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ORIGINAL ARTICLE

Information systems performance evaluation, introducing a two-level technique: Case study call centers

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Abstract With the emergence of Information and Communication technologies, and the relatively cheap cost of calls (voice and data), the use of call centers to provide new services to citizens has grown extensively. Evolution in call centers technologies, systems and infrastructures allowed the transformation of industries and services in big enterprises and organizations, customer support services, marketing services and after sales support are examples of such transformations.

The objective of this paper was to introduce a new technique that can support decision makers in the call centers industry to evaluate, and analyze the performance of call centers. The technique presented is derived from the research done on measuring the success or failure of information systems. Two models are mainly adopted namely: the Delone and Mclean model first introduced in 1992 and the Design Reality Gap model introduced by Heeks in 2002. Two indices are defined to calculate the performance of the call center; the success index and the Gap Index. An evaluation tool has been developed to allow call centers managers to evaluate the performance of their call centers in a systematic analytical approach; the tool was applied on 4 call centers from different areas, simple applications such as food ordering, marketing, and sales, technical support systems, to more real time services such as the example of emergency control systems. Results showed the importance of using information systems models to evaluate complex systems as call centers. The models used allow identifying the dimensions for the call centers that are facing challenges, together with an

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identification of the individual indicators in these dimensions that are causing the poor performance of the call center.

1. Introduction

With the emergence of Information and Communication technologies, and the relatively cheap cost of calls (voice and data), the use of call centers to provide new services to citizens has grown extensively [1]. Evolution in call centers technologies, systems and infrastructures allowed the transformation of industries and services in big enterprises and organizations, customer support services, marketing services and after sales support are examples of such transformations. Moreover, the use of call centers in real time critical services is growing.

In Egypt, call centers have been used to improve the service of emergency control systems. Call centers have been used for call taking, dispatching and tracking of emergency calls [2]. The system monitors the overall performance and response time to guarantee the quality of service provided to the citizens. The system has successfully proved the improvement in the services provided by the ambulance system during the circumstances that Egypt has faced since the 25th of January revolution. An example of using specialized call centers in other countries is India, where first line health consultations have been provided by a specialized call center in order to reduce the referral of cases to primary care health units [3]. Outsourcing critical services to specialized call centers will definitely help in improving the quality of services provided by the government, companies and organizations to the targeted customers.

This new shift in services provisioning necessitates a thorough analysis of the design, implementation and performance evaluation of call centers. This analysis should not only include the call center system design, infrastructure, connectivity, reliability, and information systems used, but also organizational, management structures, and agents' skills should be considered. Different techniques have been used in the literature for the evaluation of the performance call centers. Due to the complexity of the system, simulation based techniques are the most commonly used [4], these techniques do not take into consideration recent trends such as skill-based routing, electronic channels and interactive call handling. On the other hand, analytical techniques and operation research and queuing theory techniques are also adapted to model and analyze call centers.

Queuing theory approach is usually associated with assumptions in order to ease the modeling and the analytical complexity. These techniques do not reflect the reality due to the complexity of the system and the assumptions and the simplifications in the models proposed. The models are used to calculate the blocking rate, the average waiting time for the calls, the number of customer retrials [5]. A survey of the recent literature on call center operation management is provided [6]. Special focus has been given to new management challenges that have been caused by emerging technologies, to behavioral issues associated with both call center agents and customers, and to the interface between call center operations and sales and marketing.

Many researchers and call centers industry associations and institutions have proposed a number of performance indicators [7,8] to be used to measure call centers operation. Some of these performance indicators are targeting measurement of the call center overall performance, others target the quality of service provided to the customers, while other indicators target the quality and skills of the individual employee according to North American Quitline Consortium (NAQC) [7] as presented by Tables 1–3.

The objective of this paper was to introduce a new technique that can support decision makers in the call centers industry to evaluate, and analyze the performance of call centers. The technique presented in this work is derived from the research done on measuring the success or failure of information systems. Two models are mainly adopted to measure the performance of success and failures of information systems namely: the Delone and Mclean model first introduced in 1992 [9] and the Design Reality Gap model introduced by Heeks in 2002, [10]. Applying the models to include Internet

Table 1 NAQC service indicators.

Accessibility	
Blockage	Blockage is an accessibility measure that indicates what percentage of callers will not be able to access the call center
Hours of operation	The defined period of time of operation
Abandons	The abandon rate is measured by looking at the calls that abandon during the defined period of time compared with all calls for that period
Self-service availability	Many contacts today are being offloaded from call center agents to self-service alternatives, such as an upfront telephone menu using IVR and/or Web interactions
Speed of service	
Service level	It denotes the percentage of calls that are answered in a defined wait threshold and is most commonly stated as x percent of calls answered in y seconds
Average speed of answer	Average speed of answer (ASA) is the average delay of all calls for the period
Longest delay in queue	The "worst-case" experience of a customer over a period of time, such as a day

Table 2 NAQC quality indicators.

Call-handling process	
Telephone etiquette	The degree to which general telephone communications skills and etiquette are displayed is generally measured via observation or some form of quality monitoring
Knowledge and competency	Is the ability of the agent or counselor to provide correct and thorough product and service information, and to be competent at handling caller questions and problems
Error/rework rate	The error and rework rate is the degree to which errors have to be corrected or work redone
Adherence to protocol	Ensuring callers receive a consistent call-handling experience regardless of the contact channel or the individual agent involved in the contact is particularly important to the perceived quality of the contact
Resolution	
First-call resolution rate	The percentage of calls completed within a single contact, often called the ''one and done''
Transfer rate	The transfer percentage indicates what portion of calls has to be transferred to another person to be handled

Table 3 NAQC efficiency indicators.

Contact handling	
Average handle time	(AHT), which is talk time plus after-call work. AHT is used when determining overall workload and staffing requirements
After-call work time	ACW is the time, after the conversation, that the agent spends filling out associated paperwork, updating files, and doing similar work related to the call before the agent is ready to handle the next contact
On-hold time	On-hold time is the amount of time a caller spends on hold during the course of the conversation
Resource utilization	
Agent occupancy	The percentage of logged-in time an agent is busy on a call or doing after-call work compared with available time. It is calculated by dividing workload hours by staff hours
Staff shrinkage	The percentage of paid time that agents are not available to handle calls
Schedule efficiency	The degree of overstaffing and understaffing that exists as a result of scheduling design
Schedule adherence	The degree to which the agents work the specific hours scheduled
Availability	The percentage of time that staff are logged in and available to take calls
Cost efficiency	
Conversion rate	The standard conversion rate in a call center refers to the percentage of calls in which a sales opportunity is translated into an actual sale
Cost per call	The cost-per-call rate can track just labor costs per call or it can include all the telecommunications, facilities, and other service costs in addition to labor costs

based information systems has been experimented by Delone and Mclean for eCommerce systems [11]. The use of the Design Reality Gap model to evaluate the performance of ERP systems, and eGovernment systems has been studied by Heeks [12,13].

