

Chapter-III

Information Systems Audit

Department of Urban Development

3.1 'Sajala' Revenue Billing & Collection System in Bangalore Water Supply and Sewerage Board

Executive Summary

Bangalore Water Supply and Sewerage Board (BWSSB) implemented 'Sajala' Revenue Billing and Collection System with the objectives of improving accuracy in bill payments, hassle free service and better monitoring by top management. An Information System Audit of 'Sajala' for the period 2012-13 to 2016-17 revealed the following:

- Absence of password policies, insecure operations over HTTP coupled with incomplete audit trails indicated poor appreciation of the need for security.
(Paragraphs 3.1.8.1, 3.1.8.2 and 3.1.8.3)
- Due to inconsistencies in data and non-validation of data, the information in the system was unreliable and BWSSB was exposed to the risk of incorrect decision making and risks of incorrect billing.
(Paragraphs 3.1.10.1, 3.1.10.2 & 3.1.10.3)
- Gaps in billing and non-generation of bills periodically resulted in non-levy of meter charges of ₹1.11 crore for unbilled periods.
(Paragraph 3.1.6.3)
- Incorrect application of business rules resulted in short levy of meter charges on working meters of ₹1.41 lakh (loss of revenue) and excess levy of meter charges on non-working meters ₹3.94 crore.
(Paragraph 3.1.6.4)
- Levy of penalties towards Rainwater Harvesting and Occupation Certificate was poorly implemented, resulting in non-levy of ₹3.08 crore.
(Paragraphs 3.1.6.5 & 3.1.6.6)
- Strategic advantages arising from the centralisation of 'Sajala' Billing and Collection Software was not utilised by the Senior Management of BWSSB.
(Paragraphs 3.1.8.5)

3.1.1 Introduction

The Bangalore Water Supply and Sewerage Board (BWSSB) was established (October 1964) for providing water supply and sewerage system to Bengaluru city. The mandate of BWSSB is to provide adequate water supply to meet demand, creation of sewerage network and safe disposal of sewage and levy and collection of water charges on 'no loss no profit basis' in order to ensure

sustainability of the system. BWSSB implemented ‘Sajala’ Revenue Billing & Collection System with the objectives of improving accuracy in bill generation, hassle free service and better monitoring controls by top management. There are 9,28,524 connections (as on 15 March 2017), which included Domestic, Non-Domestic, Partial Non-Domestic, Sanitary connections *etc.* Each connection was allotted with a unique Revenue Register Number (RR number). BWSSB generated revenue from about 58.36 *per cent*²⁵ of the water pumped and the rest was Non-Revenue Water (NRW).

3.1.2 Organisational Structure

BWSSB functioned under the overall control of the Additional Chief Secretary, Urban Development Department. It was headed by Chairman, who was assisted by Engineer-in-Chief and five Chief Engineers for Cauvery, Maintenance, Waste Water Management and Corporate Planning, Quality Assurance and Project along with Chief Administrative Officer-cum-Secretary, Financial Advisor and Chief Accounts Officer. The Officers were supported by technical, administrative and financial staff at various levels. The ‘Sajala’ system was managed by Executive Engineer, Revenue Billing Information Technology who reports to Engineer-in-Chief.

3.1.3 Audit Objectives

The Information Systems audit was conducted to evaluate the

- Design of ‘Sajala’ and mapping of business rules in the system to ensure completeness, accuracy and the reliability of the billing system;
- The adequacy of general IT controls to ensure security, reliability and integrity of the system;
- IT Application controls built into the system for implementing Business Rules; and
- The quality of data in the information system.

3.1.4 Audit Criteria

The audit findings were benchmarked against the criteria sourced from the following:

- Bangalore Water Supply and Sewerage Board Act, 1964, and Regulations issued thereunder;
- Guidelines for Indian Government Websites, issued by Government of India;
- Information Technology (IT) Act, 2000;
- Agreements with service providers;
- eSAFE-GD220-Assessment Guidelines_ver1.0 issued by the Department of IT, Government of India; and

²⁵ Average monthly NRW for the 12 months of November 2016 to October 2017 was 41.74 *per cent.*

- Open Web Application Security Project (OWASP) Top ten 2013 vulnerabilities.

3.1.5 Scope and methodology of audit

The information systems audit commenced with an entry conference held in April 2017, in which, audit scope and methodology was explained. Detailed audit was conducted during March to September 2017 covering the period 2012-13 to 2016-17. The methodology adopted by audit included scrutiny of files and documents relating to 'Sajala', testing of functionality of applications and restoring database dumps and analysing the databases. An exit conference was held on 28 November 2017 with the Additional Chief Secretary to Government of Karnataka, Urban Development Department and the Chairman BWSSB, wherein the audit findings were discussed. The report takes into account the replies furnished by the Board/Government in response to the audit observations communicated to them.

