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Balanced scorecard model for water utilities in Egypt

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Abstract

Water utilities in Egypt are facing difficulties in managing the numerous indicators generated from the different departments. The increasing number of indicators and factors cause distraction and difficulties to interpreting the causes of problems, time wasting in analyzing redundant and unnecessary information, and delays in taking effective decisions. The BSC (Balanced Score Cards) technique has been utilized by many international utilities as the most influential multidimensional performance management system worldwide. This paper developed a new BSC model in cooperation with experts and managers to help decision makers managing water utilities' performance efficiently. The proposed model is based on the Egyptian Water and Wastewater Regulatory Agency performance indicators. In addition, new indicators have been developed to integrate all indicators that might affect overall utility performance. The proposed model will provide the utilities' managers with a fast but comprehensive view of the utility's performance. It also can be used by the regulatory agency as an evaluation and ranking tool for different water providers on the national level.

Key words: AHP, balanced scorecards, performance indicators, water utilities

INTRODUCTION

The EWRA (Egyptian Water and Wastewater Regulatory Agency) has a performance indicator management system called AIR (annual information return), where all Egyptian utilities are obligated to send the data annually to EWRA for assessment (Soulie 2013). AIR is well developed to capture the utility indicators. However, the huge number of tables and indicators make interpreting utility performance difficult and causes delays in applying the optimum corrective actions. The Balanced Scorecard (BSC) developed by Kaplan and Norton is an effective tool and can be used by water utilities to help managers effectively managing their utilities' performance (Kaplan & Norton 2001). The BSC has been applied in several utilities for both public and private sectors all over the world (Mendes *et al.* 2012). In Egypt, the BSC was introduced in the banking sector (Hamdy 2018; Mobarez & Elfar 2016) and in the hospitality industry (El-Deep & Halim 2011). However, as yet BSC has not been applied to water and wastewater utilities in Egypt. This paper proposes a new BSC model for the Egyptian water utilities to provide decision makers with a comprehensive view about specific utility performance in order to improve the overall utility management system.

LITERATURE REVIEW

Balanced scorecards (BSC)

The BSC contains a diverse set of performance indicators addressing the following four perspectives: financial, customers, internal business, and innovation and learning (Kaplan & Norton 2001). The

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financial perspective includes items that measure how the company will be viewed by its shareholders (Liyai 2014). The second perspective (customer) identifies how the company manages the relationship with its customers (Strategic Management Group 2015). The internal business perspective highlights critical processes under each utility's objectives such as production and quality (Kaplan & Norton 2001). This perspective focuses on the internal processes the organization must undertake to gain customer satisfaction and maximize financial returns to shareholders (Venanzi 2012). Finally, the innovation and learning perspective considers how an organization learns and makes changes and improvements so that long-term value formation can be recognized. This perspective mainly focuses on the competences of employees, systems, and procedures applied to improve the performance of internal processes (Strategic Management Group 2015). Figure 1 illustrates these four perspectives.

BSC success heavily relies on the way of linking the measures (performance indicators) of the four perspectives in a causal chain to obtain the desired outcomes (Chen *et al.* 2012). BSC can be adapted and applied in public sector organization (Kaplan 2010). This can be done by integrating the customer perspective on the top of hierarchy (Kaplan & Norton 2001; Kaplan 2010; Northcott & Taulapapa 2012).

Figure 1 | Typical BSC. (based on Kaplan & Norton 1996).

However, public sector organizations have always been affected by economic stability, political change, the involvement of external agencies and demands for public services (Arnaboldi *et al.* 2015). Accordingly, the different nature and challenges related to public sector made developing and applying new system to integrate and manage the huge amount of data is a must to any organization to get full overview about their utilities performance. Previous efforts have been done to apply BSC models to the healthcare (Behrouzi *et al.* 2014; Al-Hosaini & Sofian 2015), banking and hospitality sectors (El-Deep & Halim 2011; Hamdy 2018). However, no effort has been done to apply the BSC model to manage the performance of water and wastewater utilities in Egypt.