This research has adopted the Delone and Mclean model to analyze the performance of the call centers [14]. A call center performance index reflecting the success index of the call center was proposed to measure the overall performance of the call center. A total of 43 indicators were proposed and mapped to the six dimensions of the Delone and Mclean model. The results obtained demonstrate that using multi-dimensional modeling for call centers gives the possibility of analyzing individual dimensions and identifying the impact of each dimension on the overall performance [14]. Moreover, weighted dimensions indicators would reflect the priorities given by the top management for the calculation of the performance index.

As a contribution of this work, this article highlights the possibility of applying the Design Reality Gap model, in this respect it is proposed a Gap Index in addition to the performance index already proposed in [14]. An overall performance Gap Index is introduced in this article using the seven dimensions of the design-reality gap model. Additionally, a Call Center Performance Evaluation (CCPE) tool is developed to be applied in the two models to calculate the performance success index and the Gap Index.

The reason behind developing the Gap Index is to measure the existing gap between the benchmarked values for the indicators and the resulting values of the indicators during the operation of the call centers.

This paper applies the Design Reality Gap model to analyze the performance of call centers by mapping the call centers indicators introduced for the Delone and Mclean model in [14] to the seven dimensions of the Design Reality Gap model. It also compares both the Delone and Mclean model in [14] and the Design Reality Gap model presented in this paper.

The rest of the paper is described as follows: Section 2 describes the design-reality gap model as applied to call centers, together with the mapping of the call centers indicators to the design-reality gap model dimensions. Section 3 presents the Call Center Gap Index. Section 4 presents the results of the proposed methodology, and the effect of proposed indicators on the performance assessment of the call centers under study. Finally, Section 5 concludes the paper and provides insights for future work.

2. The Design Reality Gap model for call centers

The foundation of the "design-reality gap" model is expressed in simple terms as the degree of fit between, on the one hand, the requirements and assumptions built into the information system design and, on the other, the real situation found in the organizational context of implementation. Based on the analysis of the Information Systems literature, Heeks indicated that seven dimensions – summarized by the ITPOSMO acronym – are necessary and sufficient to provide a comprehensive understanding of design-reality gaps [10]:

- *Information*: includes both formal and informal information, held on both IT based and other types of information system.
- *Technology*: mainly focuses on information handling technology (particularly IT but also paper, telephones, etc.), but can cover other types of technology such as production machinery.
- *Processes*: the activities undertaken by the relevant part of the organization – both information related processes and broader business processes.
- *Objectives and values*: often the most important dimension since the 'objectives' component covers issues of self-interest and organizational politics, and can even be seen to incorporate formal organizational strategies; the 'values' component covers organizational culture: what stakeholders feel are the right and wrong ways to do things.
- *Staffing and skills*: cover both the number of staff and their competencies (particularly skills, but also knowledge).
- *Management systems and structures*: the overall management systems required to organize plus the way in which the organization is structured, both formally and informally.
- *Other resources*: time and money.

Putting these dimensions together with the notion of gaps produces the model (Fig. 1) for understanding success and failure of information systems.

Following the same conceptualization method, this paper is applying the Design Reality Gap model as a framework to measure the Gap Index of call centers. The seven dimensions of the Heeks IS Design Reality Gap model can be applied to the call centers environment as follows:

1. *Information*, customers in call centers should be properly authenticated; agents should address the customers with personalized, complete, relevant, easy to understand, and secure content especially in case of customers that perform financial transactions.
2. *Technology*, measures the essential characteristics of call center systems including availability, reliability, intelligent routing, channels of communications, as well as the response time represented by calls abandoned, waiting time to answer, and average call-handling time (time actually on phone with customer).
3. *Processes*, this dimension reflects the quality of services provided by the agents to the customers. Examples of services may include information retrieval, marketing, technical support, remote diagnosis, remote data entry as in medical transcriptions, mobile, etc.

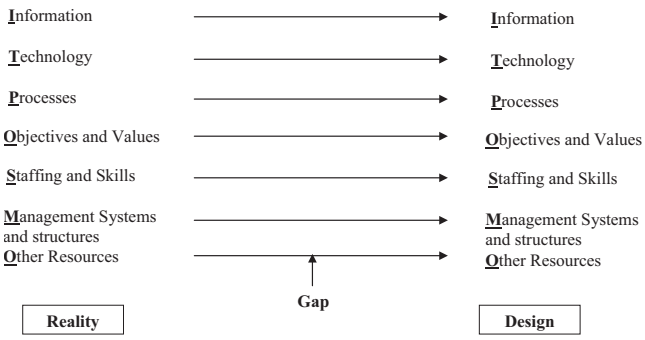

Figure 1 Design-reality gaps dimensions.

4. *Objectives and values*, measure the objectives set by the call center, these objectives may include maximizing the number of customers using the call center, the growth rate of customers using the system, as well as the rate of re-utilization of the same customer for the call center. Other targets may reflect the net profit and the return on investment for the call center.
5. *Staffing and skills*, the number of agents and staff in the call center. A critical parameter to be measured for the agents' skills is the rate of the escalation of calls beyond the agent representative as the existing system failed to answer the customer query. Measuring customers' feedback of the call center system should cover the entire customer experience cycle based on the services provided from the call center.
6. *Management systems and structures*, this dimension reflects the internal organization structure for the call center, the scheduling design and the degree of overstaffing and understaffing that exists as a result of the scheduling design. Also, it reflects the efficiency of utilization of available resources and the productivity of agents in the call center.
7. *Other resources*, cost of service to customer, profit of call center.

Tables 4–10 propose the indicators defined for each dimension of the Design Reality Gap model. Tables 11–16 propose the indicators defined for each dimension of the Delone and Mclean model. Table 17 depicts the proposed mapping between the different call centers indicators, the Delone and Mclean model dimensions, and the Design-Reality gap model dimensions. As it is seen from the tables, different grouping for the indicators is made based on the definition of the dimensions for each model.

Table 4 Mapping Heeks' Design Reality Gap model dimension 1 – information.

Relevant and correct
Complete
Secure
Accuracy in data entry and call coding
Personalized
Grammar and spelling in text communication (email and chat)

Table 5 Mapping Heeks' Design Reality Gap model dimension 2 – technology.

Blockage
Hours of operation
Abandons
Self-service availability
Service level
Average speed of answer
Longest delay in queue
Availability
Error/network rate
Transfer rate
On-hold time

Table 6 Mapping Heeks' Design Reality Gap model dimension 3 – processes.

First-call resolution rate
Inquiry
Orders
Technical support
Financial transactions
Other services

Table 7 Mapping Heeks' Design Reality Gap model dimension 4 – objectives and values.

User retention rate
New customers
Customer re-occurrence
Growth in customer base
Increased sale
Market share
Global reach

Table 8 Mapping Heeks' Design Reality Gap model dimension 5 – staffing and skills.

