water source development	City-wide 24 x 7 water supply system
Water audit	80% Household metering	100% consumer metering
Energy audit	80% recovery of O&M cost	100% O&M cost recovery
Hydraulic modeling	80% collection efficiency	100% Billing & Collection efficiency
GIS mapping	MIS at various level	Sewage System with STPs
Computerization of Billing	Establish water tariff frame	
Measuring existing Service Level Benchmark (SLB)	Upgrading SLB to 80%	

The overarching goal of MSNA is to ensure sustainability of the water supply systems and assets created. The starting point for the reforms programme is the consumer survey. The house-to-house survey helps in obtaining information on water requirement, detect illegal connections and have the connection regularized on payment. Together with the GIS mapping and water audit, these measures help in assessing the Non-Revenue Water (NRW) and in planning to reduce the same. Energy audit helps in optimizing the electrical equipment for lowest possible power consumption and thereby reducing the expenditure. Computerized billing is intended to make the billing and collection systems more effective and reduce commercial losses. Hydraulic modeling assists in the rationalization of distribution networks, thereby leading to savings in capital as well as operation costs. Overall, the steps adopted have the convergent objective of reducing water losses/ NRW (thereby saving precious water as well as costs), optimizing expenditure and enhancing the revenue. 4

Project Based Learning

ITM College of Engineering, Nagpur (ITMCOEN) has adopted a village Ghorpad which is located near the college in Kamptee, Nagpur. The process of adoption was started on October 8, 2014 which is the foundation day of ITM Group. Local Member of Parliament Mr. KrupalTumane and village chief of Ghorpad were invited on this occasion. The intention of adopting the village Ghorpad was announced on this occasion. Local MP Mr. Tumane assured funding for projects in the village through MP LAD funds.

The data about MSNA reforms' objectives gives the direction for possible research and projects in the water supply in village Ghorpad. As a first step it was decided to have a leadership level dialogue between ITMCOEN and Ghorpad. This will help in identifying particular projects. It was decided to implement pilot projects in the college campus before they are implemented in the village. This will enhance the skills and confidence in students and faculty. Projects on water quality monitoring can be started for the village early as the students and faculty are trained in conducting laboratory experiments. Even the surveys can be conducted with immediate effect. ITMCOEN has Civil Engineering as one of the disciplines. This Department has faculty members who haveEnvironmental Engineering or Hydraulics as specialization for post graduation. These faculty members, laboratories and students can be used as important resources in attaining the objectives of MSNA.

Subsequently leadership team of ITM College of Engineering visited the local self government office of the village (Gram Panchayat) and met the village chief (Sarpanch) Mrs. PramilataiMeshram to have detailed discussion regarding the present status with respect to water supply, sanitation, solid waste management and indoor air pollution (Plate 1). This visit took place in June 2015. Many other activities such as computer education for health children, health camp are conducted for the village. But the activities related to clean village and project based learning are only discussed here.

With respect to water supply, the village chief told that there is a water supply scheme and all thehouses get treated water. The source is a small lake and the only treatment given is disinfection (Chlorination). The water is lifted into a surface reservoir and

supplied through distribution network through gravity. Butthe supply is only for one hour in a day. In some parts of village, it is for two hours - onehour in the morning and one hour in the evening. Apart from this, water hand pumps are also provided at different locations. In the absence of electric supply, people use water from hand pumps. The water is tested in the local laboratory intermittently. There are no water meters and each house is charged at a rate of Rs. 1 per day. The attendant was also interviewed. He told that area around the water reservoir is not clean and used for open defecation. It was decided to conduct house to house survey by students to collect the data with respect to water supply, health etc. In the next phase, it was decided to conduct water audit, energy audit, digitization of data, use of GIS, installation of water meters, explore possibility of 24x7 water supply. Financial viability of the water supply scheme will be also assessed. Energy audit will be undertaken by Electrical Engineering students whereas all other projects will be undertaken by Civil Engineering students. The faculty members can work with ULBs/LSGs. Training to staff of ULBs, Gram Panchayats can be also provided in these Engineering Colleges.

Considering the knowledge of students and need of the village it was decided to give the project of Design, Operation, Maintenance & Troubleshooting of Water Treatment Plant (WTP) to a group of students of Civil Engineering, faculty dealing with Environmental Engineering and Chemistry and staff involved in the maintenance of WTP.

