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Development of an Assessment Tool for Maintenance Management in Public Schools in Saudi Arabia

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Abstract

Saudi Arabia is witnessing unprecedented development in many aspects. Most of this development is realized in the construction industry. These large facilities require extensive maintenance programs in order to preserve these facilities in running conditions as were originally intended. The purpose of this research is to formalize the development of an assessment tool for maintenance management for facilities of public schools in Saudi Arabia. The methodology adopted in this research consists of two parts. The first part employs the holistic system approach to maintenance to identify quality criteria for incorporation in the developed an assessment tool. This part uses ISO 9001:2000 standards, extensive literature review in addition to a series of interviews with experts in maintenance. The second part involves the assessment of the identified quality criteria through conducting in depth, well-structured survey of experts in the maintenance of large public organizations. Based on the results obtained from the assessment, the assessment tool will be developed and applied to evaluate the current practice on a case study to test its practicality. The significance of this study stems from the fact that at the current time there is no such standards in Saudi Arabia and it is expected to help for prolonging the life cycle of such public facilities if applied consistently, improving the safety of occupants, providing high level of satisfaction for users of these facilities, Providing healthy and safe environment to improve productivity levels, Increasing retain on investment in public facilities.

Keywords Public schools, maintenance management, an Assessment tool, Saudi Arabia.

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Paper type Research paper.

Introduction:

Saudi Arabia is witnessing unprecedented development in many aspects. Most of this development is realized in the construction industry. Examples that illustrate this development involve constructing university campuses, health-care, residential, educational, commercial facilities, etc. These large facilities require extensive maintenance programs in order to preserve these facilities in running conditions as were originally intended. Climate conditions and use are different in Saudi Arabia than other parts of the world. Public organizations in the Kingdom are organizations which controlled by the government and faced different kinds of problems that results from a poor maintenance. As a result of that there is a need for development of an assessment tools for maintenance management to help assure of carrying out maintenance effectively and have consistent assessment among public schools. An assessment tool is a set of clauses (quality criteria) that must be met in maintaining public schools to ensure that the functionally of facilities is continued as was originally designed and demanded by users.

Statement of the Problem

The development of unsafe conditions at schools in the kingdom is a current hot issue and it concerns people, students, directors and government. Nowadays, public schools in the Kingdom suffer from many problems because of the lack of maintenance work at schools. As a result many fires have occurred in different schools and have caused the loss of life and property in these buildings. For example, 15 young girls died, and more than 50 were injured at a Mecca girls' school fire, in 2002.

Public schools in the Kingdom are organizations which are controlled by the government which provides a huge investment in these building. So they need an assessment tool for effective maintenance management throughout their life to ensure the efficient use of state and local funds to support these facilities. Also, students and teachers spend most of their time indoor at schools.

Poor maintenance at schools will affect the performance of students and teachers. Furthermore, for any maintenance department in any public school to achieve its goals, it is necessary to know the condition of their school: whether it is maintained in the right way or whether some action should be taken to improve the maintenance system.

Research Objectives

The objectives of this study are:

(١) To develop an assessment tool for maintenance management (a set of clauses (quality criteria) of facilities at public schools in Saudi Arabia. This involves:

a. Identifying measurable quality criteria.

b. Assessing the significance of the identified quality criteria by maintenance experts .

2) To conduct a case study to demonstrate the applicability and validity of the developed assessment tools for maintenance management.

Research Methodology

The first objective will be achieved through conducting the following research activities:

• Extensive review of literature, including ISO 9001:2000 to identify the main elements of the maintenance management standards (measurable quality criteria.(

• Conducting a pilot-study through interviews with five maintenance management experts of large public organizations, with at least 10 years of experience, to assess the proposed quality criteria to be used for maintenance management standards and solicit additional ones .

• Developing and administering a well-structured questionnaire (survey) to assess the identified measurable quality criteria to be used for the maintenance management standards in large public organizations. The questionnaire will consist of two parts:

Part I. includes general information about the maintenance management experts' organization, position, and years of experience.

Part II. Includes a listing of the quality criteria that will be assessed by the experts using Likert type scale to solicit their opinion on the desirability of including the quality criteria in the standards. The list of the quality criteria is expected to include: response time, continuous improvement, compliance with statutory requirements, trace-ability and continual improvement. Additional quality criteria may result from this survey. The target number of respondents is 40 to ensure reliability .

• Analyzing the obtained data statistically.