Audit findings of 'Sajala'-Revenue Billing and Collection Software

BWSSB centralised its Billing and Collection System by migrating its two tier (client server architecture) Revenue Billing and Collection System to a web based citizen centric application 'Sajala'. The application is developed, hosted and maintained by National Informatics Centre (NIC). Analysis of the operations of 'Sajala' revealed the following:

3.1.6 Design of the system and mapping of business rules

3.1.6.1 Relationship between BWSSB and NIC

The lifecycle of an information system consists of various activities such as requirements gathering, development, testing, maintenance, creating and maintaining documentation, *etc.* There are various stakeholders such as end users, data owners, database administrators, system administrators, authorities for initiating and approving changes to the system, *etc.* It is necessary that the roles and responsibilities of various actors and the services to be provided by different actors to each other are well defined. Lack of clarity in this regard poses the risk of the actors overstepping their roles/or not undertaking/triggering the activities, which are their responsibility. BWSSB was requested to provide all files relating to project initiation and related documents such as User Requirements Specification (URS), Software Requirements Specification (SRS), allocation of roles, *etc.* Despite repeated written requests, the management did not provide any files other than SRS for the project. In the absence of URS/detailed documents, the gaps between URS and SRS could not be ascertained in audit.

3.1.6.2 Normalisation of database

Normalising a logical database design involves using formal methods to separate the data into multiple, related tables. Database normalisation is a systematic approach of decomposing tables to achieve data integrity and

eliminate undesirable characteristics like data duplication. In a normalised database, all non-key columns will be dependent only on the primary data field.

During analysis of the design of the tables and the data contained therein, we observed that implementation of normalisation principles was not done correctly as the consumer table contained 12 unique RR_numbers²⁶ assigned to two consumers each.

This was due to presence of RR_number in the consumer table, even though it was not dependent on the primary key of the table *i.e.* consumer_id and sd_id. Instead, RR_number was primary key in m_connections table, which contained consumer_id and sd_id as non-key columns. This permitted unintended duplication of RR_numbers in consumer table.

The Government accepted (December 2017) the observation and stated that the table would be revisited to remove all discrepancies.

3.1.6.3 Non-generation of bills periodically and loss of revenue for unbilled periods

For every active connection, bills have to be raised as per billing cycle. We observed that there were instances of breaks in billing. An illustrative list of breaks in billing noticed are listed in **Appendix-3.1**. However, in such cases of breaks in billing, the bill included monthly meter charges only for the month in which, bill was generated and not for the intermittent months when bill was not generated.

We analysed the data for the period from January 2014 to December 2016 and noticed breaks in billing for 1,09,817 consumers in respect of whom 5,52,611 monthly bills, which were not generated. We calculated the revenue leakage based on minimum monthly meter charges of ₹20 and the total revenue foregone worked out to ₹1.11 crore. The actual amount to be levied would be higher since we calculated the amount on the basis of minimum of monthly meter charges applicable²⁷ for Domestic connections till November 2014 and not actuals.

The Government while accepting the non-generation of bills periodically, stated in its reply (December 2017) that the process of ‘pending reading’ would be refined to mandate the raising of short amounts against unbilled periods. Also, it stated that a proposal to limit the non-billing period to two months in unforeseen events was currently under perusal in the New Metering Policy.

However, the reply was silent about loss of revenue due to non-levy of monthly meter charges for unbilled period.

²⁶ Illustrative examples: RR Number C-302357 assigned to Consumer IDs 1881 and 14645 of Sub-division SW1; RR Number E-400172 assigned to Consumer IDs 136 and 12484 of Sub-division E4, *etc.*

²⁷ Monthly meter charges were revised upwards w.e.f. 1 December 2014.

3.1.6.4 *Inconsistencies in meter charges*

Until March 2016, meter charges/meter service charges were leviable only on meters in working condition. Analysis of the data for the period January 2014 to December 2016 revealed the following:

- 4,782 bills of 2,777 consumers contained zero monthly meter charges though the meters were working. Illustrative list of such bills is given in **Appendix-3.2**.

We calculated the meter charges in respect of these 4,782 bills generated without monthly meter charges by taking the minimum meter charges²⁸ applicable and the short levy worked out to ₹1.41 lakh.

While ascertaining the reasons for non-levy of meter charges, we observed that 364 out of these 4,782 bills were generated without monthly meter charges as the meter charges were dependent on bore size of connection and bore size of these connections was stored as zero in 'Sajala' database.

The Government replied (December 2017) that at the instance of audit, 616 distinct RR_numbers verified till date were found to have this shortcoming. It was also stated that these cases were referred to Operations and Maintenance (O&M) for compliance. Further, it agreed that since the meter charges were calculated based on the bore size and connection type, the meter charges were not raised in monthly billing due to the bore size of connection not being updated in some cases. In cases of new connections where supply of water was yet to be provided, connection type was declared as "New Connection" but no demand was raised. BWSSB stated that necessary action was being taken by the sub-divisions to update the bore size and convert the type of water connection if the water was supplied. Till date, 278 connection types were updated from "New Connection" and 91 connections were updated with correct bore size.

- Similarly, there was undue levy of meter charges on non-working meters, amounting to ₹3.94 crore. Illustrative list of such bills is given in **Appendix-3.3**.

In the exit conference (November 2017) it was stated that there was a regulation to levy meter charges irrespective of whether the meter was working or non-working. The reply is not acceptable as regulation for levying meter charges was amended only during March 2016 and until then, the meter charges were leviable only for working meters.