Plate 1: Interaction of ITM team with Village Sarpanch

The students designed the project. The design calculations were checked by the faculty. The different units comprised pressure sand filter, softner, chlorination, raw water tank, treated water tank along with pumps. The design calculations and drawing are shown in separate Annexure. The plant was fabricated by commercial vendor. The students monitored the parameters of treated water like pH, Chlorides, hardness, MPN. These values were checked against standards as specified by IS 10500. Faculty and students operated the plant through operator (staff). Theoretical knowledge of the students was strengthened by practical problem. They came to know about constraints such as fire fighting norms, different materials like FRP, PVC, RCC etc; Mechanical and electrical items like pumps, motors, cables, panels etc; capital cost & operating cost; digital drawings and software like Autocad, Solidworks; automation. During the operation, students found that there is no removal of hardness. On contacting the vendor, they found that the regeneration of softner was not taking place due to mechanical problem. Thus project based learning significantly helps in achieving learning outcomes. The plant is semiautomatic i.e. the pumps in the tanks get on and off after particular levels are reached. In the next phase, the team will try to reach complete automation. They are interacting with faculty and students from University of Massachusetts, Lowell for collaboration. The knowledge achieved will be used for the automation of WTP in Ghorpad.

The questionnaire survey is prepared. It is shown in separate Annexure. It was also decided to monitor the quality of water in college laboratory for MPN and other parameters.

3. Sanitation

In 2008, 88% of the population in India had access to an improved water source, but only 31% had access to improved sanitation. In rural areas, where 72% of India's population lives, the respective shares are 84% for water and only 21% for sanitation. In urban areas, 96% had access to an improved water source and 54% to improved sanitation. Access has improved substantially since 1990 when it was estimated to stand at 72% for water and 18% for sanitation.5
Table 3 summarizes the access to potable water and improved sanitation.

Table 3 : Access to improved water supply and sanitation in India

	Urban	Rural	Total
Improved water supply	96	84	88
Improved sanitation	54	21	31

In 2010, the UN estimated based on Indian statistics that 626 million people practice open defecation.6 In

June 2012, the then Minister of Rural Development Jairam Ramesh stated India is the world's largest "open air toilet". He also remarked that Pakistan, Bangladesh and Afghanistan have better sanitation records.7

According to Indian norms, access to improved water supply exists if at least 40 liters/capita/day of safe drinking water are provided within a distance of 1.6 km or 100 meter of elevation difference, to be relaxed as per field conditions. There should be at least one pump per 250 persons.

Availability of water supply for Maharashtra is almost at the same level as that of India.8 However with respect to sanitation or availability of toilets, itis better in Maharashtra than India. 9 Table 4 below shows the details.

Table 4: Comparison of availability of toilets in Maharashtra with India

	Urban	Rural	Total
Maharashtra	94.1	39.3	63.6
India	88.7	34.8	50.8

The data shows that a lot of work still needs to be done in the area of providing toilets in rural areas. Coverage of sewage treatment facilities in rural and semi urban areas is abysmally low. Government of Maharashtra is using a patented technology of IIT Mumbai titled soil bio reactor (SBR) and installing the waste water treatment plants along with the conveyance system to treat waste water generated in villages. Though the terminology used is liquid waste, the underlying assumption is that it will be grey water i.e. the waste water from bathrooms and kitchen. There is a provision that the contractor should also undertake operation and maintenance of the scheme for two years. 10 It appears that the technology is similar to constructed wetland systems. The constructed wetlands are combination of settling, filtration and biological action. These systems utilize wetland plants, soils, and associated microorganisms to remove contaminants from wastewater. They can remove contaminants such as BOD, suspended solids, metals including cadmium, chromium, iron, lead, manganese, selenium, zinc and toxic organics from wastewater.11 The thrust is on treatment. The focus should be on integrated approach in water management which covers the aspects of availability of water, sustainable development, financial viability and resource utilization. Being aerobic the area requirement is more. After two year O&M period of contractor is over, how the local gram panchayat will operate the scheme is a question mark. However this is the first good move made by the government of Maharashtra in the direction of treatment of domestic waste generated in rural areas.

Another alternative for treating wastewater in rural areas is stabilization ponds which is low cost and also requires least operation and maintenance and energy. Some researchers have proposed the stabilization for the treatment of black water whereas sand filter for treating grey water. 12 The option requires more land and also there is no effective use of biological energy of the wastewater. It may also release methane which causes green house effect.