EWRA performance indicators

EWRA developed a framework to assess technical, financial, and economic performance for water and wastewater service providers. EWRA cooperated with experts from the UK Drinking Water Inspectorate (DWI) and the UK Office of Water Services (OFWAT) to prepare the AIR spreadsheets

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to be submitted by the companies to EWRA for measuring performance indicators and level of service (Soulie 2013).

The AIR is an excel workbook consisting of 25 sheets each sheet contains number of indicators related to the scope of its category. For example, first sheet 'Coverage and subscribers in the water service' includes 17 indicators (such as, total population, served population, number of subscribers, etc.). Table 1 shows different categories arranged into separate sheets and related performance indicators under each category.

Table 1 | Annual information return (AIR) spreadsheets (EWRA 2013, annual information report)

Table No.	Category Name	No. Indicators
T01	Coverage and subscribers in the water service	17
T02	Number of force mains and networks samples complying with the Egyptian standard	14
T03	Number of force mains samples complying with the Egyptian standard (branches level)	28
T04	Number of network samples complying with the Egyptian standard (branches level)	22
T05	Performance and purification	36
T06	Water balance	18
T07	Design and actual capacities of purification plants (branches level)	14
T08	Costs and expenses according to type of activity	33
T09	Costs and expenses, according to the stages of operation	18
T10	Costs and expenses, according to the stages of operation	18
T11	Revenues	25
T12	Grants and subsidies	7
T13	Employees cost and number	27
T14	Amount of water sold and number of subscribers and connections	25
T15	Customers and bills collections	19
T16	Classification of employment, according to the phases of operation	14
T17	Electricity consumption and costs	15
T18	Fixed assets and the replacement and renewal	24
T19	Coverage and subscriber's sewer service	7
T20	The number of samples and their conformity with the specifications and standards	6
T21	The number of samples and their conformity with the specifications and standards (branches level)	4
T22	Performance and treatment	22
T23	Design and actual capacities of treatment plants (branches level)	9
T24	Classification of customer complaints	27
T25	Sources of complaints, customer inquiries and resolve complaints	29

Problem identification

To assess a particular water utility, data for a huge number of indicators should be collected on a yearly basis from all Egyptian water utilities through the AIR (Soulie 2013). However, although the data collected captures every aspect of utility management, it fails to provide a clear and comprehensive image for the utility's overall performance. Furthermore, the huge number of indicators confuse the utilities' managers and keep them busy with incorrect information, leading to late decisions in applying corrective actions. Accordingly, the performance of most of Egyptian water utilities is low and in need of improvement (Hassanein & Khalifa 2007). So, this research is proposing a BSC model to help decision makers improve the overall performance of water utilities in Egypt. The following sections will discuss the BSC model building process.

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METHODOLOGY

Comprehensive evaluation for the water utilities' performance requires a simple and easy to apply model considering all indicators affecting water utility performance. The proposed BSC model methodology has been summarized as shown in Figure 2. In order to develop the proposed BSC model, first the EWRA indicators have been thoroughly studied, and a process map was designed to plan the model development. The process starts with developing the main BSC model perspectives. The second process is to link the BSC perspectives with the utility strategic goals. The third process is to select the most critical performance indicators from the AIR, in addition to developing some new indicators based on experts' opinions. Finally, the analytical hierarchy process (AHP) will be applied for the final list of indicators under each perspective to get their weights and ensure their consistency. The weighted BSC then can be used to develop a performance measurement tool to help decision makers manage their water utilities. Figure 2 shows the process map used to build the proposed BSC model.

Figure 2 | Water utilities BSC model methodology.

PROPOSED BSC MODEL DEVELOPMENT PROCESS

BSC perspectives

Face to face interviews have been held with water utilities' experts to investigate their opinion on the proposed BSC perspectives. A total of 15 experts were interviewed over two rounds. The first round was to explain the BSC perspectives and get their feedbacks and recommendations. Then, round two was held to discuss the final BSC perspectives intended to be used in the BSC model. The experts were chosen from different organizations working in the water and wastewater utilities sectors (i.e., Cairo Water Company, Sharqia Water Company, Ministry of Housing, Utilities & Urban Communities, National Organization for Potable Water and Sanitary Drainage, Holding Company for Water and Wastewater, water and wastewater consultants).