3.1.6.5 *Penalties for non-implementation of Rain Water Harvesting (RWH) system*

The BWSSB (RWH) Regulations, 2010, amended in June 2011 prescribes all existing buildings on site area of 2,400 sqft and above and proposed buildings on site area of 1200 sqft and above, to provide for RWH structures. Not complying with the above regulation, attracted penalties. The above

²⁸ ₹30 and ₹50 per month in respect of Domestic and Non-Domestic connections respectively.

regulations were to be implemented from March 2016 by BWSSB as per the Government order. Hence, RWH is one of the business rules of 'Sajala' and the site area is one of the important attributes, which has to be captured for all the connections to decide on the RWH regulations applicability.

On analysis of the data, we observed the following:

- Since implementation of RWH regulations, 25,731 new connections were granted (as on 15 March 2017) but in respect of 639 connections granted since April 2016, the site area was captured as zero.
- Out of total 8,79,837 metered connections (as on 15 March 2017), only 2,97,553 connections were stored with site area greater than zero. Out of these, 1,538 connections with site area measuring 2,400 sqft and above were not penalised despite non-implementation of RWH.
- Further, the Government in its order did not define 'partial non-domestic' consumers and hence, the system cannot levy any penalty for such category of consumers.

In the absence of sital area information for all consumers, RWH policy was rendered ineffective and audit could not ascertain the exact number of consumers who should implement RWH but did not implement.

Poor implementation of business rules for effecting RWH penalties also highlighted the need for defined change management policies, processes for assessing the change, approving the change, implementing and testing the change and a change management board to implement changes as and when they are necessitated by changes/addition of business rules.

The Government replied (December 2017) that:

- The 639 connections wherein the sital area was not captured were verified and it was found that these connections were earlier sanctioned as sanitary only and now transferred to metered (water and sanitary) connections. Provision would be made in the 'Sajala' to verify the sital area for such connections being transferred.
- Action was taken to penalise all the 1,538 connections whose sital area was 2,400 sqft and above and who did not implement RWH, from November 2017 billing cycle onwards.
- The penalty towards 'Partial Non-Domestic' connections would be implemented in 'Sajala'.

Since the objective to levy penalty was to encourage people to opt for RWH, effective implementation would aid in conservation of water.

3.1.6.6 Additional water and sanitary charges for non-submission of occupancy certificate

Production of occupancy certificate issued by Bruhat Bengaluru Mahanagara Palike or Local Authorities was mandatory for sanction of water and sanitary connection by the applicant in case of multistoried residential and non-

residential building. In case of non-production of occupancy certificate, temporary connection of water and sanitation is sanctioned subject to additional levy of 50 *per cent* and 100 *per cent* of total water and sanitary charges in respect of domestic and non-domestic consumer respectively. These rules came into effect from March 2016.

On analysis of the database, it was observed that there existed a table with fields for holding RR number, occupancy certificate number, occupancy required, occupancy submitted, occupancy date, site area, number of floors and built up area. However, the table was empty and it was not populated.

Analysis of other related tables by audit revealed that 3,555 connections were sanctioned on or after 1 April 2016 without receipt of occupancy certificates. Therefore, these connections were to be treated as temporary and subjected to additional levy of water and sanitary charges. However, we observed that in respect of the above cases, regular water and sanitary charges amounting to ₹6.16 crore were collected without levy of additional charges. Thus, poor implementation of the business rules regarding submission of occupancy certificate resulted in loss of revenue by way of additional charges worked out to ₹3.08 crore calculated conservatively²⁹.

The Government agreed (December 2017) that though ‘Sajala’ was upgraded to assist in implementing the regulation, the new feature was not effectively utilised by O&M division. It further stated that all the 3,555 cases were referred to O&M for verification and that the loss of revenue due to non-penalisation since the implementation of regulation was being calculated and raised in the current or subsequent billing cycle.

3.1.6.7 Meter Missing Connections

According to BWSSB Regulations, 1965, the consumer is responsible for any damage or tampering of the meter installed inside his premises and if on examination, any meter is found to be tampered with intentionally, consumption of water during the period since the last reading till the meter is repaired or a new meter installed, shall be calculated at twice the average monthly consumption.

During the data analysis of the billing data provided to audit for the period from July 2016 to March 2017, it was observed that out of 79,19,525 bills in the table, 7,331 records pertaining to 1,266 consumers had Meter Missing Connection (MMC). However, the water charges in respect of these bills were charged at six months’ average consumption basis instead of charging at twice the average monthly of the last six months.

The Government replied (December 2017) that ‘Sajala’ was upgraded to include a new reason ‘meter damaged intentionally’, which was to be operated by the authorised official on due inspection of the meter installed in the premises and meter found to be tampered or damaged or cut intentionally.

²⁹ Calculated considering 50 *per cent* penalty for all 3,555 connections irrespective of the type of connection.

Further, it stated that bills with the above said reason would be billed at twice the average monthly consumption for the last six months.

