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A multi-phase systematic framework for performance appraisal of architectural design studio facilities

Mohammad A. Hassanain and Mohammed Alhaji Mohammed
Architectural Engineering Department,
King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia
Murat Cetin
Architecture Department, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Abstract

Purpose – The objectives of this paper are to present the development of an indicative multi-phase systematic framework for performance appraisal of architectural design studio facilities, and to present the findings of the post-occupancy conditions of an architectural design studio facility as a case study to demonstrate the applicability of the developed framework.

Design/methodology/approach – The authors carried out a number of activities. These include reviewing the published literature to address the significance of the architectural design studio as a resource for students majoring in architectural design, and ascertaining the significance of post-occupancy evaluation as a performance appraisal methodology in educational facilities. On the development of the proposed framework, the authors carried out a case study in one of the studios of the Architecture Department at King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. The authors utilized a series of data collection methods, including photographic documentation, observations through walkthrough inspection, questionnaires and interviews.

Findings – The developed framework consists of four phases. It entails identifying the performance requirements of the architectural design studio; collecting data – through conducting walkthrough inspection, questionnaire survey and interviews – to ascertain the present performance level of the architectural design studio; analyzing the data gathered from the preceding steps and subsequent reporting of findings on the degree of user satisfaction with the architectural design studio space and facilities; and developing a plan of actions in the form of recommendations to improve the conditions of the evaluated design studio. The case study served as a validation of the developed performance appraisal framework.

Originality/value – The architectural design studio is known to be the place where students majoring in architectural design generate, review and display their design projects. Previous research on the performance appraisal of educational facilities indicates that the comfort of the architectural design studio space is a significant aspect to be considered and maintained for the success of the architectural education process. The paper provides a systematic approach for evaluating the major performance requirements of an architectural design studio. It is of practical value to space planners, design professionals, facility managers and administrators involved in the planning, design, operation and management of such facilities.

Keywords Post occupancy evaluation, Framework, Performance appraisal, Design studio, Architecture, Performance management

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Introduction

Architectural graphics and design courses are the most primary set of courses in architectural education. The design studio in architectural education is one of the renowned and most commonly used spaces for developing, evaluating and exhibiting collections of art and design works (Duggan, 2004). Design studio environments serve both as a learning center and as a multi-faceted social setting. Students enrolled in design courses usually work in these spaces during their free times, in addition to their scheduled class hours (Demirbas and Demirkan, 2000). Architectural design studios are becoming a significant resource for enabling students to gain applied and theoretical knowledge that could be transformed with creativity into design solutions. Likewise, they also serve as a resource for developing and upgrading the level of practical knowledge especially computer-based drafting among the students of programs like architecture, architectural engineering and planning. Institutions around the world have become progressively more conscious of the need for continuous assessment of their educational facilities for architectural design. Recently, several studies have focused on exploring the role of the architectural design studio to prove its value as a significant resource to academic institutions. And, as a result, several schools of architecture or the built-environment are endeavoring now on means to improve their design studios in a way that respond to changes in the nature of higher education and different life style needs of the students (Duggan, 2004). Previous studies on performance appraisal of educational facilities indicate that comfort of architectural design space is a significant aspect to be considered and maintained for the success of the architectural education process. And as such, academic institutions are aiming to provide design studio spaces that are comfortable and conducive for collaborative learning. The objective of this paper is to present the development of a multi-phase systematic framework for performance appraisal of architectural design studio facilities. The paper also presents the findings of an assessment of the post-occupancy conditions of one of the architectural design studio facilities at King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, as a case study to demonstrate the applicability of the developed framework. This paper provides a systematic approach for evaluating the major performance requirements of architectural design studio facilities. It is of practical value to space planners, design professionals, facility managers and administrators involved in the planning, design, operation and management of architectural design studio facilities.

POE: a performance appraisal methodology in educational facilities

Post-occupancy evaluation (POE) is usually achieved through the efficient utilization of occupancy feedbacks from facility users to building services personnel. Leaman and Bordass (2001) indicate that occupants' feedback on the aspects they perceive to be important, if comprehended and utilized efficiently, can add value the operation of the facility without excessive efforts. Cohen *et al.* (2001) states that "such feedback will help making building better for their occupiers, individual users, and the environment; and provide a continuous stream of information for benchmarking and continuous improvement". POE is considered by Hadjri and Crozier (2009) as a formal way for the gathering of data/knowledge that can be drawn on to better the procurement of the built-environments.