Agents occupancy
Staff shrinkage
Courtesy and professionalism
Telephone etiquette
Knowledge and competency
Adherence to protocol
Average handle time
After-call work time

Table 9 Mapping Heeks' Design Reality Gap model dimension 6 – management systems and structures.

Schedule efficiency
Schedule adherence
Productivity

Table 10 Mapping Heeks' Design Reality Gap model dimension 7 – other resources.

Conversion rate
Cost per call
Profit
Return on investment

Table 11 Mapping Delone and Mclean model dimension 1 – system quality.

Accessibility	Speed of service	Resource utilization
Blockage	Service level	Agents occupancy
Hours of operation	Average speed of answer	Staff shrinkage
Abandons	Longest delay in queue	Schedule efficiency
Self-service availability		Schedule adherence
		Availability

Table 12 Mapping Delone and Mclean model dimension 2 – information quality.

Relevant and correct
Complete
Secure
Accuracy in data entry and call coding
Personalized
Courtesy and professionalism
Grammar and spelling in text communication (email and chat)

Table 13 Mapping Delone and Mclean model dimension 3 – service quality.

Call-handling process	Resolution
Telephone etiquette	First-call resolution rate
Knowledge and competency	Transfer rate
Error/rework rate	
Adherence to protocol	

Table 14 Mapping Delone and Mclean model dimension 4 – usage.

Nature of use	Amount of use
Inquiry	User retention rate
Orders	New customers
Technical support	Customer re-occurrence
Financial transactions	
Other services	

Table 15 Mapping Delone and Mclean model dimension 5 – user satisfaction.

Contact handling	Cost efficiency
Average handle time	Conversion rate
After-call work time	Cost per call
On-hold time	

3. Call Center Gap Index

In order to analyze the performance of call center and to diagnose the challenges and the reasons of success or failure of a specific dimension or indicator in call centers, two indices are proposed in this work namely: the Linear Call Center Performance Index (L-CCPI) and the Call Center Gap Index (CCGI). The success index has been introduced in [14] with the objective of evaluating the overall performance of the call

Table 16 Mapping Delone and Mclean model dimension 6 – net benefits.

Growth in customer base
Increased sale
Market share
Global reach
Profit
Productivity
Return on investment

center based on the success index for each of the dimensions of the Delone and Mclean evaluating model.

The L-CCPI in its simplest form can be calculated as the summation of the D&M dimensions' performance index as follows:

L-CCPI (Linear Call Center Performance Index).

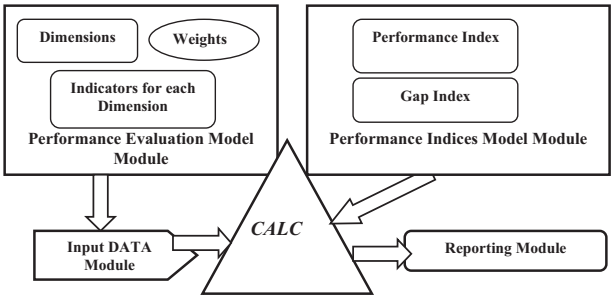

Figure 2 CCPET main modules.

$$\text{L-CCPI} = 1/m \sum_{j=1}^{m} \sum_{i=1}^{n} (a_{ji})/(n) \quad (1)$$

Table 17 Mapping call centers indicators to D&M and design-reality gap model dimensions.

	Call center indicators	D&M dimensions	Heeks dimensions
1	Blockage	System quality	Technology
2	Hours of operation	System quality	Technology
3	Abandons	System quality	Technology
4	Self-service availability	System quality	Technology
5	Service level	System quality	Technology
6	Average speed of answer	System quality	Technology
7	Longest delay in queue	System quality	Technology
8	Agents occupancy	System quality	Staffing and skills
9	Staff shrinkage	System quality	Staffing and skills
10	Schedule efficiency	System quality	Management systems and structures
11	Schedule adherence	System quality	Management systems and structures
12	Availability	System quality	Technology
13	Relevant and correct	Information quality	Information
14	Complete	Information quality	Information
15	Secure	Information quality	Information
16	Accuracy in data entry and call coding	Information quality	Information
17	Personalized	Information quality	Information
18	Courtesy and professionalism	Information quality	Staffing and skills
19	Grammar and spelling in text communication (email and chat)	Information quality	Information
20	Telephone etiquette	Service quality	Staffing and skills
21	Knowledge and competency	Service quality	Staffing and skills
22	Error/network rate	Service quality	Technology
23	Adherence to protocol	Service quality	Staffing and skills
24	First-call resolution rate	Service quality	Processes
25	Transfer rate	Service quality	Technology
26	Inquiry	Usage	Processes
27	Orders	Usage	Processes
28	Technical support	Usage	Processes
29	Financial transactions	Usage	Processes
30	Other services	Usage	Processes
31	User retention rate	Usage	Objectives and values
32	New customers	Usage	Objectives and values
33	Customer re-occurrence	Usage	Objectives and values
34	Average handle time	User satisfaction	Staffing and skills
35	After-call work time	User satisfaction	Staffing and skills
36	On-hold time	User satisfaction	Technology
37	Conversion rate	User satisfaction	Other resources
38	Cost per call	User satisfaction	Other resources
39	Growth in customer base	Net benefits	Objectives and values
40	Increased sale	Net benefits	Objectives and values
41	Market share	Net benefits	Objectives and values
42	Global reach	Net benefits	Objectives and values
43	Profit	Net benefits	Other resources
44	Productivity	Net benefits	Management systems and structures
45	Return on investment	Net benefits	Other resources

where n is the number of indicators for dimension j, m represents the six dimensions of the D&M model, a_{ji} represents the value for the indicators for the dimension (D_j).

In this paper, CCGI is proposed to measure the discrepancy of each dimension in reality from the design value. It should also be noted that in case of availability of benchmark values for the different indicators as in the case of call centers [15], the Design Reality Gap model will be substituted by the Benchmark Reality Gap model, where the benchmark values will be used for the gap calculations.

The Call Center Gap Index CCGI in its simplest form can be calculated as the summation of the Design Reality Gap model dimensions' index as follows:

CCGI (Call Center Gap Index).

$$\mathrm{CCGI} = \sum_{j=1}^{m} \mathrm{GI}(D_j)/(m) \tag{2}$$

where m represents the seven dimensions of the Design Reality Gap model and $GI(D_j)$ is the Gap Index value for each dimension.