3.1.6.8 Demand Collection and Balance Statement

Test-check of the Demand Collection and Balance (DCB) statements generated through 'Sajala' revealed the following:

- Though the application provided facility for generating DCB statements, it was restricted to the last six months only.
- BWSSB had various items of revenue such as consumption charges for water, sanitary charges, penalty/fines for delays and dishonour of cheques, interest *etc.* However, in DCB statements while all the demands were listed, the collection was shown as a single figure without apportionment towards the different items constituting the demand.

These issues indicated inadequate stakeholder participation/requirements gathering.

The Government replied (December 2017) that now DCB reports were made available for one year. It further stated that the present system was inceptionalisised between the year 2000 and 2003 and till date, no requests were received by the users of the application or other stakeholders for breakup of the collection amount.

The reply on the fact that there were no requests for breakup of collection amount was not acceptable as maintenance of breakup of collection in terms of consumption charges of water, sanitary charges, penalty/fine was essential in order to have MIS reports, which would help the management in taking various decisions.

3.1.7 IT General Controls in Sajala

3.1.7.1 Non-maintenance of data dictionary

Data dictionary is the key to understanding the database. BWSSB was requested to furnish the data dictionary for 'Sajala' and the data dictionary so provided was studied to understand the system.

Comparison of the data dump with the data dictionary revealed that

- Out of 2,279 tables in the database dump provided to audit, the data dictionary contained details of only 77 tables. The content and description as well as the reason for existence of the remaining 2,202 tables were not documented. Further, there was no version numbering for the data dictionary which indicated that the data dictionary was not maintained as a configuration item and was not updated accordingly.
- Further, the meanings of coded values were incomplete as there were several undocumented User_ids whose purpose was known only to the developer team as it was not listed in the related lookup tables/parent tables. The nature and purpose of these ids could be understood only by scrutinising the front end source code, which introduced these IDs.

Non-maintenance of data dictionary would mean that the meaning of the coded values would be in the unaided memory of the developer team or in the source code. Hence failure to maintain data dictionary would have significant implications during change management i.e., change of system as well as personnel.

The Government confirmed in reply (December 2017) that data dictionary was not available and at the instance of audit, a detailed analysis of the tables made and categorised as used, unused and temporary tables. It also stated that necessary measures would be taken to clean the database in respect of used and temporary tables and henceforth, the data dictionary would be updated for each modification and the same would be maintained with versioning.

The reply is partly acceptable as the data dictionary is yet to be completed in respect of some important tables³⁰.

3.1.7.2 Automatic Meter Reading system

The Board approved (April 2010) the proposal for implementing Automatic Meter Reading (AMR) system for new connections. The system consists of AMR devices, Global System for Mobile Communications (GSM)/General Packet Radio Service (GPRS) transmission of readings, receipt of readings in a central server and billing based on the readings. The objectives were to avoid the burden of periodic trips to each physical location to read a meter, billing based on near real time consumption and improved billing and to avoid the billing mistakes by entering wrong reading, *etc.* The cost of AMR meters was much higher than the normal meters and ranged between ₹37,200 and ₹1,54,500 based on the bore size, which was chargeable to the consumer.

A review of data in 'Sajala' system revealed that although 2,261 connections were fitted with AMR meters as on 15 March 2017, AMR billing was done only in respect of 133 consumers accounting for 193 bills raised. This indicated poor utilisation of AMR infrastructure, which defeated the very purpose of fixing AMR meters.

In the exit conference (November 2017), BWSSB agreed that AMR billing was done in respect of only 133 consumers and also stated that it would be coming out with an AMR policy. Further, the Government replied (December 2017) that bills were being issued regularly, manually or through AMR and actions were taken to provide annual maintenance contract for all AMR meters to streamline the existing issues.

However, the reply is silent about specific reasons for non-generation of bills through AMR system.

³⁰ Suspense Consumers, tmp_c1readings, tmp_c1bills, Prorata BGS, *etc.*

3.1.8 Security, Reliability and Integrity

3.1.8.1 Security in 'Sajala'

User interaction with a web based Information System is by means of transfer of packets of information between user's computer (client) and server through the communication channels. For maintaining confidentiality and integrity of the communication, it is necessary that the communication channel should be secure. This is achieved by using HTTPS³¹, which employs SSL/TLS³² encryption.

We observed that in BWSSB, departmental users' interaction with the server was on an unencrypted channel *i.e.* HTTP³³ instead of HTTPS. This mode of communication did not guarantee confidentiality and integrity of the data being transferred.

Besides this, audit observed that the passwords of all the departmental users were stored in the database in plaintext. Since the application accepted and transmitted user ids and passwords, session keys and biometric data in plain text over the network without encryption, this rendered the application vulnerable to exposure of the biometric information and its replay by way of man in the middle attacks (OWASP Top Ten 2013 – A6 Sensitive Data Exposure).

The resultant vulnerabilities and potential for exploitation were demonstrated to BWSSB by successfully causing transactions to be recorded against a user without the concerned user affixing his/her biometric.

The Government replied (December 2017) that subsequent to audit observation, 'Sajala' was now available both in HTTP as well as HTTPS. In addition, it stated that the 'Sajala' would be completely switched over to HTTPS from 1 December 2017 onwards.