Some companies have come up with FRP biogas plants which is a good solution for rural areas where centralized waste water treatment schemes are absent. Along with toilet wastes they can be used to treat other solid wastes such as animal waste, kitchen waste. They can generate biogas, which can be used as fuel. 13 In rural areas women and infants are exposed to high dose of air pollutants due to use of low grade cooking fuel such as wood. 14 Biogas is a cleaner fuel and will help in reducing indoor air pollution in rural areas. These biogas plants are underground and the footprint in terms of use of land is lower. The cost may be slightly higher than the plants constructed traditionally with brick wall/RCC. But the payback period is two years. The liquid waste can be used as manure. Alternatively it can be collected and treated centrally by using treatment like oxidation ponds. Sludge removal in these plants can take place once in year.

Project Based Learning

For the success of any mission, it is necessary to have accurate data. It is necessary to collect data at village level such as current practices, mindset and opinions of villagers, population and subgroups, income data, availability of water etc. This can be achieved by questionnaire survey.A questionnaire survey is conducted from house to house in November 2015. A sample questionnaire is presented in a separate Annexure. Large number of toilets are built under the clean India mission. But in many states like UP, Bihar they are lying unused whereas in states like Rajasthan, they are accepted. Under Clean India mission 10 million toilets are built in India in 2 years and there are plans to built 110 millions in 5 years. 15 The attitude of people plays a very important role in

the success. Engineering students and faculty can help in raising awareness and changing the attitude from negative to positive. In many areas, girls and women are strongly demanding toilets. Many waste water treatment plants are lying unused due to problems in operation and maintenance. Engineering Colleges can help local gram panchayats in training the staff and technical support and maintaining the data related to O&M.

In the discussion with village Sarpanchin June 2015, it was revealed that there is neither sewerage system nor sewage treatment facility. Also there is no toilet for around 50% households. In some cases, people prefer open defecation even if toilets are provided. However there is greater demand from school children to their parents to provide toilets. The details of activities conducted in the village are shared and published in media which motivates the stakeholders in village and college to work in thedirection of clean village. The author who is also Director monitors the progress of Clean Village mission continuously with Principal and concerned faculty.

It was decided to design a sewerage system and waste water treatment scheme as per the pattern approved by Maharashtra Government i.e. Grey water conveyance and treatment using constructed wetland technology. The project will be designed by faculty and students of Civil Engineering. Engineers of Maharashtra JeevanPradhikaran of Government of Maharashtra will be taken as resource persons. Attempts will be made to secure funding for this project through Government of Maharashtra, MP LAD funds, CSR funds of industries etc.Awareness campaign will be launched to encourage construct new toilets and use of existing toilets. Help of local school children will be taken for this. ITM team visited the local school for initial discussion (Plate 2).

Plate 2: Visit of ITM team to village school

It was decided to launch a project on constructed wetland to treat the wastewater generated in the campus. A team of students and faculty members is already working on this project. The team has analyzed the wastewater and studied the existing primary wastewater treatment which is provided by septic tank. At present the treated wastewater is not recycled. It is decided to recycle the treated wastewater generated after constructed wetland treatment. The details of the work done are presented in a separate Annexure. After the project, the treated water will be recycled.

4. Solid Waste Management

In villages the problem of solid waste management is not as acute as in urban areas due to less generation and better availability of land. However it will be a good move to inculcate the habit of segregation of wet and dry waste. Wet waste can be treated in biogas plants where as dry waste can be recycled.

Project Based Learning

Old habits die hard. Engineering students along with school children can educate and the villagers in solid waste segregation and recycling. There are many NGOs and women organizations which participate in recycling of solid waste which generates employment for weaker sections and women. Engineering colleges can create data base of such organizations and connect the villages with them.

It was decided to start segregation of solid wastes into dry waste and wet waste in village Ghorpad as the first step. This will be followed by recycling. Wet waste can be treated in the biogas plant. First this project will be implemented in the college campus.

4. Indoor Air Pollution

Women and infants in villages suffer from high level of exposure to air pollutants generated due to use of low grade cooking fuels such as wood, cow dung etc as discussed above. 14 The exposure results in respiratory diseases and adversely affects the health and also results in quality of life and economic loss. The biogas plants can generate biogas which is a cleaner fuel that can be used for cooking. Other options such as smokeless chullah, solar cooker, which are supported by ministry of renewable energy can be also tried. Ventilation of houses can play a major role in reduction of concentration of air

pollutants indoors. A simple innovation such as provision of vent helps a lot.

Project Based Learning

The Engineering Colleges can support by conducting survey, measurement of air pollution data and training. They can also manufacture smokeless chullah, solar cooker as part of their project work and provide them in villages. Theycan also help in the provision of proper ventilation arrangement of rural houses.