The Gap Index value for each dimension of the model $GI(D_j)$ is calculated based on the values of the indicators defined for each dimension as follows:

$$\mathrm{GI}(D_j) = \sum_{i=1}^{n} (g_{ji})/(n) \tag{3}$$

where n is the number of indicators for dimension j, g_{ji} represents the value for the Gap indicators for the indicator I in dimension Dj, g_{ji} is calculated as the difference between the design value for the indicator and the real or measured value.

g_{ji} = (Design value − Real value) for indicator i

In the case of Benchmark Reality Gap model, the g_{ji} is calculated as the difference between the benchmark value for the indicator and the real or measured value.

g_{ji} = (Design or Benchmark value
− Real value) for indicator i

Based on Eq. (2) and (3) the Call Center Gap Index is calculated as follows:

CCGI (Call Center Gap Index)

$$\mathrm{CCGI} = 1/m \sum_{j=1}^{m} \sum_{i=1}^{n} (g_{ji})/(n) \tag{4}$$

4. Data analysis and results

In recent years, Egypt has become one of the most prominent outsourcing countries, offering a large variety of products meeting the internal and external needs of customers. Existing call centers in Egypt vary in size, the number of clients served, the priority of services provided (real time service vs. nonreal time service, example emergency call centers) and the location of the call center (capital city, big cities, small cities). Four call centers in Egypt were studied during the work, data for the proposed indicators were collected based on the type of indicator whether hard or soft indicator. Data for hard indicators (example: blockage rate) are collected using call centers management systems, these systems generate reports that actually include a lot of data, the main challenge resides in the analysis of these reports and to make it easy for decision makers to identify whether a problem exists, and then to identify the source of the problem. The four call centers vary in their nature and location representing two different food sector, marketing, and IT support and a capital city and small city call location.

On the other hand, in order to collect the data for soft indicators (example: knowledge and competency, user satisfaction), call centers use a variety of methods that may include the following:

- Test calling where calls are made to the call center by staff pretending to be customers.
- Silent monitoring of calls where a manager or supervisor listens in on certain calls.
- Call recording where recording the entire call is made.
- Making follow-up outbound call where calls are made after the initial interaction and the customer is questioned about their experience of the original interaction.

These methods are resource intensive, especially for test calling, silent monitoring and follow-up outbound calls where someone should actually do the monitoring of the outbound call. Moreover, the results of these methods are subjective and dependent on the interpretation of the person in charge of the monitoring and measurement process. With the evolution of call centers and Interactive Voice Response (IVR) systems, automated feedback and surveys are done automatically by the system upon approval of the customer. Survey scripts (i.e. the questions asked to customers) can be created online over the Internet or through the IVR system. This means that customer satisfaction can be measured almost immediately. The results of these surveys are used for the soft indicators.

For this research, hard indicators data were collected for the four call centers monthly for one year. Four sets of surveys have been conducted for 100 users for each call center using IVR, and phone calls.

Due to the complexity of the system and the large number of indicators included in the study, an evaluation tool was designed, namely the Call Center Performance Evaluation Tool (CCPET) that can be used by the call centers to make self-assessment. Results for the Delone and Mclean model are presented. Using Heeks' Design Reality Gap model, results for Gap Index are presented with a comparison between the two models under study with the two performance indices used: the performance index and the Gap Index.

4.1. Call Center Performance Evaluation Tool (CCPET)

Based on the two performance indices proposed in Section 3, a Call Center Performance Evaluation Tool is designed to be used by the call center industry. The tool can be used to analyze the performance of any information system. In its general form, it can also be considered as a generic tool for

Table 18 Performance and gap indices using D&M model.

	(D&M) final gap dimensions rating				(D&M) final performance dimensions rating			
	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4
D1	18.67	16.00	13.33	10.67	8.00	10.67	13.33	16.00
D2	12.44	4.67	4.67	9.33	3.11	10.89	10.89	6.22
D3	12.00	8.67	8.00	7.33	1.33	4.67	5.33	6.00
D4	16.22	14.67	13.78	13.11	1.56	3.11	4.00	4.67
D5	10.00	10.00	7.78	7.11	1.11	1.11	3.33	4.00
D6	15.56	14.67	13.11	13.11	0.00	0.89	2.44	2.44
D&M L-CCPI (Linear Call Center gap performance index)	84.89	68.67	60.67	60.67	15.11	31.33	39.33	39.33

Table 19 Performance and gap indices using design-reality gap model.

	Design-reality final gap dimensions rating				Design-reality final performance dimensions rating			
	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4
D1	10.44	4.22	3.33	8.00	2.89	9.11	10.00	5.33
D2	18.67	14.44	12.89	10.00	5.78	10.00	11.56	14.44
D3	12.22	10.89	9.78	9.33	1.11	2.44	3.56	4.00
D4	14.89	13.56	12.67	12.44	0.67	2.00	2.89	3.11
D5	14.67	11.78	10.00	9.78	3.11	6.00	7.78	8.00
D6	5.56	5.33	4.44	3.56	1.11	1.33	2.22	3.11
D7	8.44	8.44	7.56	7.56	0.44	0.44	1.33	1.33
Design-reality gap model L-CCPI (Linear Call Center performance Gap Index)	84.89	68.67	60.67	60.67	15.11	31.33	39.33	39.33

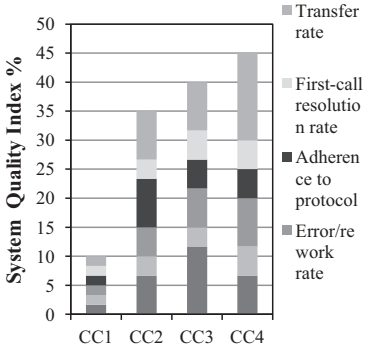

Figure 3 Distribution of system quality success index indicators.

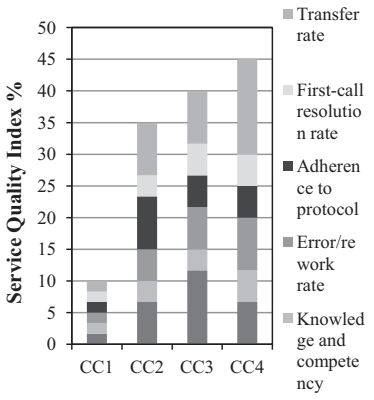

Figure 5 Distribution of service quality success index indicators.

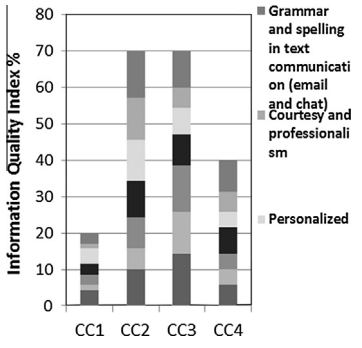

Figure 4 Distribution of information quality success index indicators.

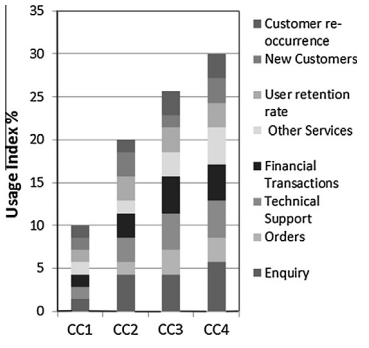

Figure 6 Distribution of usage success index indicators.

performance evaluation. The tool is composed of five main modules: the model definition module, the performance indices module, the Input Data module, the calculation module, and the reporting module. Fig. 2 shows the different modules of CCPET as applied to the call centers.