However, the 'Sajala' was available in HTTP also as on 14 December 2017.

3.1.8.2 Password management

Guidelines for Assessment of Effectiveness of Security Controls GD 220 (January 2010) published by Government of India emphasises use of quality authentication secret (password). Guidelines recommend imposing password complexities, password change on first use and after specific periods, restrictions on re-use of passwords *etc.*

In contrast, analysis of the passwords which were stored in plaintext in the database tables showed that BWSSB did not enforce any such controls of password age restriction, complexity *etc.*, indicating insufficient appreciation of importance of password security by BWSSB. These deficiencies affect the security, reliability and integrity of the system and the underlying data.

³¹ Hyper Text Transfer Protocol Secure.

³² Secure Sockets Layer/Transport Layer Security.

³³ Hyper Text Transfer Protocol.

The Government replied (December 2017) that the password policy would be implemented in a complete manner at the earliest.

3.1.8.3 Maintenance of audit trail

An audit trail serves many purposes such as establishing accountability, reversing any incorrect changes, review at a later date, *etc.* The 'Sajala' database employs triggers to track changes to various tables arising out of insert, update and delete events to provide audit trail. The audit trail was recorded in a table lying in the same database. Another trigger was set up on the said table to prevent deletion of entries from the log.

On analysis, it was observed that though there were triggers for both update and delete option, while the for update trigger recorded the pre-update and post update values of all fields that underwent a change, the delete trigger merely recorded the fact that a particular record was deleted without recording the values that were deleted. Hence, the system did not guarantee ability to review the records that were deleted.

From the statistics relating to deleted records, it was seen that 44,09,582 records were deleted from various tables during the year 2015. Out of this, 41,24,358 (93 *per cent*) of the records were deleted from the table containing the breakup of bills. Further analysis of this deleted records showed that 39,81,557 records were deleted in the months of April, May and July 2015.

The Government replied (December 2017) that records were deleted as part of monthly processes, where the data was moved to history but since it was being handled as a manual job, it was carried out at opportunities when less activities were processed on the server. It was also stated that corrective action was taken to store data deleted using triggers.

However, since the trigger did not record the details of data deleted it was not ascertainable whether these records were actually stored in history after deletion. This needs to be addressed by BWSSB. On this being demonstrated (December 2017) to the officials of BWSSB, it was stated that scripts to move records to history would be streamlined and a register would be maintained for all such kind of backend operations.

3.1.8.4 Non-initiation of action in respect of non-billed meters

In some cases, water meter readings were not recorded by the Meter Reader of BWSSB citing various reasons such as door locked (DL), gate locked (GL), meter damaged (MD), dial not visible (DNV), suspected meter stop (SMS), moisture, meter stopped (MS), *etc.* This warranted replacement of meters, follow up visit or attempt reading check by a superior officer.

Analysis of the data showed that meter readings were not recorded over extended periods citing any of the above mentioned reasons in several cases (100 illustrative cases indicated in **Appendix-3.4**, where readings were not recorded in more than 60 out of 75 bills generated in each case during January 2011 to March 2017). In all the said cases, since the actual meter readings

were not captured, the system resorts to charge the consumer on the basis of average consumption. Hence, actual consumption of water in all such cases was not known. This had an adverse effect on revenue. Further, BWSSB's calculations of "Unaccounted for Water" (UFW) would also be affected as the consumption figures in respect of these connections were not actual but notional.

The Government agreed (December 2017) that though various reasons were incorporated into the 'Sajala' system for situations wherein the meter was inaccessible, this had to be further streamlined as there was no time limit on the period upto which a connection can be billed on the average consumption of previous six months. A proposal was made to incorporate timelines for such cases in the metering policy being finalised.

3.1.8.5 Under utilisation of advantages from Centralised Information System

BWSSB issued a circular (March 2016), which required installation of Sewage Treatment Plants (STP) in buildings having 20 or more flats/apartments as well as buildings for non-domestic purposes on sites exceeding 100 sq m. The order provided for levy of penalties for non-compliance.

Penalties were levied on non-compliant consumers from bills of September 2016. Subsequently, BWSSB extended (April 2017) the date for provision of the STP to 31 December 2017 stating that the penalties levied and paid as well as levied and not paid from October 2016 to January 2017 shall be respectively adjusted against the following month's bills or reversed. 'Sajala' being a centralised system, these adjustments could be implemented by BWSSB at its head office by writing and executing appropriate commands/procedures on the centralised database.

However, it was observed that the advantage of a centralised database and application was not availed by BWSSB. Instead BWSSB continued to carry out the operation in a decentralised manner requiring the sub divisional officers to carry out the necessary adjustments manually. Hence, despite centralisation of data (Consumer data, Connection Data, Readings, Bills, Bill Breakup, Receipts *etc.*) and the application, BWSSB did not utilise the benefits arising from such centralised availability of data.