Based on data analysis, most of interviewed experts have the same idea about the sector challenges and accordingly their feedback was very similar. Figure 3 shows the final proposed BSC model perspectives after experts' interviews in round two. The final four BSC perspectives are Customer, Technical, Financial, and Employees which will be used to develop the proposed BSC model. The final BSC perspectives comply with the recommended perspectives by (Kaplan & Norton 2001). The only difference is that the 'innovation and learning' perspective has been changed to the 'Employees' perspective, which is commonly known as employee's problems in different water utilities in Egypt.

Strategic goals

Strategic goals have been selected based on different water utilities' business plans in Egypt (e.g., Behiera Governorate, Cairo Governorate, and Sharqia Governate). The business plans were developed by a private consultant as a part of technical assistance program funded by the European Union in 2014. Figure 4 provides a schematic overview of the conducted business planning process.

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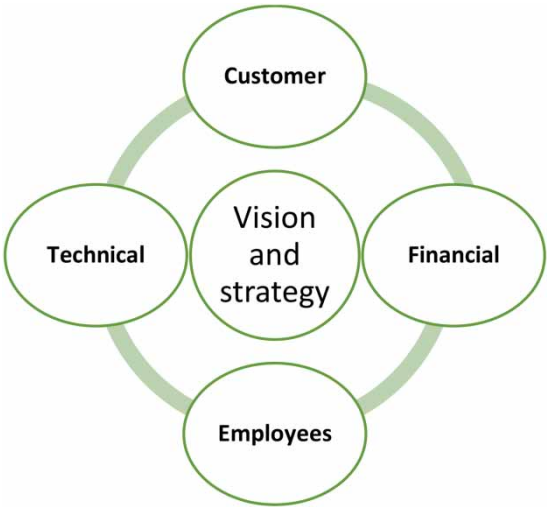

Figure 3 | Proposed BSC model perspectives.

Figure 4 | Utility business plan process.

According to utility business plan process, the private consultant held different workshops to determine the company's vision, mission, and strategic goals/objectives. The analysis resulted in 23 potential strategic choices, in which six strategies have been chosen as they are the most critical and directly reflect the performance of each water utility, so it will be used by the proposed model. The chosen strategic goals are:

- Increase customer satisfaction
- Increase service sustainability
- Increase service efficiency
- Increase employee satisfaction
- Achieve cost recovery
- Increase collection efficiency

The business plan report was then discussed with the same 15 experts (who selected the BSC perspectives) to link them with their associated perspectives. The discussion concluded the following strategic goals under the four BSC perspectives:

- Customer perspective:
  - Increase customer satisfaction
- Technical perspective:
  - Increase service sustainability
  - Increase service efficiency
- Employees perspective:

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- Increase employee satisfaction
- Financial perspective:
- Achieve cost recovery
- Increase collection efficiency

Performance indicators

Twenty performance indicators were selected from the indicators list used by EWRA and extracted from the AIR tables. Five more indicators were newly developed based on AIR indicators. The indicators were then identified under each strategic goal according to the scope similarity between them.

The urge for creating new indicators has been determined from the deep discussion with the experts. All the newly developed indicators are under the 'Employees' perspective. New indicators reflect ignorance of the employees' condition and needs by the utilities' managers as they are an important aspect to effectively managing the utility.

An example of one of the new indicators that was developed, the 'Employees to Customers' indicator, was not listed in the AIR indicators. This indicator is crucial for the Employees' satisfaction perspective. It reflects the employees' work load and accordingly their satisfaction. The 'Employees to Customers' was calculated by dividing the number of employees by the number of customers. Real data have been collected from the AIR sheets and used to calculate the 'Employees to Customers' indicator.

The indicators were then distributed into the four perspectives according to the experts' opinions. Table 2 shows the BSC model structure without any weight for the different indicators within each perspective.