• Developing maintenance management standards. All assessed measurable quality criteria that are recommended by at least 67% of the survey respondents are included in the standard.

The second objective will be achieved through conducting the following research activities:

• Validate the standard using three experts in the maintenance management of large public organizations.

• Apply the developed maintenance management standards on case study in Saudi Arabia to evaluate and assess the existing maintenance management practices. In addition, the application of the standards is expected to provide additional validity for it by checking the consistency between the outcomes of the standards and the maintenance management practices .

• Review and update the standard in light of the above mentioned case study.

Literature Review

Many studies have been conducted to develop effective maintenance management systems for large public organizations. Examples include the following:

Howard (2006) reported on the best practices and actions for preventative maintenance for school buildings. He further stated that "without these practices, a preventive maintenance program may not fulfill its goals". These best practices include "inventory building components and assess their conditions, build the capacity for ranking maintenance projects and evaluating their costs, plan strategically for preventive maintenance in the long-and-short-term, structure a framework for operating a preventive maintenance program,

use tools to optimize the preventive maintenance program, advance the competence of maintenance workers and managers, and involve appropriate maintenance personnel in decision-making and in communicating buildings' needs". This study has not indicated how the effectiveness of these best practices can be judged to preserve the intended use of the school buildings.

The Department of Environmental Health & Safety and Code Enforcement, Florida (2009 – 2010) developed Custodial Standards which contain many categories such as clean campus committee, air fresheners/deodorants in school facilities, universal precautions, classrooms standards, restroom standards, gymnasiums standards, locker room standards, restrooms/locker areas/shower areas, administrative office/libraries/auditoriums standards, science and vocational/ technical laboratories standards, clinic rooms standards, corridors standards, entrances standards, and maintenance/storage rooms. Similarly, this effort does not illustrate a method to judge the results of their implementation.

Binggeli, (2010) in his paper, aimed to develop a custodial standard. His assessment to evaluate maintenance is based on five elements, namely cleanness, landscaping storage rooms, maintain structure systems and fire extinguisher.

Lavy and Bilbo (2008) in their paper have presented previous studies that showed that most school buildings in the State of Texas, USA are suffering from inadequate physical conditions. They conducted a survey of 320 school facilities managers to investigate the state of the facilities maintenance management in large public schools. They found that there is an inferior quality of facilities maintenance management and they usually do not incorporate students and staff in the maintenance plan. They recommended that the maintenance plan should be updated periodically for long-term planning to meet the requirements of the facility and its condition. This study has necessitated the need to develop maintenance management standards to ensure that the objectives from acquiring these school facilities are achieved Legat and Jurca (2004) presented essential trends in maintenance quality management system in relation to ISO 9000:2000. However they fail short of developing a standard for maintenance management.

Ali and Wan Mohamad (2009) in their paper, aimed to evaluate maintenance management in public hospitals in Malaysia. Their assessment is based on five categorises, namely leadership, Policies, plan and procedures, Training and orientation, monitoring and supervision; and service performance.

In his paper, Lam (2001) listed several quality criteria such as high reliability of services, quick response to maintenance problems, on-going improvement and compliance with statutory requirements. Although these quality criteria can be used in developing maintenance management standards, , however, has not assessed these criteria, or suggested a way for their utilization.

In his study, Alsyouf (2009) aimed at analysing the maintenance practices implemented in the Swedish industry. He presented several quality criteria that should be considered to analyse maintenance practices. The most important of these criteria included the implementation of computerized maintenance management systems (CMMS), recoding and analyzing failure data to improve causes of equipment failure, monitoring the rate of poor quality, monitoring spare parts and keeping cost at a level low, providing an inventory between machines and comparing maintenance tasks based on statistical modelling and condition monitoring.

The ISO 9000 series standards have evolved since the publication of the first version in 1987. This followed by a revision in 1994. Prior to 2000, the series has three standards which are ISO 9001, ISO 9002 and ISO 9003 and are adopted by organizations depending on the scope of certification requirements. In 2000 a new version has been published that combined the three ISO 9000 series in one integrated standard ISO 9001:2000. The new standard (ISO 9001:2000) has eight major sections and five of them specify the standards for quality criteria such as control of monitoring & measuring devices and identification & traceability as outlined in the International Organization for Standards cross reference map (2008).