The Government replied (December 2017) that withdrawing of penalties using 'Sajala' required extensive modifications and since the order of application of payments (including arrears and interest) received was not defined, adjustments could not be processed through Sajala, especially where part payments were made. Hence, in order to ease the calculation of amount to be withdrawn, the penalty data was shared with all O&M divisions for calculating the withdrawal amounts and informing the actuals thereof to the head office. Hence, BWSSB could not utilise the centralised software for the adjustments or reversal of penalty due to inadequate provisions in the system to show breakup of the collection, as also discussed in Paragraph 3.1.7.1.

3.1.9 IT Application Controls in 'Sajala'

3.1.9.1 Weaknesses in Input validation controls

Weak input controls leads to entry of incorrect, un-authorised, incomplete or redundant data being fed to the database and brings down the integrity and reliability of data.

Analysis of data of consumers, bills and installation history of meters tables revealed the following deficiencies in the data due to weak input controls:

- While 1,867 records in the table containing consumer details contained the consumer names as dots and spaces, 50 records contained the consumer names as dashes. In 19,901 records, the pincode field was left empty.
- The bills table contained 13,809 bills for future years also as detailed in **Appendix-3.5** on account of bill date not being validated.
- Similarly, the date of fixing meters and initial date of water connection in metered consumers table contained 51,565 records and 8,369 records respectively showing the meters/water connections were fixed on 1 January 1900.

The Government replied (December 2017) that

- The 1,867 records identified by audit were referred to O&M division for updating correct information.
- Date of future years was an issue relating to battery of hand held devices used to issue the bills. This was taken up with the service provider for immediate rectification.
- Date being recorded as 1 January 1900 was attributed to the initial data entry during 2000-2004 when the billing was being computerised and at present it stated that such default date was not being recorded.

However, connections made as late as February 2016 also recorded the initial date of fixing meter as 1 January 1900. The controls need to be rechecked by BWSSB.

3.1.9.2 Weaknesses in Processing controls

(a) *Inconsistency between closing and opening balance of meter reading*

Water consumption is calculated based on the difference between closing balance (present meter reading) and opening balance (previous meter reading). Thus, opening balance of any bill should match with closing balance of the previous bill. However, analysis of billing data for the period of April 2012 to March 2017 showed that there are 530 cases of mismatch of atleast 1000 litres between opening balance of present bill and closing balance of previous bill. This resulted in adoption of incorrect water consumption figures in the bill leading to short/excess billing. An illustrative example is indicated in **Appendix-3.6**.

The Government accepted (December 2017) the mismatch between opening and closing balance of meter reading and stated that this issue pertained to the bills generated using the hand held devices. It further stated that all such discrepancies were rectified in the Head Office upon requests from the sub-division and that O&M had to short audit³⁴ or write off the amount manually, depending on the case.

The reply is not acceptable as once the discrepancy in readings is rectified, 'Sajala' system should automatically account for the excess/short billing due to those discrepancies, in subsequent bills instead of relying on O&M to carry out the changes manually. We observed the cases, as illustrated in **Appendix-3.6**, where despite the rectification of discrepancies in readings, short/excess bill amount due to these discrepancies was not accounted for in subsequent bills.

(b) Improper recording of consumption of water

The table of bills and bill breakup table of 'Sajala' contains details of the monthly bills and breakup of monthly bills in terms of water charges, meter charges, sanitary charges *etc.*

Analysis of these tables for the period from July 2016 to March 2017 revealed that there were 35 bills, where consumption values were negative. Since the consumption values could be only zero or positive, the reason for negative value was not clear. Further, in respect of 5,625 records pertaining to 2,922 connections, while there was water consumption, the bill amount was zero. In addition, it was observed that 59 bills with respect to 16 connections were generated without consumer names, address *etc.*, which reflected poor reliability of data.

The Government replied (December 2017) that:

- Negative consumption figures were arising as a result of spot billing errors and meter change errors and demands against the resultant short levies were raised at the instance of audit;
- In respect of bill amount being zero, the consumers made excess payments, which were carried as advances and adjusted in the subsequent bills; and
- O&M division updated the records, where the bills were generated without the details of consumers.

The reply in respect of bill amount being zero due to advances is not acceptable, as audit observed that even though the advance amount was nil in respect of 1,468 bills pertaining to 291 consumers, the bill amount was also zero despite water consumption ranging from 1 kilo litre (KL) to 29,920 KL. Thus, the zero bill amount is not attributable to advances in all the cases and BWSSB needs to re-examine the entire database for similar cases and make necessary corrections.

³⁴ Short audit: claims for earlier short billing or additional claims being demanded now.

3.1.9.3 Non-capture of period of arrears

The monthly bills raised by BWSSB on consumers has time period of 15 days for its payment from the date of the bill. The payments can be made through different channels such as 24×7 kiosks for cash and cheque payments, Bengaluru One, online payments, Electronic Clearing Service, etc.