Table 2 | BSC model strategic goals and their performance indicators

BSC	Strategic goals	Indicators
Customer	Increase customer satisfaction	Complaints by customers (customer satisfaction) Complaints solved to total complaints Calls answered within 30 s to total calls Population served to total population Unserved population to total population Service complaints Administrative complaints
Technical	Increase service sustainability	Unplanned service interruptions Connections with pressure <2.5 bar Number of bursts Working meters to total meters
	Increase service efficiency	Non-revenue water Physical & chemical samples within limits Bacteriological samples within limits
Employees	Increase employee satisfaction	Employees to customers Average water employee salary Average wastewater employee salary Employees to WTP Employees to WWTP Wastewater to water employees
Financial	Achieve cost recovery	% cost recovery Total revenue per m3 Total cost per m3
	Increase collection efficiency	Revenue collected per m3 % Bills collection

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AHP analysis

The Analytic Hierarchy Process (AHP), introduced by Thomas Saaty (Saaty 2008) has been used to assign relative weights for indicators and prioritise them to help decision makers focus on the critical ones. AHP incorporates a useful technique for checking the consistency of decision makers' evaluation, thus reducing the bias in the decision-making process.

The model perspectives and their indicators shown in Table 2 were presented to the same 15 experts who were involved in the BSC perspectives selection. The experts were asked to score each indicator under each perspective. The scores were based on the definitions listed in Table 3.

Table 3 | The fundamental scale for indicators scoring

Number	Definition
5	The selected attribute is significantly more important than the compared attribute
3	The selected attribute is more important than the compared attribute
1	Attributes are equal in importance
1/3	The selected is slightly less important than the compared attribute
1/5	The selected is significantly less important than the compared attribute

After collecting all evaluations, the final average score was calculated for each indicator. Table 4 shows an example for the final scores collected from all experts for the financial perspective indicators.

Table 4 | Financial perspective indicators relative scores

Financial Indicators	% Cost recovery	Total revenue per m3	Revenue collected per m3	Total cost per m3	% Bills collection
% Cost recovery	1.0	5.0	3.0	3.0	1.0
Total revenue per m3	1/5	1.0	1/3	1/3	1/5
Revenue collected per m3	1/3	3.0	1.0	1.0	1/3
Total cost per m3	1/3	3.0	1.0	1.0	1/3
% Bills collection	1.0	5.0	3.0	3.0	1.0

Accordingly, the normalized matrix has been developed to insure the consistency of each perspective. Since the numeric values of indicators' weights are derived from subjective preferences of individuals, it is impossible to avoid some inconsistencies. AHP calculates different ratios such as the consistency ratio (CR) and consistency index (CI) of the matrix, then CI should be divided by CI of a random-like matrix (RI). Table 5 shows the weighted indicators and consistency check for the four perspectives using the AHP technique.

CASE STUDY APPLICATION

The BSC model developed has been applied to real data from a selected case study to calculate the performance of each perspective and to evaluate the overall performance for this utility, as well as to test its applicability and its limitation. Based on the BSC model, weighted indicators calculation sheet was developed. Table 6 presents the proposed BSC model calculation sheet.

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Table 5 | Four perspective indicators weights and consistency check