Preliminary data collection in the village Ghorpadrevealted that many households use gas for cooking as fuel. Some households also use cowdung as fuel. More data on fuel usage will be collected through surveys. In case of use of low grade cooking fuels leading to high level of air pollution exposure, efforts will be made to persuade the people to go for biogas plants and use biogas as fuel.

5. Solar Energy

Ghorpad village is provided with the solar lamps. But many of these lamps are not in working condition. Mechanical Engineering students can take part in repair. They can also train villagers. Maharashtra Government is offering subsidy for solar pumps for irrigation to farmers. The college can help in implementation of the scheme by supporting and training the farmers.

Project Based Learning

The students have already installed a solar energy project in the college campus. They can use the expertise to undertake the repairs of the existing solar lamps in the village. Students will be given a pilot project on solar pump. The pump can be used in the wastewater plant. The knowledge of solar pumps will be shared with the farmers and help will be provided to install solar pumps with government support.

6. Conclusions

The task of Clean Village poses multiple challenges. This paper has proposed that Engineering colleges can support and participate in this mission particularly in the areas of water supply, sanitation, solid waste management, indoor air pollution and solar energy through project based learning. ITM College of Engineering, Nagpur has adopted a village in its vicinity and identified projects which can be implemented in the village. These projects will be first implemented in the campus and then extended to village. Some of the projects are already implemented in the campus and work is in progress for remaining. The work for the projects in village is already commenced and is in progress. This approach is a win-win situation for both village and college. It is stronglyrecommended to replicate this approach at the state and national level which will help in achieving Clean India mission.

Acknowledgements

The author acknowledges the funding provided by Chairman, ITM Group of Institutions for implementing various initiatives in Engineering Education. The author also acknowledges the co-operation provided by SarpanchofGhorpad village Mrs. Meshram and the people of Ghorpad village. The support provided by Principal Dr. HemantHajare and faculty and staff of ITM College of Engineering, Kamptee, Nagpur was critical.

References

[1] Urban growth in Developing Countries: A review of current trends and a caution regarding Existing Forecasts. B. Cohen, World Development 32(1), pp23-51, 2004.

[2] Government of India population measurement exercise conducted every 10 years, Census, 2011

[3] http://www.worldbank.org/projects/P073369/maharashtra - rural - water - supply - sanitation - jalswarajya - project ? lang = en, retrieved on May 27, 2015

[4] Maharashtra Sujal and NirmalAbhiyan (MSNA): A pioneering initiative in urban water sector reforms, Dr. Malini V Shankar, Journal of Indian Water Works Association, ISSN 0970-275X, July-Sept. 2014, Vol. XXXXVI No. 3, pp 116-124.

[5] UNICEF/WHO Joint Monitoring Programme for Water Supply and Sanitationestimate for 2008 based on the 2006 Demographic and Health Survey, the 2001 census, other data and the extrapolation of previous trends to 2010.

[6] Planning Commission (India): Draft report of the steering committee on urban development for eleventh five year plan (2007-2012), 2007, Retrieved 15th April 2010

[7] The Telegraph:India the world's largest open air

toilet, 25 June 2012, retrieved on 28 June 2012. According to JMP data for 2010 the share of people defecating in the open was 64% in Nepal, 63% in India, 37% in Pakistan, 29% in Afghanistan and 20% in Bangladesh. According to these figures, the statement by Jairam Ramesh is correct except for Nepal.

[8] https://mahades.maharashtra.gov.in/files/publication/unicef_rpt/chap7.pdf Retrieved on May 28, 2015

[9] NSSO 65th round survey report

[10] https://maharashtra.gov.in

[11] USEPA, United States Environmental Protection Agency, Constructed wetlands treatment of municipal wastewaters, 2000, http://water.epa.gov/wetlands/restore/cwetlands Retrieved on September 12, 2012.

[12] A unique paradigm for low cost user friendly sanitation system in Parabhani: A Case Study, Journal of Indian Water Works Association, SumeetKulkarni et al, ISSN 0970-275X, July-Sept. 2014, Vol. XXXXVI No. 3, pp 89-97

[13] http://www.sintex.in/solutions.html . Retrieved on May 30, 2015

[14] Assessment of Personal Exposure to Air Pollution in Residential cum Industrial Area of Mumbai. Ph.D. Thesis, Milind M. Kulkarni, IIT Bombay, 1998

[15] TV program Truth Vs. Hype conducted on NDTV by Mr. Srinivasan Jain on May 18, 2015