The model definition module allows the definition of the evaluation models to be adopted in the evaluation, i.e. several models can be used through the assessment. The user needs to define the name of the model and the number and names of dimensions for this model. For example 6 dimensions in the case of the Delone and Mclean model, seven dimensions for the Heeks' Design Reality Gap model, three dimensions for the NAQC [7], and in the case of a single dimension model (SDM) the number of dimensions is one without any categorization. This module also defines the indicators for each dimension and the relative weight of the dimension.

Two performance indices are defined for the performance indices module: the success index and the Gap Index. The user selects the index to be used in the analysis. The Input Data module allows the user to provide the system with the required data: the values of the different indicators, the value of the design values or benchmark values, and the values of the weights used for the different dimensions. The calculation module calculates the performance index based on the Input Data and the choices of the user.

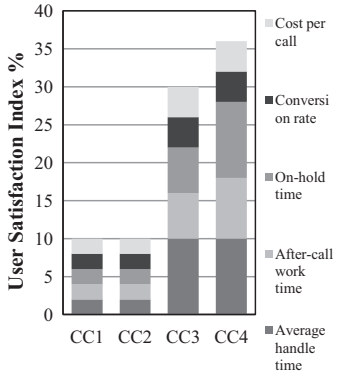

Figure 7 Distribution of user satisfaction success index indicators.

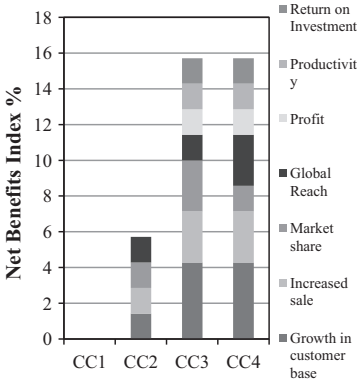

Figure 8 Distribution of net benefits success index indicators.

4.2. Analytical results using success index and Gap Index for Delone and Mclean and Heeks' Design Reality Gap model models

- In this section, the performance evaluation for four call centers using both the Delone and Mclean model and Heeks' Design Reality Gap model is studied. The objective of this section is to apply the two models studied in this paper, and analyze the results obtained.
- Indicators values calculation: for hard indicators the data for the four call centers were collected monthly for one year. Four sets of surveys have been conducted for 100 users using IVR, and phone calls. Aggregation of the results is based on averaging the values collected for each indicator.

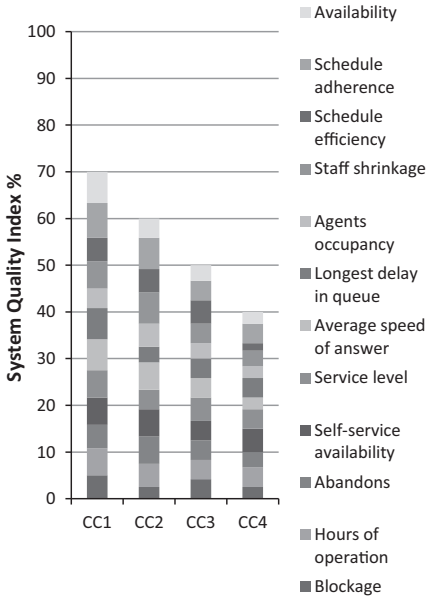

Figure 9 Distribution of system quality Gap Index indicators.

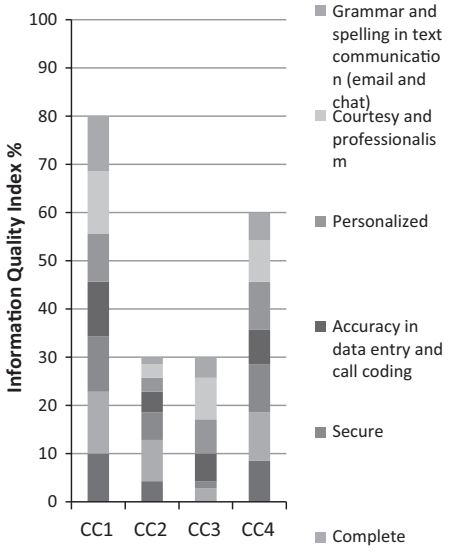

Figure 10 Distribution of information quality Gap Index indicators.

- CCPET allows to define the indicators used, entering the values, and the calculation of the average value per indicator.
- The tool also allows the calculation of the two indexes success and Gap Index.
- Table 18 depicts the resulting data for the four call centers under study for the Delone and Mclean model. The two indices proposed are calculated, for example for dimension D1, GI for D1 is 18.67%, the overall Gap Index for call center 1 is 84.89%, while the success index for the same call center is 15.11%. it is clear from the data collected to this call center that the performance of the call center for all the dimensions of Heeks is poor, this means that the design of this call center from a technology and skills needed to operate the call center needs a serious revision.
- Table 19 depicts the results of calculations of the case of applying Heeks' Design Reality Gap model. It is to be noted that the resulting overall Gap Index and success index are equal to those resulting from the Delone and Mclean model; this is due to using the same parameters in the two models. Moreover, the calculation of the Gap Index is not based on benchmarking values. This interprets the value of the gap dimension to be equal to (100 – Success Dimension). It is clear that the main strength for the Design Reality Gap model is to use Benchmarking values to reflect the real gap.

4.3. Call center evaluation using Delone and Mclean model

In this section, the success index as well as the Gap Index for the Delone and Mclean model is calculated. Applying the Design Reality Gap model in the Delone and Mclean model means that the same approach proposed by Heeks was applied to the dimensions proposed by the Delone and Mclean model. Figs. 3–8 depict the Gap Index distribution for the different indicators defined for the six dimensions of the Delone and Mclean model. Call center 4 as shown in Fig. 3 is the top center in the system quality dimension index. Call centers 2 and 3 as shown in Fig. 4 have the best performance for the Information quality dimension. For the net benefits dimension, the call center 3 has the lowest value of gap as shown in Fig. 8. Similarly, Figs. 9–14 show the distribution of the Gap Index for the Delone and Mclean model. Results using the Gap Index confirm the results of the success index; call center 4 has the lowest system quality dimension Gap Index.

4.4. Call center evaluation using Heeks' Design Reality Gap model

In this section, the performance evaluation for the four call centers using Heeks' Design Reality Gap model is implemented. CCGI in its simplest form was calculated as the summation of the Design Reality Gap model dimensions' index (Review Section 3 of "Call Center Gap Index" and Eq. (2)).

Figs. 15–21 depict the Gap Index distribution for the different indicators for each of the seven dimensions of the Heeks' Design Reality Gap model. For example, Fig. 15 shows the distribution of the information gap dimension function of the indicators defined for this dimension. For the

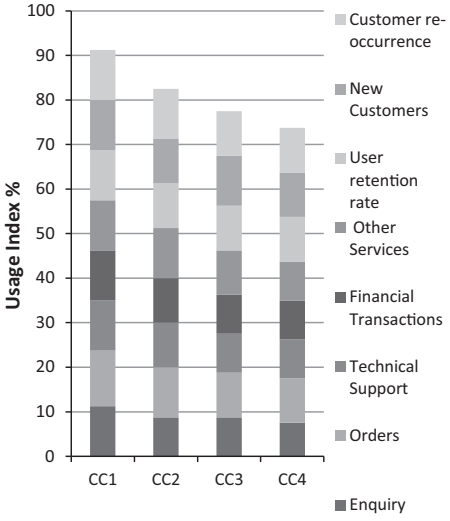

Figure 12 Distribution of usage Gap Index indicators.