Based on the above presented literature, it is evident that previous research has not addressed a holistic approach for developing the needed quality criteria for generic maintenance management standards. Furthermore, in Saudi Arabia, a search for published standards on maintenance management for large public facilities revealed the non-availability of such standards.

Such findings necessitate the need for developing maintenance management standards for facilities of large public organizations in Saudi Arabia.

Identification of the Measurable Quality Criteria

In Saudi Arabia, research for maintenance management systems for school buildings necessitates the need to develop assessment tools for maintenance management. Based on the review of literature, sixty two elements under twenty measurable quality criteria have been identified. These criteria have been classified into four main categories in order to group the common criteria which address the same issue (Baharum et al. (2006), Myeda et al. (2011) and Preiser et al. (1988). These categories are as follows :

(1)Technical Category

(2)Functional Category

(3) Behavioral Category

(4) Managerial Category

Data Analysis

This chapter presents the analysis of the data received from the 40 maintenance experts to the questionnaire survey. These experts are working in the Eastern Province of Saudi Arabia in different organization that related to maintenance management for public schools as shown in table below:

Table (1) Data Collection

Organizations	Surveys distributed	Surveys received
Saudi Aramco Government Built School	16	12
General Administration of Education in the Eastern Province (boys) – Construction Department	14	10
General Administration of Education in the Eastern Province (girls) - Construction Department	12	8
King Fahd University of Petroleum and Minerals (Maintenance Department)	10	6
Royal Commission for Jubail and Yanbu (RCJY)	6	4
Total	56	40

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To reflect the scale of the respondents' answers to the questionnaire, the importance index is classified as the following:

The importance index of 0–<12.5% is categorized as ''Extremely Not Important'' (ENI); 12.5–<37.5% is categorized as ''Not Important'' (NI); 37.5–<62.5% is categorized as ''Moderately Important'' (MI); 62.5–<87.5% is categorized as ''Important'' (I); and 87.5–100% is categorized as ''Extremely Important'' (EI) as illustrated in table (2).

Table (2) Significance of the Identified Quality Criteria

An Assessment Tool for Maintenance Management		Important	Important	Important	Important	Important	E(X)	SI %	Mean response
Technical Criteria									
Thermal Comfort		Overall average					4.4	89.0	EI
01.	Provision of comfortable temperature during summer throughout all spaces in the building.	26	10	2	2	0	4.5	90.0	EI
02.	Provision of comfortable temperature during winter throughout all spaces in the building.	20	16	4	0	0	4.4	88.0	EI
Acoustical Comfort		Overall average					4.0	80.0	I
01.	Provision of acoustical comfort throughout all spaces in the building.	20	6	8	4	2	4.0	79.0	I
02.	Provision of a system for regularly evaluating the quality of acoustical comfort through all spaces in the building.	14	6	10	10	0	3.6	72.0	MI
03.	Implementation of noise control and speech privacy measures wherever needed.	14	12	8	6	0	3.9	77.0	I
Visual Comfort		Overall average					4.5	85.0	EI
01.	Provision of good appearance and quality of	28	4	6	2	0	4.5	89.0	EI

	lighting as per identified standards.								
02.	Provision of a system for regularly evaluating the quality of lighting throughout all spaces in the building.	14	14	8	4	0	4.0	79.0	I
Indoor Air Quality		Overall average					4.2	85.0	I
01.	Implementation of periodical inspection of the HVAC system to comply with ASHRAE Standard 62.1.	24	10	4	2	0	4.4	88.0	EI
02.	Provision of a system for regularly evaluating indoor air quality throughout all spaces in the building including procedures for managing processes with potentially significant pollutant sources and procedures for responding to IAQ complaints.	20	6	10	4	0	4.1	81.0	I
Safety and Security		Overall average					4.3	86.7	I
01.	Proof of compliance with the local safety statutory requirements.	24	16	0	0	0	4.6	92.0	EI
02.	Provision of a checklist for regular upkeep of safety systems throughout all spaces in the building as well as the playgrounds.	18	12	6	4	0	4.1	82.0	I
03.	Proof of evacuation drill at least once a year.	16	12	6	0	0	4.3	85.9	I
Cleanness (Arkansas Division,2009)		Overall average					4.3	85.9	I
01.	Implementation of preventive maintenance plan for cleanness.	26	4	12	0	0	4.3	86.7	I
02.	Ensure the overall cleanness throughout all spaces in the building.	20	12	6	2	0	4.3	85.0	I
03.	Support a recycling program during cleanness	14	12	8	6	0	3.9	77.0	I

