

Wastewater Management: Early Lessons from Private Sector Partnership of a Municipal Wastewater Treatment Plant

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Summary: Induction of private sector partnership into a municipal wastewater treatment facility of the local government of Daegu City, South Korea was studied. Performance of the plant operated by a private party following the management contract for the period of three years (1998-2000) was examined. Quality control parameters determined throughout pre- and post-privatization periods were analyzed. Efficiency of the plant in term of operational cost based on per capita labor and per capita removal of bio-solid material was evaluated. Under the private management, influent flow rate was increased by 5 % in the year 2000 compared to pre-privatization period. BOD and COD in the incoming flow were reduced to 30.4 % and 20.5 %, respectively, while those in outgoing flow were reduced to 26 % and 14.6 %, respectively. Approximately 40.7 % of TSS was reduced at influent level, presumably due to improvement in drainage system. Work force was reduced to 29 %, which proportionally increased the per capita removal of bio-solid material by 41 %. In spite of the fact that the consumer price index was increased by 18.8 %, treatment cost per ton was reduced to 11.5 %. Increases in the hydraulic loading rate over and above optimization of the labor were the main causes in bringing down the operational expenditures of the plant. Successful running of the partnership during the trial period recommended the city government of Daegu, South Korea that ownership of the facility could be handed over to the private operator probably under a concession type contract for a period of 25-30 years.

Introduction

Privatization of state owned enterprises (SOEs) has been on the top of the economic reform policies of many developed and developing countries since 1980. To date, 2,000 SOEs were privatized in developing nations alone, a total 6,800 worldwide [1]. The radical change of balance between private and public provision of goods and services particularly in the field of water utility was necessitated by politico-economic and technical factors like, poor performance of SOEs and gross mismanagement of the state assets. In addition, emergence of new technologies, consumer concerns over the health and environmental damages had increased pressure on the utilities to deliver services, which were efficient, clean and above all affordable to the community. Execution of utility transnational and multi-utilities also raised public awareness to the new structures and forms of ownership and operation. These trends persuaded governments in the developing countries switching over ownership of the public utilities following any of the prevalent methodologies of privatization in a bid to deliver up-to-date services to

the consumers [2]. More than 100 countries in recent years including Korea, Pakistan, Malaysia and the Philippines in Asia have embarked on projects to privatize or restructure their SOEs [3]. There are various models of privatization for public run utilities ranging from minimum to full withdrawal of the state. At the minimum withdrawal level, some schemes provide for contracting out of all or parts of the operations, where governments retain some rights in running the facility, while contracts and concessions grant private developers full responsibility for management and investment [4-6].

The Korean government (1987-92) had utilized various conventional reform programs including use of managerial performance evaluation system (MPES), internal restructuring, and partial cash-flow right privatization of state monopolies rather than out-right sale of SOEs [7]. In response to the financial crisis in 1997, the government launched structural reform programs and privatization initiatives with the assistance of the World Bank.

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Work plan was formulated to execute in two main areas: (1) reform state-owned enterprises to improve efficiency and responsiveness and (2) release resources to facilitate other structural reforms and privatization [8]. Key elements of the program were announced in July 1998 and were started to implementing in January 1999. This paper presents overall performance (1998-2000) of a state run municipal wastewater treatment facility that was handed over to a private operator under management agreement for the period of 1-5 years on trial basis. Private operator was not required to finance the asset; instead, the public sector financed both fixed asset and working capital. Efficiency evaluation measures set on comparative statement of the quality control standards of the effluent, and operational cost of the plant determined throughout the period of pre- and post-privatized management were analyzed and discussed. Suggestions and future approach to the private led venture to help shape a sustainable partnership between private sector and the local government have also been discussed in the study.

Location and Specification of the Plant

Dalsung municipal wastewater treatment plant is located in Daegu, the third largest city of Korea, having a population of 3.5 million. The facility has been in operation under the authority of local government of Daegu City since its construction in 1990. Operating capacity of the plant was set at 28,000 ton wastewater/ day. The plant is comprised of 12 buildings, and spaced on a total area of 44,663 m². Wastewater flows into the plant by a network of drainage system, which is roughly expended on an area of 15.2 km² bearing a load of approximately 110,000 inhabitants. The drainage network breaks into 50 km main stream and about 150 km tributaries. The plant is equipped with both the wastewater treatment and sewage treatment facility employing primary and secondary treatment units by using activated sludge process. Effluent from secondary treatment plant is treated by advanced wastewater treatment, biological nutrient removal (BNR) plant. Advanced wastewater treatment facility was built in the second phase of the construction of plant and has been in operation since 1996. Parameters set for quality control of influent and effluent flows are given in Table-1.

Results and Discussion

Influent Flow

Under the authority of local government (1995-97), the plant was operated at influent flow

Table-1. Design parameters for wastewater treatment process

Treatment method		BOD (mgO ₂ /l)	COD (mgO ₂ /l)	TSS (mg/l)
Secondary treatment	Incoming flow	250	250	250
	Outgoing flow	30	30	70
	Efficiency, %	88	80	72
Advanced treatment	Incoming flow	26	40	40
	Outgoing flow	12	28	27
	Efficiency, %	54	30	33

rate of about 18,612 m³/ day. During the first two years of the private management (1998-99), no significant increase in the influent flow rate was recorded but it was increased by 5% in the year 2000 (Fig. 1).