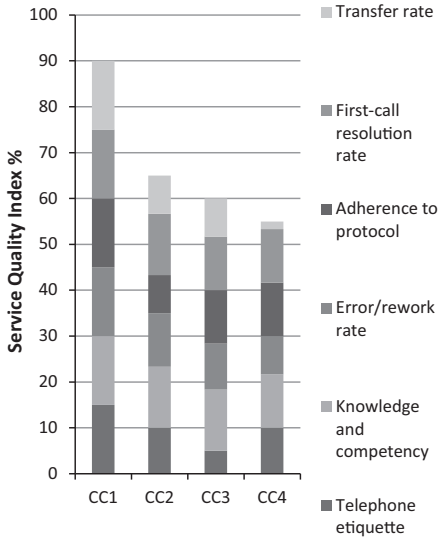

Figure 11 Distribution of service quality Gap Index indicators.

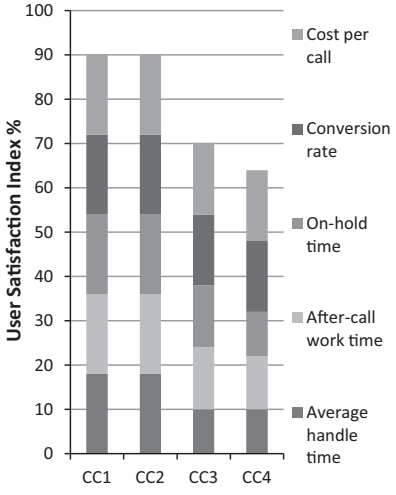

Figure 13 Distribution of user satisfaction Gap Index indicators.

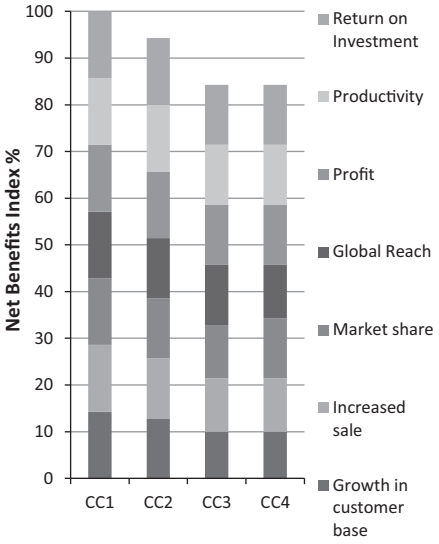

Figure 14 Distribution of net benefits Gap Index indicators.

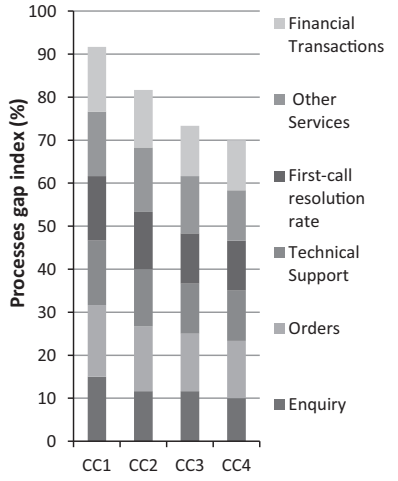

Figure 17 Distribution of processes Gap Index indicator.

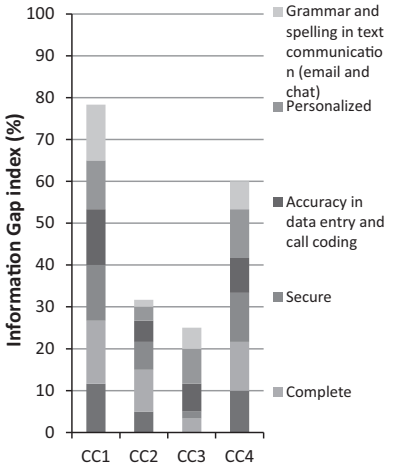

Figure 15 Distribution of information Gap Index indicator.

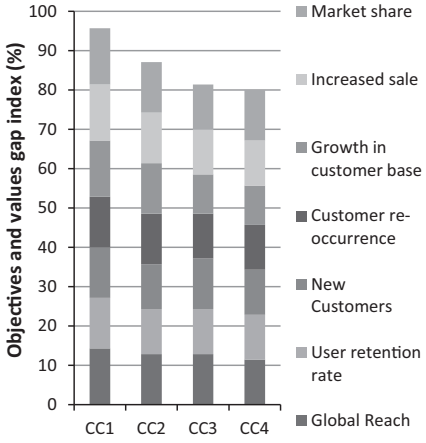

Figure 18 Distribution of objectives and values Gap Index indicator.

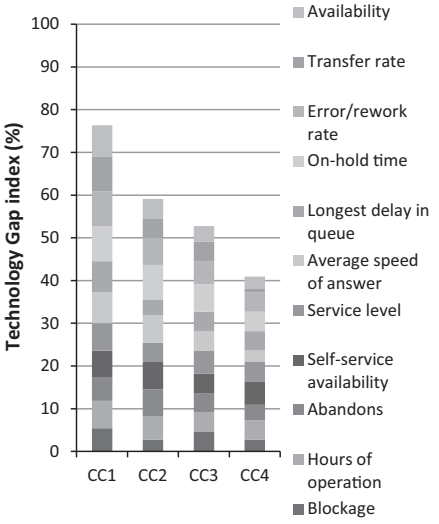

Figure 16 Distribution of technology Gap Index indicator.

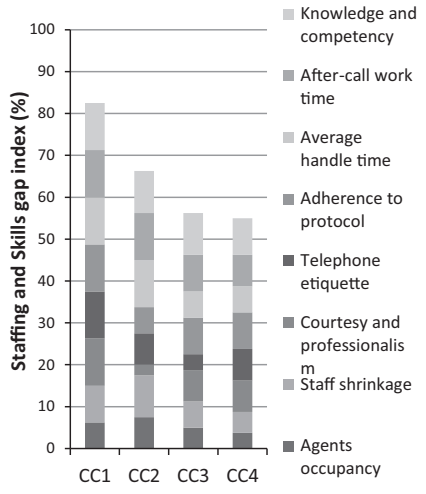

Figure 19 Distribution of staffing and skills Gap Index indicator.