	process.								
04.	Ensure the overall cleanness of laboratories including removal foreign materials.	18	10	10	0	2	4.1	81.0	I
05.	Provision of a system for regularly evaluating the quality of cleanness and custodial programs throughout all spaces (including bathrooms) in the building.	16	10	8	2	2	3.9	78.9	I
Landscaping		Overall average					3.9	79.0	I
01.	Implementation of periodical checking for both indoor and outdoor plants.	24	8	8	4	2	4.0	80.9	I
02.	Provision of a system for regularly evaluating the quality of landscaping throughout all spaces in the building.	16	10	12	2	2	3.9	77.1	I
Structural Systems		Overall average					4.4	88.0	EI
01.	Implementation of periodical checking of structural systems in the building as well as removal of any overload.	28	6	2	4	0	4.5	89.0	EI
02.	Provision of a system for regularly evaluating the quality of maintaining structural systems throughout all spaces in the building.	24	10	2	2	2	4.3	86.0	I
Mechanical, Electrical and Plumbing Systems		Overall average					4.5	89.0	EI
01.	Implementation of preventive maintenance of the mechanical and electrical systems.	30	4	4	2	0	4.6	91.0	EI
02.	Implementation of periodical inspection of the water supply / sanitary systems.	30	8	0	2	0	4.7	93.0	EI
03.	Provision of a system for regularly checking the availability of spare parts required and its efficient	24	6	10	0	0	4.4	87.0	I

	use.								
04.	Provision of a system for regularly evaluating the quality of drinking water.	32	4	4	0	0	4.7	94.0	EI
Functional Criteria									
Human Factors		Overall average					4.3	86.7	I
01.	Implementation of guidelines to instruct maintenance staff to minimize interruption of educational process.	16	14	6	4	0	4.1	81.0	I
02.	Availability of maintenance staff to provide any assistance required and easy to contact them and they understand user's requirements.	22	10	8	0	0	4.4	87.0	I
Storage		Overall average					4.0	80.9	I
01.	Provision of enough storage space for maintenance supplies \spare parts as well as required inventory.	16	12	6	8	0	3.9	77.1	I
02.	Provision of sealable, labeled containers for storage chemical products and supplies.	24	4	8	6	0	4.1	81.9	I
Space Layout and Furniture Quality		Overall average					4.1	79.5	I
01.	Implementation of periodical checking of the availability of teaching tools and making sure that it ready for use.	18	10	6	4	0	4.1	82.1	I
02.	Implementation of periodical checking of the furniture arrangement in the classrooms and making sure that they are enough for students and teachers especially at the beginning of every semester.	20	10	6	2	2	4.1	82.0	I
03.	Implementation of periodical checking of the	18	6	6	8	2	3.8	75.0	I

	adequacy and capacity of teacher's offices and computer laboratories.								
04.	Provision of a system for regularly evaluating the arrangements of furniture in the classrooms and teacher's office.	18	8	6	8	0	3.9	78.0	I
Accessibility & Parking Space		Overall average					3.9	78.2	I
01.	Implementation of periodical checking of the function and position of all signage.	16	6	10	4	2	3.8	75.8	I
02.	Implementation of periodical checking of the ease of identifying and reaching the building's main entrance.	16	4	12	4	2	3.7	74.7	MI
03.	Implementation of periodical checking of the ease by which visitors can locate rooms in the building.	14	2	14	10	0	3.5	70.0	MI
04.	Implementation of periodical checking of the availability of emergency signage.	18	10	10	2	0	4.1	82.0	I
05.	Proximity of the building to car parking spaces.	20	4	14	2	2	3.9	78.1	I
06.	Sufficiency of car parking spaces.	20	8	12	0	0	4.2	84.0	I
07.	Availability of ease of access to handicaps.	24	6	8	2	0	4.3	86.0	I
08.	Provision of a system for regularly evaluating the quality of accessibility function.	18	2	12	6	0	3.8	76.8	I
Behavioral Criteria									
Image and Environmental Perception		Overall average					4.0	81.0	I
01.	Implementation of periodical checking for quality of interior and exterior finishing throughout all spaces in the building.	20	10	8	0	2	4.2	83.0	I
02.	Provision of a system for regularly evaluating the	18	8	8	4	2	3.9	78.0	I