Financial	% Cost recovery	Total revenue per m3	Revenue collected per m3	Total cost per m3	% Bills collection	Weight			
% Cost recovery	1.000	5.000	3.000	3.000	1.000	34%			
Total revenue per m3	0.200	1.000	0.333	0.333	0.200	6%			
Revenue collected per m3	0.333	3.000	1.000	1.000	0.333	13%			
Total cost per m3	0.333	3.000	1.000	1.000	0.333	13%			
% Bills collection	1.000	5.000	3.000	3.000	1.000	34%			
Normalized matrix					**Weights**	**Products**	**Ratio**		
0.3488	0.2941	0.3600	0.3600	0.3488	34.2%	1.7419	5.087972		
0.0698	0.0588	0.0400	0.0400	0.0698	5.6%	0.2792	5.014259		
0.1163	0.1765	0.1200	0.1200	0.1163	13.0%	0.6549	5.044966		
0.1163	0.1765	0.1200	0.1200	0.1163	13.0%	0.6549	5.044966		
0.3488	0.2941	0.3600	0.3600	0.3488	34.2%	1.7419	5.087972		
						CI =	0.014007	**CI/RI =** 0.01	**consistent**
Technical	**Unplanned services cut**	**% connections with pressure <2.5 bar**	**Number of Bursts**	**% working meters**	**% Non revenue water**	**% Physical & Chemical samples within limits**	**% Bacteriological samples within limits**	**Weight**	
Unplanned service interruptions	1.000	3.000	1.000	3.000	0.200	0.333	0.333	10%	
% connections with pressure <2.5 bar	0.333	1.000	0.300	1.000	0.200	0.200	0.200	4%	
Number of bursts	1.000	3.333	1.000	3.000	0.333	1.000	1.000	13%	
% working meters	0.333	1.000	0.333	1.000	0.333	0.333	0.333	6%	
% Non Revenue Water	5.000	5.000	3.000	3.000	1.000	3.000	3.000	34%	
% Physical & chemical samples within limits	3.000	5.000	1.000	3.000	0.333	1.000	1.000	16%	
% Bacteriological samples within limits	3.000	5.000	1.000	3.000	0.333	1.000	1.000	16%	

(*Continued.*)

Table 5 | Continued

Customer	Number of complaints	% Telephone complaints solved the same day	Calls answered within 30 sec	% population served water 247	% unserved population	Quality complaints	Bills complaints	Weight
Number of complaints	1.000	3.000	3.000	1.000	0.333	1.000	1.000	13%
% Telephone complaints solved the same day	0.333	1.000	1.000	0.200	0.143	1.000	1.000	6%
Calls answered within 30 sec	0.333	1.000	1.000	0.200	0.143	0.300	0.300	4%
% population served water 247	1.000	5.000	5.000	1.000	0.333	3.000	3.000	21%
% unserved population	3.000	7.000	7.000	3.000	1.000	3.000	3.000	36%
Quality complaints	1.000	1.000	3.333	0.333	0.333	1.000	1.000	10%
Bills complaints	1.000	1.000	3.333	0.333	0.333	1.000	1.000	10%

Employees	Employees to customers	Average water employee salary	Average wastewater employee salary	Employees to WTP	Employees to WWTP	Wastewater to water employees	Weight
Employees to customers	1.000	0.333	0.333	0.333	0.333	1.000	7%
Average water employee salary	3.000	1.000	1.000	1.000	1.000	3.000	21%
Average wastewater employee salary	3.000	1.000	1.000	1.000	1.000	3.000	21%
Employees to WTP	3.000	1.000	1.000	1.000	1.000	3.000	21%
Employees to WWTP	3.000	1.000	1.000	1.000	1.000	3.000	21%
Wastewater to water employees	1.000	0.333	0.333	0.333	0.333	1.000	7%

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Table 6 | Proposed balanced scorecard model calculation sheet

Overall	BSC	Weight	Status	Strategic goals	Indicators	Unit	Value	Target	weight	Status
75%	Customer	25%	67.4%	Increase customer satisfaction	Number of complaints (customer satisfaction)	Complaint/connection (i)	0.09915	0.01	13%	10%
					Complaints solved to total complaints	%	100	100	6%	100%
					Calls answered within 30 s to total calls	%	0	100	4%	0%
					Population served to total population	%	100	100	21%	100%
					Unserved population to total population	%(i)	0	0	36%	100.0%
					Service complaints	Complaint/connection (i)	9.86521	1	10%	10%
					Administrative complaints	Complaint/connection (i)	0.04985	0.01	10%	20%
	Technical	25%	81.8%	Increase service sustainability	Unplanned services cut	# (i)	680	4,000	10%	100%
					Connections with pressure <2.5 bar	per water connection (i)	0	0	4%	100%
					Number of bursts	# (i)	10	1	13%	10%
					Working meters to total meters	%	55.0719	100	6%	55%
				Increase service efficiency	Non revenue water	%(i)	26.1628	25	34%	96%
					Physical & chemical samples within limits	%	94.2909	100	16%	94%
					Bacteriological samples within limits	%	92.5639	100	16%	93%
	Employees	25%	59.8%	Increase employees' satisfaction	Employees to customers	%(i)	83.1865	140	7%	100%
					Average water employee salary	EGP/month	3,360.65	5,000	21%	67%
					Average wastewater employee salary	EGP/month	3,150.56	5,000	21%	63%
					Employees to WTP	%(i)	193.333	25	21%	13%
					Employees to WWTP	%(i)	28.5714	20	21%	70%
					Wastewater to water employees	%	35.7453	35	7%	98%
	Financial	25%	89%	Achieve cost recovery	% cost recovery	%	81.3121	100	34%	81%
					Total revenue per m3	EGP/m3	1.23654	1.5	6%	82%
					Total cost per m3	EGP/m3 (i)	1.18832	1	13%	84%
				Increase collection efficiency	Revenue collected per m3	EGP/m3	1.64565	1.2	13%	100%
					% Bills collection	%	96.1002	100	34%	96%