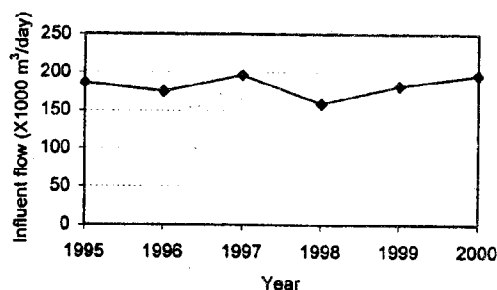


Fig. 1: Profile of influent flow during pre-and post-privatization periods.

Quality Control Parameters

During the period under local government, biochemical oxygen demand (BOD) of the influent and effluent flow was recorded at 204 mg/l, and 12.6 mg/l, respectively. These values were reduced to 142 mg/l (30.5 % reduction) at influent and 9.3 mg/l (26.0 % reduction) at effluent flow during the years 1998-2000. Chemical oxygen demand (COD) of the influent and effluent flow during pre-privatization period was recorded at 134.6 mg/l, and 22.6 mg/l, respectively and the values were reduced to 107 mg/l (20.5 % decrease) at influent and 19.3 mg/l (14.6 % decrease) at effluent flow during the years 1998-2000 (Fig. 2). Total suspended solids (TSS) in the incoming and outgoing flow (1995-97) were recorded at 293 mg/l and 15.6 mg/l, respectively while the values were reduced to 173.6 mg/l (40.7 %) for incoming and 8.0 mg/l (48.7 %) for outgoing flow in the years 1998-2000 (Fig. 3). Reduction in TSS at influent level during the period under private management could be due to improvement in drainage system, repair and replacement of leaking sewer connections and pipes. Improvement in quality control parameters of BOD and COD in effluent flow would corroborate handling of the plant with better technical hands and expertise under private authority.

Table-2. Work load and treatment cost during pre- and post-privatization era

Year	1995	1996	1997	1998	1999	2000
Management type	Public	Public	Public	Private	Private	Private
Operating capacity (m ³ /day)	28,000	28,000	28,000	28,000	28,000	28,000
Influent flow (m ³ /day)	18,670	17,543	19,624	15,958	18,261	19,669
Work force						
Non-technical	10	10	6	4	3	3
Technical	21	26	27	18	19	19
Total	31	36	33	22	22	22
Treatment cost (million Won)*	1,740	1,902	2,211	1,854	1,482	1,607
Cost (Won/ton)	255	297	309	318	222	224
Consumer price index (CPI)	100	104.0	109.6	117.8	118.8	121.5

*1 US \$ = 1200 Won

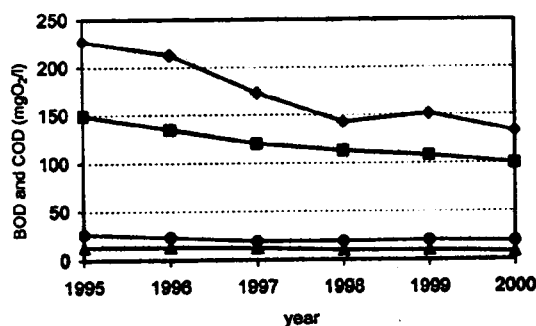


Fig. 2: BOD and COD at influent and effluent flow during pre-and post-privatization periods. (◆ influent BOD), (■ influent COD), (▲ influent BOD), (● effluent COD).

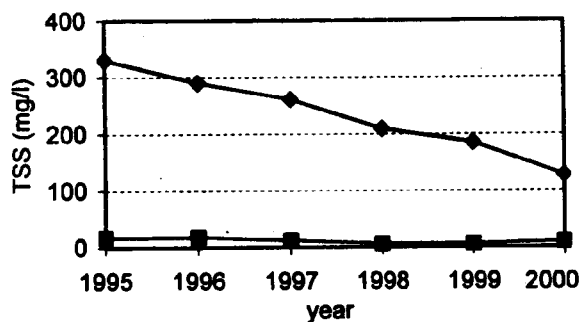


Fig. 3: TSS at influent and effluent flow during pre-and post-privatization periods (◆ influent flow), (■ effluent flow).

Effluent quality with regard to total nitrogen (T-N) and total phosphorous (T-P) was also improved and their concentrations were reduced to 32 % and 61 %, respectively during the years under private management compared to pre-privatization period (Fig. 4). Reduction of nutrients in effluent was accomplished due to the commissioning of advanced treatment facility of biological nutrient removal

(BNR) by the private management, which was not practiced in the period of local government authorities. Effluent of the secondary treatment plant was treated by BNR process, which further decreased the biodegradable portion of the wastewater bringing down concentration of nitrogen and phosphorous in the effluent to the minimum possible limit. Quality of the treated effluent became more environment friendly and worth of safe disposal to the receiving water bodies.