	quality of interior and exterior finishing throughout all spaces in the building.								
Managerial Criteria									
Maintenance Strategy(Cholasuke and Bhardwa (2004))		Overall average					4.1	83.6	I
01.	The maintenance department must have a process for identifying the most effective maintenance strategy\tasks.	22	8	6	4	0	4.2	84.0	I
02.	The maintenance management department has a quality manual that documented maintenance quality policy, objective and control and operation procedures.	20	10	4	6	0	4.1	82.0	I
03.	The maintenance department must have comprehensive databases for each school including building systems and equipment with information such as location, warranty information, and replacement parts.	26	8	0	4	2	4.3	86.0	I
Management Responsibilities		Overall average					4.2	84.6	I
01.	Maintenance mission stated and known to everyone in the organization.	16	16	4	2	0	4.2	84.2	I
02.	Existence of clear organization structure.	22	8	4	6	0	4.2	83.0	I
03.	Top management must check that responsibilities and authorities are identified to all staffs.	24	10	2	2	2	4.3	86.0	I
Resource Management		Overall average					4.3	85	I
01.	The maintenance department identified the resources needed to support the maintenance effectiveness and achieve customer satisfaction.	20	10	8	2	0	4.2	84.0	I

02.	Staffs who related to provide the services must be competent with good skills, education, training, and experience and sufficient in with numbers.	26	6	6	2	0	4.4	88.0	EI
03.	The maintenance department must provide an appropriate infrastructure for maintenance staff to carry out the required services.	22	10	4	4	0	4.3	85.0	I
Service Realizations(Lwarere and lawal,2011)		Overall average					4.0	80.4	I
01.	The maintenance department must have a planning function for delivering the required services.	22	8	10	0	0	4.3	86.0	I
02.	The maintenance department must identify service requirements which include customer requirements specified, regulatory requirements, and any necessary requirements.	18	8	12	4	0	4.0	79.0	I
03.	The maintenance department must have a clear process for delivering services and its traceability.	20	8	10	6	0	4.0	79.1	I
04.	Implementation of a work-order system that provided high reliability and quality of services.	20	4	8	8	0	3.9	78.0	I
05.	The maintenance department must have a plan to reduce deferred maintenance that includes a list of major deferred maintenance projects and estimates of the cost for reducing the existing backlog.	16	8	14	4	0	3.9	77.1	I
Measurement, Analysis and Improvement		Overall average					4.1	82.0	I
01.	Implementation of IT support including CMMs to handle information related to customer requirement or perception such as customer	20	6	6	8	0	4.0	79.0	I

	satisfaction surveys.								
02.	The maintenance department must have a system for maintenance performance measurement that has maintenance respond time and its measures.	20	4	16	2	0	4.0	80.0	I
03.	The maintenance department must have internal audits with its criteria and methods.	20	4	14	2	0	4.1	81.0	I
04.	On-going improvement through established quality policy, analyze data and management review.	22	6	4	8	0	4.1	81.0	I
Maintenance Financing(Lawal and Adeyemo,2004&) Al-Najjar, B. (1996))		Overall average					4.3	87.5	EI
01.	Implementation of a good budgetary planning and control.	24	10	4	2	0	4.4	88.0	EI
02.	Ability to select adequate and effective outsourcing contracts and effectively coordinate with them.	26	10	4	4	0	4.3	86.4	EI

Development of an Assessment Tool for Maintenance Management in Public Schools in Saudi Arabia: A case study (Abdlrhman Binalqasem School)

Based on the results obtained from the questionnaire survey, an assessment tool for maintenance management for facilities of public schools in Saudi Arabia have been developed and validated by three maintenance experts who are working in the Eastern Province of Saudi Arabia, these are:

An assessment Tool Implemented Through the use of Devices

An assessment Tool Measured by Walkthrough Inspection

An assessment Tool Measured by User Satisfaction Survey

An assessment Tool Measured by Staff Opinion Survey

An assessment Tool Measured by provision of a documented system

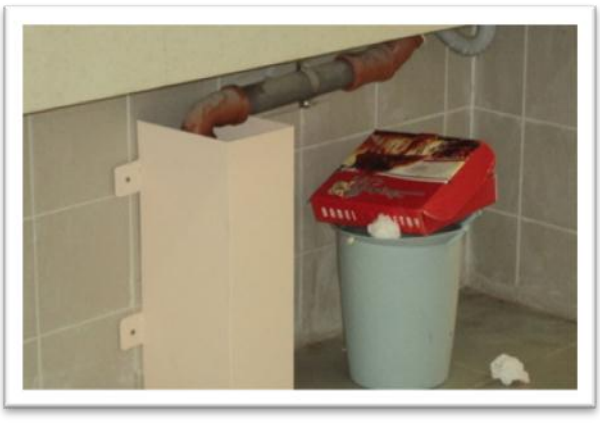
The developed assessment tools for maintenance management were applied at a public school in the Eastern Province of Saudi Arabia; to evaluate and assess the existing maintenance management practices and to provide validation for it by checking the consistency between the outcomes of the assessment tools and the maintenance management practices. Furthermore, additional quality criteria were obtained whilst conducting the case study.