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The BSC model sheet is divided into three main parts as shown in Table 6. The last six columns are designated to evaluate each indicator and to calculate its performance. Columns from 2 to 5 are associated with four perspectives where performance is calculated by aggregating the performance for all indicators under each category. The first column presents the overall utility performance by aggregating the performance of the four-perspectives. The BSC Model Calculation sheet consists of the following columns for indicators: Unit, Value, Target, Weight and Status to evaluate each indicator. The 'Unit' column is to identify the measurement unit for each indicator. Some units have the (i) at the end, this indicates that the relationship between the indicator and the strategic goal is inversely proportional.

Indicator performance

The 'Value' column of indicators represents the value of each indicator that have been obtained from the AIR of the utility. The values used in this table is for demonstration, however it was obtained from real data from one of the water utilities in Egypt based on their AIR. The equations used to calculate each indicator are presented in the Table 7.

The 'Target' column is the desired value of the indicator that the utility managers would like to achieve. The target for each indicator will be set by the utility manager/decision-maker based on current status reports and the desired goals. There are different methods to set the target; one of them is by taking a national sector average. The target values used in this case study are proposed by changing the original indicator value slightly to a higher desired value to be achieved according to utility preference. These target values have been set to demonstrate the model's capabilities.

The 'Status' column of indicators is calculated by two methods based on the relationship between the indicator and the perspective. If the indicator is inversely proportional to the perspective, then the equation is dividing the indicator 'Target' by the indicator 'Value' as shown in Equation (1). If the indicator is directly proportional to the perspective, then the equation is dividing the indicator 'Value' by the indicator 'Target' as shown in Equation (2). The indicators' 'Weight' column values are obtained from the AHP analysis discussed earlier.

$$\text{Indicator status (inversely proportional)} = \text{Indicator Target/Indicator Value} \tag{1}$$

$$\text{Indicator status (directly proportional)} = \text{Indicator Value/Indicator Target} \tag{2}$$

Perspective performance

Each perspective's performance is shown in Table 6. The perspective weight shown in column 3 is according to the results of AHP analysis and can be modified by users. The weights are distributed evenly between the four perspectives; 25% each. The perspective 'Status' column values have been calculated by summation of the indicator's weights and status as shown in Equation (3).

$$\text{Perspective status} = \sum_{i=1}^{n} \omega_i s_i = \omega_1 s_1 + \omega_2 s_2 + \ldots + \omega_n s_n \tag{3}$$

where:

n = number of indicators within the perspective
W_i = Indicator Weight
S_i = Indicator Status

The overall performance shown in column 1 'Overall' has been calculated by averaging the summation of weights and status of four perspectives.