Analysis of bills, receipts and dishonoured cheques details showed that many consumers were habitually submitting cheques which bounced. The instances of such cases are brought out in **Table-3.1**:

Table-3.1: Consumers whose cheques bounced habitually

Sl. No.	RR number	Average cheque amount	Minimum cheque amount	Maximum cheque amount	Earliest Bounce date	Latest Bounce date	Bounce Count
1.	N-131134	52,769	163	2,12,899	13-Oct-2006	07-Dec-2016	80
2.	N-184477	17,486	20	1,37,796	13-Oct-2006	03-Aug-2016	76
3.	W-229062	7,721	825	20,000	30-Jun-2004	22-Oct-2016	73
4.	N-184476	34,897	155	1,50,669	13-Oct-2006	07-Dec-2016	69
5.	W-283834	9,429	1,550	30,000	09-Jul-2004	09-May-2014	41

(Source: Compiled from the database)

Analysis of table of details of connections showed that there was a field to capture the earliest month since which arrears was pending in respect of a particular customer. In the above mentioned cases, though the arrears were pending for more than a decade, this field (Last Arrear Month and Year) in respect of these consumers showed their last arrear month as falling in 2017. Thus, by submitting invalid cheques once in every few months for the bill amount, these defaulting consumers were able to manipulate the system into showing a more favourable position of pendency of arrears. Thus, despite centralised availability of data, review of trends in data was not done. No mechanism existed to validate whether the cheques were being encashed before indicating payment details of a customer.

The Government replied (December 2017) that while arrears from one consumer was recovered, connection was disconnected in respect of other consumers until payment by cash/demand draft will be received. Further, it stated that a report on dishonoured cheques based on number of irregularities would be generated to track who did not pay regularly.

3.1.10 Quality of data

3.1.10.1 Inconsistency in data

Analysis of table of metered connections revealed that RR numbers of 3,068 connections were not traceable to the consumers table. Further analysis of the tables based on consumer identification numbers revealed that 171 consumers who were available in the table of metered connections were not traceable to the consumer tables. Hence, though there was a Parent and Child relationship between the two master tables, non-traceability of records available in the child table - metered connections to the parent table - consumers indicated data integrity problems in the database.

It was also observed that RR numbers in respect of 12,972 consumer records in consumers table was not updated and bore size of 49 consumers was zero.

The Government in its reply (December 2017) stated the following:

- Discrepancy in 3,068 connections existed due to assigning same consumer_ID to disconnected RR number as well as metered/un-metered connection. Necessary steps were being taken to set the correct RR_numbers to the consumer_ID in the consumers table.
- The consumers table was rectified and 171 consumers can now be traced in the table.
- 12,792 consumers without RR_number in consumers table was due to insufficient controls placed before centralisation. It further stated that the process had now been refined and all these consumers would be marked as “suspense consumers”.
- Data for 49 consumers with zero bore size was updated.

Though BWSSB rectified the inconsistencies pointed out by audit, the system itself needed to be refined in order to avoid re-occurrence of such inconsistencies.

3.1.10.2 Non validation of meter readings

The meters purchased and supplied by BWSSB to its consumers belong to different brands, with different bore sizes and with counters, which run to different maximum readings before the counter resets to all zeroes. While these properties of each type of meter are held in the meter readings range table, the brand, bore size and meter serial number of the meters fitted to each connection is stored along with the connection properties in the table of metered connections.

Data analysis of these two tables revealed that there were no details of meters for 39,695 out of 8,79,837 metered connections. This included 4,376 records, where the meter make field was incorrectly assigned with random values and uncontrolled entries instead of valid data. This improper input of data in the table of metered connections by the Sub-divisions could result in the risk of incorrect billing. Further, it was observed that due to non-validation of meter reading with the meter reading range table, the meter reading could take value more than the maximum reading specified for the meter.

For instance, it was observed that there was a wrong input of meter reading in generation of bill no. N-230410030 for a consumer with RR number N-230410, wherein instead of input of reading as 3,57,000 wrong input of 357,000,000 was made, which resulted in erroneous generation of abnormal bill amount of ₹3,87,88,983/- instead of normal billing amount, which was around ₹1,200/- per month. The maximum meter reading the meter could take was 9999999. Hence, there was non-validation of meter reading.

The Government replied (December 2017) that the meters supplied by them were of different vendors, which had different maximum digits for the same bore size and populating the meter reading range table was not viable. For the

illustrated case, BWSSB stated that reports on abnormal and subnormal readings were available in 'Sajala', which were accessible by the sub-division. Based on the above reports, the sub-divisions can identify errors and rectify the meter readings.

The reply is not acceptable as reading ranges of all meters are known even before the meters are issued to a customer and this data should be used to populate the meter reading range table. The readings are to be validated against the maximum reading possible for the meter. Errors as indicated in the illustrated case could be completely avoided by populating the meter reading range table.