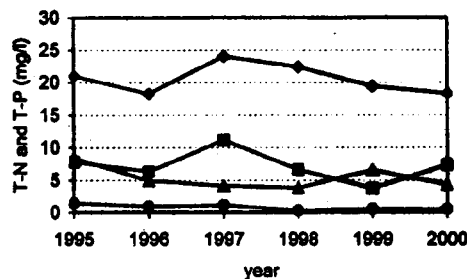


Fig. 4: T-N and T-P at influent and effluent flow during pre-and post-privatization periods. (◆ influent T-N), (■ effluent T-N), (▲ influent T-P), (● effluents T-P).

Work Force

Work force of the plant was reduced gradually from 31 men to 22 men until the end of third year (2000) of private management (Table-2). During the period of local government, wastewater was treated at a rate about 18,612 ton wastewater/ day, sharing the workload of per capita labor 600 ton/ man.day. In the year 2000, work force was reduced to 22 men, which proportionally increased the workload per capita labor by 41 %, (i.e. 846 ton/ man.day). Working within the same duty hours and timing under the private management as with the local government authorities, 29 % decrease in labor, however, did not decrease efficiency of the plant,

instead the plant got progress. Optimization of labor while maintaining the statutory requirements of the effluent quality standards was an act of good performance on the part of private operator.

Operational Cost

Treatment cost calculated for the years (1995-97) was 287 Won/ ton but the cost was reduced to 254 Won/ ton (11.5 % reduction) during post privatization period. However, during the financial year 2000, the federal government of Seoul imposed 10 % value added tax (VAT) to be paid by the private operator on the final product. This increased treatment cost for the following years. In spite of the fact that the consumer price index (CPI) calculated from the base year 1995 to the year 2000 was increased by 18.8 %, treatment cost per ton was reduced to 11.5 % (Table 2). Treatment of the increased amount of influent flow with the employment of minimum number of work force and reduction of TSS at the influent level were the main causes in bringing down the operating expenditures of the plant.

Per Capita Removal of Bio-Solid Material

Commissioning of the BNR facility and down sizing in labor contributed to an increase in per capita removal of bio-solid material. During the period (1995-97), it was recorded at 216 kg/ man.day, while it was increased by 306 kg/man.day (41.6 %) during the year 1998-2000 (Fig. 5).

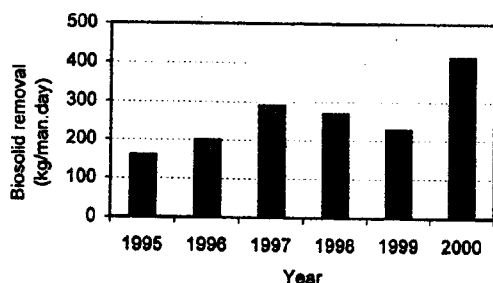


Fig. 5: Per capita removal of bio-solid material during pre-and post-privatization periods.

Recommendations and Comments

Successful running of the partnership during the period of three years recommended the city government of Daegu that ownership of the facility could be handed over to the private operator probably under concession type contract for a period of 25-30

years. Favorable outcome of the concession contract would pave the way to the out right privatization of the facility. Concession model is one of numerous alternatives for infrastructure privatization [9]. Since, 87 concession projects awarded between 1985 and 1998 covering 12 Asian countries are already in progress [10]. Additionally, the long-term period of contract, i.e. 25-30 years would provide a reasonable time frame to the concessionaire for the development of sound and sustainable policies in shaping mutually beneficial partnership rather than turning it into early profit making venture.

Value added tax imposed by the federal government put an additional financial burden on the private management since it was not included in the agreement. To the future approach, the Seoul government should exempt it. Privatization of the wastewater treatment facility may have beneficial or detrimental effects on the natural environment. Thus the use of new technologies by the private management in waste treatment should be encouraged, which would help in limiting further environmental damages.

Experimental

Effluent quality tests were conducted at Environmental Engineering Laboratory, Kyungpook National University, Daegu, Korea following procedures adopted from Standard Methods for the Examination of Water and Wastewater [11]. Reagent kits used were made of HACH Company, USA. Photometric analyses were done by Spectrophotometer model (DR/2010), HACH, USA [12]. Total phosphorous (T-P) was conducted by following molybdovanadate method with acid persulfate digestion. Total nitrogen (T-N) was conducted by persulfated digestion method. Biochemical oxygen demand was determined by using BOD Trak apparatus (HACH, USA). COD was calculated by heating the sample with potassium dichromate solution in sulfuric acid for two hours at 148 °C followed by determination of transmittance of the cooked solution at 600 nm.

Conclusions

Transfer of ownership of a local government wastewater treatment facility to a private party for a period of 1-5 years improved the overall performance of the plant. Quality of the effluent was improved while efficient use of the labor results in significant reduction of the wastewater treatment cost. Award of

concession type contract, being a mode of privatization, for the induction of private sector partnership into the management of municipal wastewater treatment facility was suggested. Successful accomplishment of the Daegu led private sector partnership venture would be a paradigm shift in making government policies for the transfer of ownership of other public run facilities to the private parties.

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