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Table 7 | Proposed balanced scorecard model indicators' equations

Indicator	Equation
Customer perspective	
Number of complaints (customer satisfaction)	Number of complaints/Number of water connections
Complaints solved to total complaints	Complaints solved/Number of complaints*100
Calls answered within 30 s to total calls	Calls answered within 30 s/total calls received *100
Population served to total population	Number of population served 247/Total population*100
Unserved population to total population	Number of unserved population/Total population*100
Service complaints	Number of service complaints/Number of water connections*100
Administrative complaints	Number of administrative complaints/Number of water connections*100
Technical perspective	
Unplanned services cut	(+12 h unplanned service interruptions) + (−12 h unplanned service interruptions)
Connections with pressure <2.5 bar	−2.5 bar connections/Total number of water connections*100
Number of bursts	Number of bursts
Working meters to total meters	Total number of water meters - Non-working meters/Total number of water meters*100
Non-revenue water	Total produced water - Total number of water meters/Total produced water *100
Physical & chemical samples within limits	Physical and chemical samples within limits/total number of physical and chemical samples tested*100
Bacteriological passed samples	Bacteriological samples within limits/total number of bacteriological samples tested*100
Employees' perspective	
Employees to customers	Total number of customers/Total number of employees
Average water employee salary	Water employees cost/Water employees/12
Average wastewater employee salary	Wastewater employees cost/Wastewater employees/12
Employees to WTP	WTP employees/Number of WTP
Employees to WWTP	WWTP employees/Number of WWTP
Wastewater to water employees	Wastewater employees/Water employees*100
Employees perspective	
Cost recovery	Total revenue/Total cost*100
Total revenue	Total exported revenue/Total water sold
Total cost	Total collected revenue/Total water sold
Revenue collected	Total cost-Depreciation cost/Total water sold
Bills collection	Total collected revenue/Total exported revenue*100

DISCUSSION AND FUTURE EXTENSION

The BSC model developed has been presented to some of the experts involved in the development process. The interviews concluded the following points: (1) The weights of the perspectives could be changing depending on the utility priorities; (2) Before implementing BSC model in Egyptian utilities, the model should be developed in a more user-friendly application; (3) The model lacks the ability to link the indicators in a feedback loop, for example, how the improvement in 'Number of bursts' could affect the service complaints. This was one of major limitations and should be resolved before real implementation.

The experts discussed some of challenges that could face the implementation of the proposed model in the Egyptian water utilities and how to overcome these challenges. Their valuable comments and

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Table 8 | Challenges associated with BSC model implementation

Challenge	Challenge Description	Mitigation Action
Change resistance	Employees will not easily use the new BSC system	Involve all employees in an open discussion and get their feedback on the model. Let them know that the model will make the work load less and organize the overall work process
BSC model needs training and requires more work load	Not all the employees are familiar with the BSC	Training on the BSC model should be plan during the preparatory phase before implementation
Financial resources	The implementation might be accompanied with some costs	Software development costs worth the benefits gained from applying such system

recommendations are currently being addressed and will be integrated before applying the final BSC model in several real case studies. According to discussion with experts Table 8 summarizes some challenges and proposed solutions to be taken when implementing the BSC model in reality.

CONCLUSION

This paper developed a new BSC model that includes the necessary attributes and adoption levels to be used as an efficient management tool for water utilities in Egypt. The BSC model can be used by all water and waste utilities in Egypt to assess their service performance. The indicators were chosen and formulated to allow benchmarking between different utilities at the national level and to enable EWRA to rank/evaluate them together. The developed model includes four main perspectives that reflects the water utility management aspects. Twenty-five indicators have been identified under strategic goals of each perspective. The AHP method was used as a prioritization tool to calculate the weight for each performance indicator. During the development of the BSC model and according to experts' discussions, new indicators were developed such as 'Average water employee salary'. This indicator is very important to compare the employees' salary on the national level. This new indicator also draws the managers' attention to the importance of measuring the employees' satisfaction and to resolve the overstaffing issues.

The proposed BSC model can measure the overall utility performance considering different perspectives to help decision makers get early warnings about perspectives that need improvement. The developed model was applied in real case studies, so currently the authors are working to extend the developed model to integrate experts' recommendations and to develop the final model as a separate software. Later it will be applied in several real case studies for validation before implementation by the utility. The future implementation process will definitely provide feedback that will strengthen the model and/or validate the model capability.

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