3.1.10.3 Incorrect classification of consumers

The consumers of BWSSB are classified as domestic, non-domestic and partially non-domestic. Details of consumers, both metered and unmetered, are contained in a table of metered connections and consumers master table. Analysis of the databases of the two tables for the period July 2016 to March 2017 showed the following:

- Seventy consumers were classified as both domestic as well as non-domestic consumers simultaneously *i.e.* while the consumers were categorised as non-domestic under the sub-category in table of metered connections, they were classified as domestic under the type of connection. Hence, there existed contradictory information within the record. Illustrative examples are shown in **Appendix-3.7**.
- Connections could change from domestic to non-domestic due to various reasons such as civil works, commencement of business or doctor's clinic in part of the building, *etc.* However, audit observed that the application had no provision to capture reasons for the change in the connection type and to display the history of changes to the profile of a connection in a manner relevant to a user. Hence, due to absence of such data, analysis of the centralised data and monitoring the system by the management was deficient.
- As per BWSSB regulations, educational institutions, Government departments, hospitals *etc.*, fall under the category of non-domestic. However, in the table of metered connections, it was observed that 138 consumers such as nursery schools, high schools, colleges, Central college library, Central college physics block, Institute of Textile Technology, Director of Physical Education, University Law College, State Librarian Office, Railways, Dasappa Hospital and various other hospitals, Government offices *etc.*, which fell in the category of non-domestic, were categorised as domestic. This not only resulted in generation of incorrect MIS reports but also in loss of revenue as the tariff for non-domestic consumers was higher than domestic consumers.

The Government replied (December 2017) that

- Corrective measures were taken wherever contradictory information existed.

- Sajala was upgraded to capture the reasons for conversion of connection types.
- 138 connections were now been reviewed and reclassified suitably. Further, in the exit conference (November 2017) it was stated that out of 138 connections, 95 were declared as ‘non-domestic’.

BWSSB needs to review its entire consumer list in order to identify similar cases since the audit observation on the 138 cases was on the basis of a test-check.

3.1.10.4 Incomplete Look-up table

While the table of metered connections showed the status of the connection in a field MeterStatus, the meanings of these status values were explained in another lookup table. Analysis of these two tables revealed that there were four meter status values NULL, 'N', 'n' and 'NC', which did not have corresponding matching values and meanings/descriptions in the lookup table as given in **Appendix-3.8**.

Existence of values not traceable in lookup table indicates defective validation in the process that populates the tables.

From the above Appendix, it is seen that 46 records were captured with blank (Null) meter status, 8,20,406 records were captured with “N” meter status and 3,773 records were captured with “NC” meter status.

The Government replied (December 2017) that corrections were carried out in the application and database to address this issue and assured that measures would be taken to ensure such errors do not occur in future.

3.1.10.5 Ineligible Slum Consumers considered for waiver of dues

Government of Karnataka issued (May 2017) orders regarding the waiver of principal water bill amount and the interest from the slum consumers, whose sital area was not exceeding 600 sqft as well as 10,000 litres of water free of cost every month. For this, the Government was to release one time grant of ₹23.11 crore towards waiver of principal due from the slum dwellers.

Analysis of the data of metered connections revealed that there were 70,317 slum consumers. Further, on analysis of the data with rain water site area field, audit observed that out of 70,317 consumers, rain water site area in respect of 2,037 consumers was more than 600 sqft. Hence, these consumers were not eligible for loan waiver. The amount outstanding against these consumers was ₹32.63 lakh.

The Government replied (December 2017) that it took corrective action to remove these 2,037 consumers from waiver list. Hence, at the instance of audit, BWSSB avoided recurring extension of the scheme benefits to ineligible consumers.

3.1.10.6 Hospitals/Nursing Homes/Diagnostic laboratories not categorised as Red Category Industries - 618 cases

Regulation 20 of BWSSB Sewerage Regulations, 1974, categorises Hospitals, Nursing Homes, Veterinary Hospitals, Diagnostic Laboratories covered under biomedical waste rules as red category of industries. However, BWSSB did not classify 618 Hospitals, Nursing Homes, Diagnostic Laboratories as Red as required under the said regulation. This had an adverse impact on monitoring of the effluents generated and released by these establishments.

The Government replied (December 2017) that ‘Sajala’ software was provided with for capturing the effluent details. Further, it stated that the list of 618 Hospitals, Nursing Homes *etc.*, were forwarded to the sub-divisions for inspecting the locations and categorising it accordingly.

3.1.11 Conclusion

- Inadequate incorporation of business rules resulted in non-levy/incorrect levy of meter charges and water charges.
- Strategic advantages arising from the centralisation of ‘Sajala’ Billing and Collection Software was not understood and utilised by the Senior Management of BWSSB.
- Absence of password policies, insecure operations over HTTP coupled with incomplete audit trails indicated poor appreciation of need for security.
- Due to inconsistencies in data and non-validation of data, the information in the system was unreliable and BWSSB was exposed to the risk of incorrect decision making and risks of incorrect billing.

Revenue billing is the main source of income of BWSSB for its sustainability. Poor controls over the system resulted in revenue losses as brought out in the Report. Hence, ‘Sajala’ needs to be made more robust in order to monitor the data and avoid revenue losses.

3.1.12 Recommendations

- BWSSB should switch over to HTTPS completely for ‘Sajala’ and it should not be available in dual mode *i.e.* both HTTP and HTTPS.
- BWSSB should utilise the centralised architecture of ‘Sajala’ system to levy charges in respect of penalty for non-implementation of Rain Water Harvesting System, penalty for non-submission of Occupancy Certificate, *etc.*
- BWSSB should periodically review the data in the system for trends and inconsistencies.
- BWSSB should capture readings to have control over meter reading system in respect of Suspected Meter Stop connections.
- BWSSB should automate the billing process by installing tamper proof automatic meters recording actual consumption without manual interventions.