Numerous methods are available to effectively and accurately measure the performance of a given facility. Although there is no defined approach to POE, the methods selected should be decided on based on the uniqueness of the space and the needs and objectives of those conducting the evaluation. Educational facilities need to be designed based on the feedback obtained from their immediate users. Unless an evaluation and feedback process is in place, it will not be known if a building offers its users the maximum benefits throughout its life cycle.

Facilities in educational institutions are meant to facilitate the provision of learning environments, conducive to student's academic success throughout their life cycle. In order to ensure the provision of quality school facilities, POE is a significant contributing factor for achieving the set objectives of providing quality learning environments (Leung and Fung, 2005). Preiser (1995) defines POE as "a diagnostic tool and system which allows facility managers to identify and evaluate critical aspects of building performance systematically". Hadjri and Crozier (2009) describe POE as "a process that involves a rigorous approach to the assessment of both the technological and anthropological elements of a building in use. It is a systematic process guided by research covering human needs, building performance and facility management". Nevertheless, these evaluations should aim at comprehending the resulting building performance from the users' perspectives (Zimring, 2002). Dahl (2008) describes POE as a means for communicating the facility users' feedback on the efficiency of building systems to the facility management team. The understanding of the impact of POE on the immediate users of the facility, in relation to particular environment, remains to be the most important information to be utilized for operation, maintenance and management of any facility. Over the years, POE has been conducted to discover performance problems in existing facilities. In addition, it has been practiced as a tool for the purpose of developing design guidelines and performance measures for future projects to capitalize on the achievements to repeat, identify performance deficiencies to mitigate or reduce, adjust completed facilities, and avert from repeating mistakes in the planning, design and operation of future design studio facilities (Khalil and Husin, 2009).

Amaratunga and Baldry (2000) indicate that the analysis of data collected from the developed performance measures would serve as a mechanism to learn from similar previous projects and appraise the utilization of contemporary trends in educational facilities. Ornstein *et al.* (2009) suggest that the interpretation of the collected and analyzed performance data presented in a form of results provide potential for developing recommendations pertaining to operational interventions and maintenance activities for the educational facility. Further, performance data that emerges from previous POE activities serves to verify that the objectives from occupying the facility have been fulfilled, and the design, construction, and cost decisions are supported and justified (Vischer, 2002). Sanoff (2001) indicates that in educational institutions, design decisions pertaining to the configuration of the school facilities are exercised by a handful of administrators who are not immediate occupants of the facilities. This leads to side lining of the direct users of the facilities, including teachers and students. Zhang and Barrett (2010) assert that in any educational facility project, there exists a gap between the designer's objectives and the resulting actual performance level achieved for the facilities. This is mainly due to the fact that building occupants are usually users of the existing facilities, rather than active managers.

A framework for performance appraisal of architectural design studio facilities

The authors have developed an indicative performance appraisal framework consisting of a diverse set of activities conducted to attain a systematic approach that concentrates on the users of the architectural design studio facility. Preiser *et al.* (1988) defines an indicative POE as "a systematic and well-defined walk through the building, making observation without further testing or development of explicitly stated performance criteria". The developed framework provides for an indication of the major successes and failures in the performance of the design studio facility under review. The framework consists of four phases. It entails:

(1) Identifying the performance requirements of the architectural design studio.

(2) Collecting data – through conducting walkthrough inspection, questionnaire survey and interviews – to ascertain the present performance level of the architectural design studio.

(3) Analyzing the data gathered from the preceding steps and subsequent reporting of findings on the degree of user satisfaction with the architectural design studio space and facilities.

(4) Developing a plan of actions in the form of recommendations to improve the conditions of the evaluated design studio.

The evaluation team conducting the four phases of the framework is presumed to be knowledgeable about POEs, and is familiar with the layout and configuration of the design studio facility that will be evaluated. The team is also expected to be acquainted with the performance issues that tend to be associated with the design studio facility. The duration for completing the phases of the developed framework is expected not to exceed few days.