Physical Environment

The IEQ elements, namely interior air temperature, humidity, sound pressure level, luminance, and carbon dioxide levels were measured in the selected classrooms and teachers' offices. The outdoor weather conditions were similar during measurements at 84.7°F and 61.12% relative humidity. Temperature was within the permissible level of 22-27°C, with the average in classrooms at 26.3°C, but teachers' offices at 31.1°C were not. Similarly, relative humidity (standard is between 30-60%) was at 38.8% in classrooms and 30 % in teachers' offices. The noise level in classrooms was 77 dbA and 73 dbA in teachers' offices. The standard for noise levels is 35dbA, proving that both classrooms and teachers' offices exceed recommended noise levels. Similarly, luminance level (standard for classroom is 538.2 lux) was 755 in classrooms and 790 in teachers' offices. Finally indoor carbon dioxide concentrations were within the permissible level (< 1000 ppm).

Walkthrough Inspection

Walkthrough Inspection is one of the most important methods to implement several measurable quality criteria in the developed assessment tool. It reflects the current state related to certain criteria, such as



cleanness, landscaping, storage, space layout, furniture quality, accessibility and parking space. During a walkthrough inspection in the school, it was noted that some of the criteria and requirements of assessment tools were met. These criteria as shown in table 4-2 include adequacy and capacity of teachers' offices and computer laboratories, availability of teaching tools and their readiness for use, ease of location of rooms in the building by visitors and the high quality of interior and exterior finishing. However, it was observed that the school suffered from some problems, such as the poor level of overall cleanliness throughout all spaces in the building and the lack of support for a recycling program. Also, there were no plants in the school. Furthermore, there were no notices to show the occupants or visitors the emergency exits, thus making it difficult to locate them. Also, it was difficult to identify and reach the fire alarm system as shown in Figures 1 and 2.

Figure (1) Abdlrhmuan Binalqasem School - Unneeded Furniture

Occupants' Perceptions

To implement the developed assessment tools, we were required to measure user satisfaction (Prakash, P., 2005). The occupants' assessment of the building could provide valuable information about its performance and satisfaction levels. A total of 50 participants were expected and 42 responded. The questionnaire survey consisted of 24 questions. At the same time, as the survey was distributed to the students, a survey was also distributed to the teachers .

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The respondents to the questionnaire were required to comment on their degree of satisfaction (how do they feel) with the listed elements of performance by selecting one of four evaluation terms provided. The evaluation terms used, along with their corresponding weight, were "Strongly Satisfied" with 4 points, "Satisfied" with 3 points, "Dissatisfied" with 2 points, and "Strongly Dissatisfied" with 1 point. The mean response from the student and teachers who completed the survey indicated that they were "Dissatisfied" with five out of the six performance elements. Some of the most noteworthy trends in the Table which received a complete negative response, "Strongly Dissatisfied", were observed in the categories of periodical checking for both indoor and outdoor plants, the availability of maintenance staff to provide assistance when required, difficulty of contacting them and inability to understand the users' requirements, provision of enough storage space for maintenance supplies/spare parts as well as a required inventory, provision of sealable, labeled containers for storage of chemical products and supplies, ease of identifying and reaching the building's main entrance, availability of emergency signage, sufficiency of car parking spaces, availability of ease of access for the handicapped and provision of high quality and reliable maintenance services required.