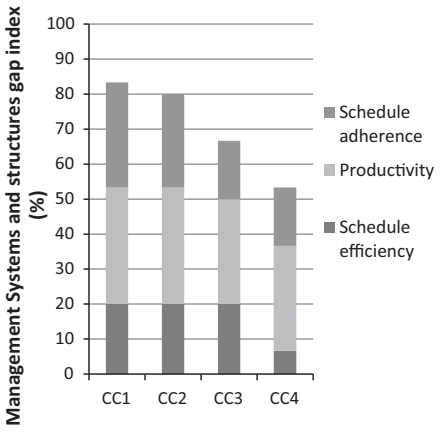

Figure 20 Distribution of management systems and structures Gap Index indicator.

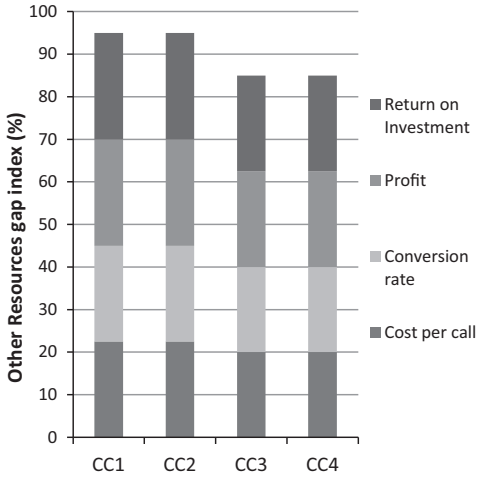

Figure 21 Distribution of other resources Gap Index indicator.

sub-dimension indicators are proposed for each of the seven dimensions. Six indicators are defined for the information gap dimension. The overall Gap Index for dimension information gap for call center 1 is 78%. The higher the value of the Gap Index the lower is the performance of the call center. From Fig. 15, it can be deduced that call center 3 is the best call center from the information dimension. Call center 2 has the lowest value of gap for the blockage indicator under technology dimension as shown in Fig. 16.

4.5. Comparison of performance and gap indices for call centers using both Delone and Mclean model and Heeks' Design Reality Gap model

In this section, a comparison is made for the two models under study using the two performance indices used: the performance index and the Gap Index. Call center 1 is the highest performance call center according to Delone and Mclean model and Heeks' Design Reality Gap model. Figs. 22 and 23 represent the analysis for the Delone and Mclean model, while Figs. 24 and 25 represent the results for the Heeks' Design Reality Gap model.

Analyzing these results and comparing it with the results obtained for the Delone and Mclean model, a number of observations can be deduced as follows:

- Application of success index and Gap Index for the two models is valid.
- The two models are providing the same results in case the reality value used for Heeks' Design Reality Gap model is equal to 100.
- In order to get the maximum benefit of the Heeks' Design Reality Gap model, the real benchmark value for the indicators should be used otherwise the two models are very much similar.
- The use of an overall index for the call center whether success index or Gap Index is providing the top management an overall figure that reflects the overall performance of the call centers.
- Grouping indicators under one dimension whether in the Delone and Mclean model or Heeks' Design Reality Gap model allows the identification of the area or dimension that faces challenges. The grouping model should be aligned with the priorities the call center provider is setting.
- Proposing success index and Gap Index at the level of the dimension allows analyzing the issues related to a certain dimension, i.e. diagnosing the points of weakness and strength for the dimension.

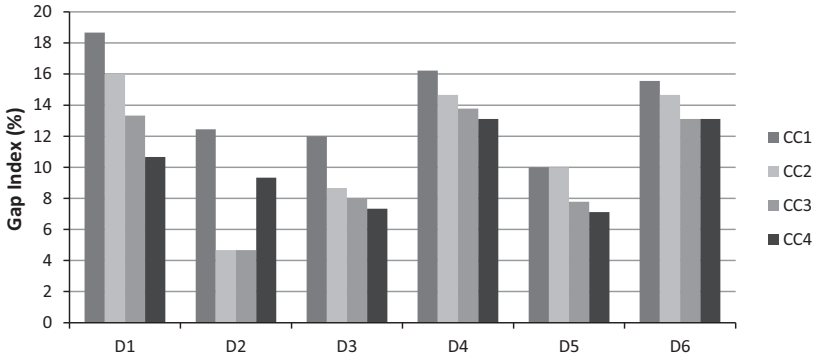

Figure 22 D&M Gap Index distribution by dimension.

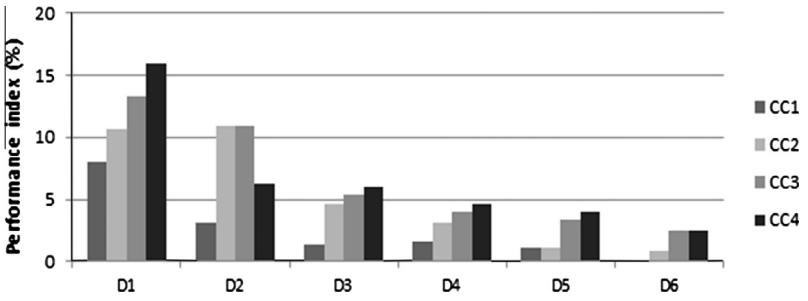

Figure 23 D&M performance distribution index by dimension.

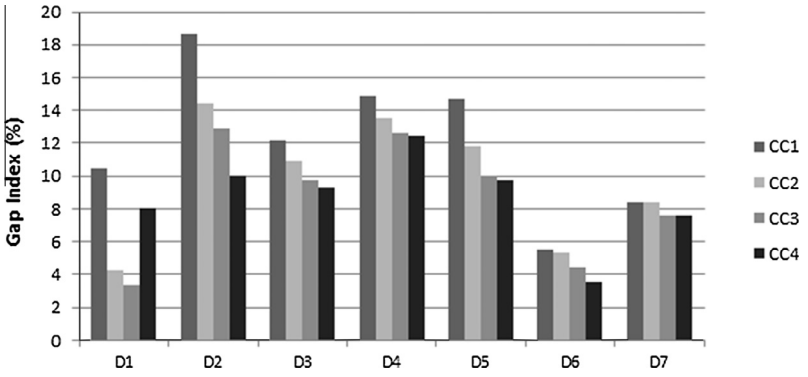

Figure 24 Heeks Gap Index distribution by dimension.

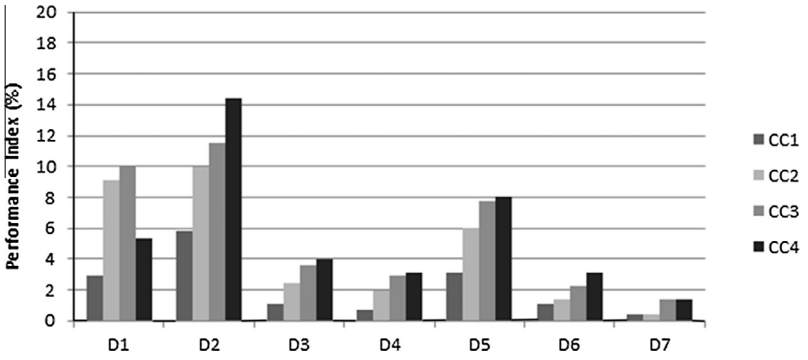

Figure 25 Heeks performance index distribution by dimension.