Table (3) Satisfaction Survey for Occupancy's Abdlrhmuan Binalqasem School

Elements of Performance		**Evaluation Terms**				**E(X)**	**Mean responses**
		SS	**S**	**D**	**SD**		
01.	Provision of comfortable temperature throughout all spaces in the building.	0	15	17	17	**2.0**	**D**
02.	Provision of acoustical comfort throughout all spaces in the building.	4	14	21	10	**2.2**	**D**
03.	Provision of good appearance and quality of lighting.	10	14	17	1	**2.8**	**S**

04.	Provision of indoor air quality.	7	10	17	7	**2.4**	**D**
05.	Provision of high reliability and quality of safety and security requirements.	0	14	28	7	**2.1**	**D**
06.	Ease to identify and reach fire alarm system.	8	11	20	10	**2.3**	**D**
07.	Adequacy of fire safety systems in the building (fire extinguishers, smoke detectors, etc).	8	7	14	10	**2.3**	**D**
08.	The overall cleanness throughout all spaces in the building.	14	16	6	7	**2.9**	**S**
09.	Periodical checking for both indoor and outdoor plants.	0	2	8	32	**1.3**	**SD**
10.	Quality of drinking water.	0	0	28	14	**1.7**	**D**
11.	Availability of maintenance staff to provide any assistance required and easy to contact them and they understand user's requirements.	0	7	7	35	**1.4**	**SD**
12.	Provision of enough storage space for maintenance supplies \spare parts as well as required inventory.	0	4	10	28	**1.4**	**SD**
13.	Provision of sealable, labeled containers for storage chemical products and supplies.	0	2	7	33	**1.3**	**SD**
14.	Quality of furniture arrangement and availability of teaching tools.	0	28	21	0	**2.6**	**D**
15.	Adequacy and capacity of teacher's offices and computer laboratories.	0	21	21	0	**2.5**	**S**

16.	Quality of accessibility function and position of all signage.	21	21	14	0	**3.1**	**D**
17.	Ease of identifying and reaching the building's main entrance.	2	2	8	30	**1.4**	**SD**
18.	Visitors can locate rooms in the building easily.	7	35	7	7	**2.8**	**S**
19.	Availability of emergency signage.	0	2	11	29	**1.4**	**SD**
20.	Proximity of the building to car parking spaces.	8	10	7	21	**2.1**	**D**
21.	Sufficiency of car parking spaces.	2	3	3	33	**1.4**	**SD**
22.	Availability of ease of access to handicaps.	0	2	9	31	**1.3**	**SD**
23.	Quality of interior and exterior finishing throughout all spaces in the building.	7	28	14	0	**2.9**	**S**
24.	Provision of high reliability and quality of maintenance services required.	0	2	9	31	**1.3**	**SD**

Discussion of the Results

While applying the assessment tools to the case study to test their applicability, some criteria have been highlighted and these include:

• Provision of awareness lectures for students about cleanliness, safety and evacuation training .

•The Ministry of Education, in cooperation with the Civil Defense, should conduct a periodical field survey to assess the maintenance and safety requirements in schools, especially schools buildings that are rented.

It was noticed that there is a consistency between the outcomes of the different methods that have been used to implement the developed assessment tool.

Conclusion

The following conclusions were reached based on this research:

1. Surveying and synthesizing various knowledge areas on maintenance management documented in international literature sources and ISO standard 9001:2000 resulted in identifying sixty-two elements under twenty measurable quality criteria classified and grouped under four main categories, namely technical, functional, behavioral and managerial.

2. A questionnaire survey was developed, for the purpose of the assessment of the identified measurable quality criteria. The sample size which was determined by using equations is 25. However, the distribution survey was 56 and received was 40 which filled by maintenance experts who are working in six different organizations that related to maintenance management for public schools in the Eastern Province of Saudi Arabia.

3 . The assessment results illustrated that the sixty-two measurable quality criteria were assessed as "Extremely Important'' or "Important''. The assessment results indicated that the highest weight was given to the measurable quality criteria "thermal comfort'' with the important index of 89%. However, it was indicated that the lowest weight was given to the measurable quality criteria "Accessibility and Parking Space'' with the important index of 78.2%.

4 . Based on the survey results, five maintenance management measurement methods have been used to implement the developed assessment tool, namely implementation through the use of devices, implementation through walkthrough inspection, implementation through user satisfaction survey, implementation through staff opinion survey and implementation through the provision of a documented system .

5. The survey results indicated that most of the measurable quality criteria can be implemented through user satisfaction survey method, which includes thermal comfort, acoustical comfort, visual comfort, indoor air quality, cleanness, landscaping, human factors, storage, space layout and furniture quality, accessibility and parking space, image and environmental perception and service realizations. However,

the least methods have been used for implementation is the use of device method, only four measurable quality criteria implemented through it, namely thermal comfort, acoustical comfort, visual comfort and indoor air quality.