- The call centers' scorecard can be composed of 14 values in the case of Delone and Mclean model and 16 values in the case of Heeks' Design Reality as follows:
  - o The success index.
  - o The Gap Index (measured by the benchmark values).
  - o The dimensions indices/gap values (6 figures in the case of Delone and Mclean model and 7 figures in the case of Heeks' Design Reality model).

- The scorecard is a simple way to monitor such complex systems such as call centers. A maximum of 16 values are monitored periodically by the top management.

5. Conclusion and future research

This paper studies the performance evaluation techniques for information systems with the call centers as a case study. Two models have been used, the Delone & Mclean model and the Design Reality Gap model.

The two levels evaluation technique used is summarized as follows: the first level is simply not to use any modeling technique, so using the indicators for the call centers as if they are mapped to one single dimension, and you get the system to calculate your success index and the Gap Index. If the results are satisfactory then actually you do not need to get into more detailed analysis. If results are not satisfactory then you need to select one of the two models the Delone and Mclean model or Heeks' Design Reality Gap model in order to analyze the overall result obtained from the first step. This will allow identifying which dimension is impacting call center performance. So, first level means to use the tool without any model to get the overall call center performance.

The work presented in this paper is a continuation to our previous report [14], which has shown the applicability of Delone and Mclean model to call centers, and introduced the

success index to measure the performance of each dimension and the overall index.

The overall approach for the two papers is the same, summarized in the following three main steps:

- The modeling using Heeks' Design Reality Gap model.
- The modeling using Delone and Mclean model.
- Measuring using the success index and Gap Index, and the analysis using the CCPET.

In this paper and our previous report [14] the models introduced by Delone and Mclean model and Heeks' Design Reality Gap model were applied without modification; hence the figures are the same as these figures represent the two models.

The Design Reality Gap model introduced by Heeks was used in this paper to evaluate the performance of call centers. A new metric is used for measuring the performance "Gap Index".

A comparison is made between the Delone and Mclean model and Heeks model. A tool is developed to facilitate the evaluation process and to be used to analyze different modeling techniques.

The main benefit of the Design Reality Gap model is to measure the gap, the gap between the design value and the real value during the operation and implementation of the information system. The gap is measured for every dimension; the overall Gap Index gives an overall metric for the call center. Use of Benchmark values for the Heeks' Design Reality Gap model gives the call centers mangers a method to benchmark their centers.

The work demonstrates that using Heeks' Design Reality Gap model and/or Delone model can be a feasible technique to model call centers. Gap Index is a better metric to measure the performance especially when Industry Benchmark values are used.

As a conclusion of this research, it was found that the two models reflect the same results when no benchmark values are used for the Heeks' Design Reality model, especially that the same indicators are used. Hence, it is really crucial in the case of applying Heeks' Design Reality model to calculate the Gap Index based on the Industry Benchmark values for the different indicators. Two indices are defined to calculate the performance of the call center namely the success index and the Gap Index. Indicators grouping per dimension and calculation of an index on the level of dimension make it clear for the decision maker to see the scorecard for the call center. The scorecard will be composed of the success index, the Gap Index, and the success index per dimension (6 or 7 numbers based on the model used Delone and Mclean or Heeks' Design Reality model) and the Gap Index per dimension (6 or 7 numbers based on the model used). This scorecard should be generated monthly so that top managers monitor continuously the performance of their call centers. An evaluation tool has been developed to allow call centers managers to evaluate the performance of their call centers in a systematic analytical approach. Results showed the importance of using information systems models to evaluate complex systems as call centers. The models used allow identifying the dimensions for the call centers that are facing challenges, together with an identification of the individual indicators in these dimensions that are causing the poor performance of the call center.

As future work, a study for specific indicators related to specific verticals may enhance the analysis of the call centers specialized in specific field, for example includes financial sectors, or health sectors. This may result in adding a specific dimension that is a vertical specific to include indicators related to the vertical. Moreover, analyzing the association of different weights for the model is based on numerical analysis, more research should be done in this area in order to identify the proper weights for each dimension, and whether there is any correlation between these weights and the type of the product or service provided by the call center. Also, there is a need to develop an automated assessment tool that can be used by decision makers to evaluate and benchmark the call centers. One important characteristic of this tool is that it could be integrated to the existing call center monitoring systems, allowing seamless communication and exchange of data between the tool developed (similar to CCPET) and the monitoring system in place.

References

[1] Duening Thomas N, Click Rick L. Essentials of business process outsourcing. John Wiley & Sons, Inc.; 2005.
[2] Ministry of Communications and Information Technology Egypt. <http://www.mcit.gov.eg>.
[3] Ganapathy K. Telehealth in India: the Apollo contribution and an overview. Apollo Med 2014;11(3):201–7.
[4] Bapat V, Pruitte EB, Jr. Using simulation in call centers. In: 1998 winter simulation conference. Proceedings, IEEE, Piscataway, NJ, USA; 1998. p. 1395–99.
[5] Aguir S, Karaesmen Fikri, Akşin O Zeynep, Chauvet Fabrice. The impact of retrials on call center performance. OR Spectrum 2004;26(3):353–76.
[6] Aksin Z, Armony Mor, Vijay M. The modern call center: a multi-disciplinary perspective on operations management research. Prod Oper Manage 2007;16(6):665–88.
[7] NAQC issue paper. North American Quitline Consortium, 2010. Call center metrics: best practices in performance measurement and management to maximize quitline efficiency and quality. <http://c.ymcdn.com/sites/www.naquitline.org/resource/resmgr/issue_papers/callcentermetricspaperbestpr.pdf>.
[8] Jaiswal, Kumar Anand. Customer satisfaction and service quality measurement in Indian call centres. Managing Service Qual 2008;18 4:405–16.
[9] Delone W, Mclean E. Information systems success: the quest for the dependent variable. Inform Syst Res 1992;3(1):60–95.
[10] Heeks R. Information systems and developing countries: failure, success, and local improvisations. Inform Soc 2002;18(2):101–12.
[11] Delone W, Mclean E. Measuring e-commerce success: applying the Delone & Mclean information systems success model. Int J Electron Commerce 2004;9(1):31–47.
[12] Heeks R. Most e-government-for-development projects fail: how can risks be reduced? Manchester: Institute for Development Policy and Management, University of Manchester; 2003.
[13] Hawari A, Heeks R. Explaining ERP failure in a developing country: a Jordanian case study. J Enterprise Inform Manage 2010;23(2):135–60.
[14] Baraka Hesham A, Baraka Hoda A, EL-Gamily Islam H. Assessing call centers success: a validation of the Delone and Mclean model for information system. Egyptian Inform J 2013;14(2):99–108.
[15] Anton, Jon, Gustin, David. Call center benchmarking: how good is. Purdue University Press e-books. Book 1; 2000.