7. The developed assessment tool was tested by its implementation in a cases study which has been selected randomly in the Eastern Province of Saudi Arabia (Abdurrahman Binalqasem School). Information gathered in an interview with several engineers in the Office of the Ministry of Education in the Eastern Province established that maintenance work in public school occurs during impromptu visits to schools or at the school director's request. Also, there is no predictive maintenance program and they do not have buildings maintenance databases or maintenance management systems to evaluate their work.

8. During conducting the case study it was observed that public school suffered from several maintenance problems related to thermal comfort, acoustical comfort, indoor air quality, cleanness, landscaping, human factors, storage, space layout and furniture quality, accessibility and parking space and service realizations.

Reference:

1) Ali, M., and Wan Mohamad, W., (2009), "Practice Briefing Audit assessment of the facilities maintenance management in a public hospital in Malaysia," Journal of Facilities Management Vol. 7 No. 2, pp. 142-158.
2) Al-Najjar, B. (1996), "Total quality maintenance: an approach for continuous reduction in costs of quality products", Journal of Quality in Maintenance Engineering, Vol. 2, No. 3, pp. 4-20.
3) Alsyouf, I., (2009), "Maintenance practices in Swedish industries: Survey results," available online: www.elsevier.com/locate/ijpe.
4) Arkansas Division of Public School Academic Facilities and Transportation, (2009), "Public school facilities, maintenance, repair and Renovation Manual: Custodial and Maintenance

Manual, State of Arkansas, The Commission For Public School Academic Facilities and Transportation, USA, Technical Report, 56p.

5) Baharum, Z., Nawawi, A. and Saat, Z. (2009), "Assessment of Property Management Service Quality of Purpose Built Office Buildings", International Business Research, Vol. 2, No.1.
6) Binggeli, B. T., (2010), "Custodial standards: 2009-2010". Department of Environmental Health & Safety and Code Enforcement, Florida, USA, Technical Report, 50p.
7) Chanter, B. and Swallow, P. (2007), Building Maintenance Management, 2nd ed., Wiley-Blackwell, Oxford/Malden, MA.
8) Cholasuke, C., and Bhardwa, R., (2004), "The status of maintenance management in UK manufacturing organisations: results from a pilot survey,"Journal of Quality in Maintenance Engineering Volume 10 · Number 1, pp. 5-15.
9) Florida Department of Education, (2011) "Maintenance and operations administrative guidelines for school districts and community colleges", available online: www.fldoe.org/edfacil/manoguid.asp.
10) Howard, M., (2006), "Best practices maintenance plan for school buildings", State Department of Education, State of Idaho, Technical Report, September, 19p.
11) International Organization for Standards, (2008), ISO 9001, International Standard, Quality Management Systems Requirements, 4th Edition.
12) Lam, K. C. "Quality Assurance System for Quality Building Services Maintenance", Building Services Engineering Department, the Hong Kong Polytechnic University.
13) Lam, K. C. (2001), "Quality Assurance System for Quality Building Services Maintenance", National Conference Part 1, Paper 2, the Chartered Institution of Building Services Engineers.
14) Lavy, S., and Bilbo, D., (2009), "Facilities maintenance management practices in large public schools", Facilities, Vol. 27, No. 1/2, pp. 5-20.
15) Lawal, K.O., and Adeyemo, S.B., (2004), "Maintenance management performance appraisal in a public transport system in Nigeria", Journal of Science and Technology Research, 3: 34-41.

16) Legát, V. and Jurča, V., (2004), "Maintenance management using quality approach", Department for Quality and Dependability of Machines, Czech University of Agriculture, Czech Republic.
17) Lwarere, H., and Lawal, k. (2011), "Performance Measures of Maintenance of Public Facilities in Nigeria", Research Journal of Business Management.
18) Myeda, N., Kamaruzzaman, S., and Pitt, M., (2011), "Measuring the performance of office buildings maintenance management in Malaysia,"Journal of Facilities Management Vol. 9 No. 3, pp. 181-199.
19) Prakash, P., 2005, Effect of Indoor Environmental Quality on Occupants perception of performance: a comparative study, Florida University.
20) US Department of Education (2003a), "Planning Guide for Maintaining School Facilities", National Center for Education Statistics (NCES) 2003-347, Washington, DC, prepared by Szuba, T., Young, R. and the School Facilities Maintenance Task Force.