The framework processes are illustrated in Figure 1.

Phase I. Performance requirements of architectural design studio space

The framework presented in this paper focuses on two performance requirement categories in architectural design studio facilities. These are the technical performance requirements and the functional performance requirements. The technical performance requirements can be described as the background environment for carrying out activities (Preiser *et al.*, 1988). The major technical performance requirements of the architectural design studio space include visual comfort, thermal comfort, acoustical comfort, indoor air quality and fire safety. The functional performance requirements deal with the fit between the building and the users' activities. These requirements enable occupants to operate efficiently (Preiser *et al.*, 1988). The major functional requirements of the architectural design studio space include cubicle quality and layout, interior finishes, brainstorming (group-gathering) space and support services. The authors have analyzed published literature to review knowledge areas pertaining to the identified technical and functional performance requirements. These performance requirements are discussed in the following:

Technical performance requirements

- *Visual comfort*: Sufficient amount of illuminance at desks in design studios can be provided naturally or by artificial means. Leung and Fung (2005) indicate that

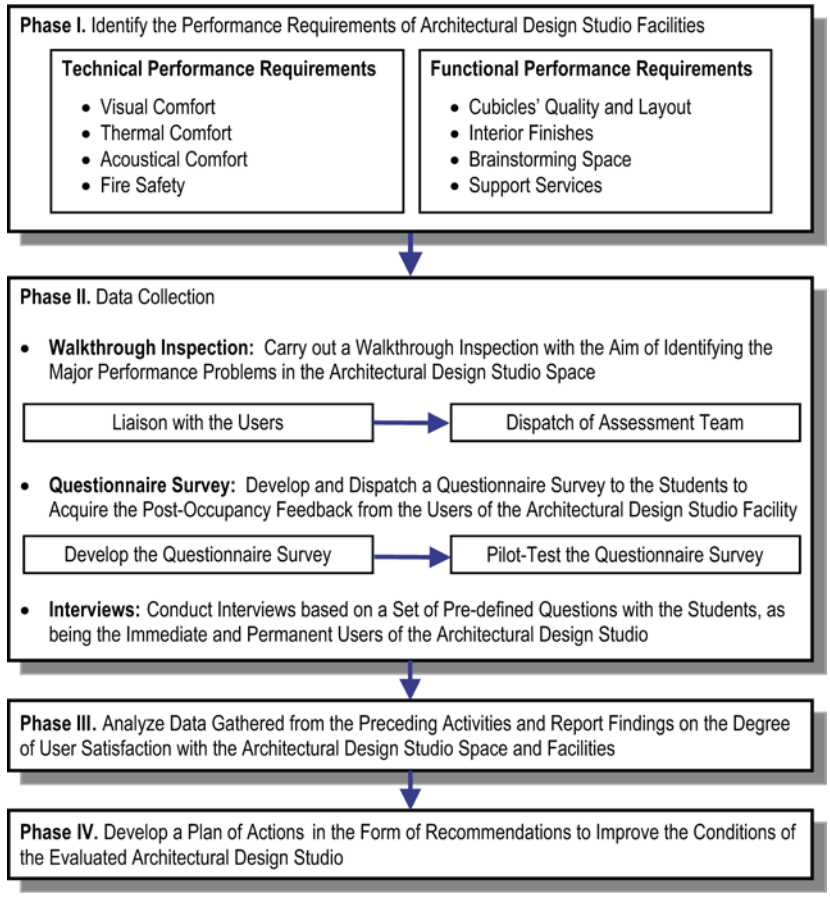

Figure 1.
Performance appraisal framework for architectural design studio facilities

provision of a suitable level of lighting has the potential of positively impacting health and performance of occupants. Bright daylight can bring in a cheerful atmosphere. Heschong (2003) affirms that provision of suitable amount of daylight in educational facilities has a positive and highly considerable connection with improved student performance. However, too much lighting can impair task performance through glare especially during the summer (Winterbottom and Wilkins, 2009).

- *Thermal comfort*: Thermal comfort is one of the most influential technical performance requirements for consideration in learning spaces. Hwang *et al.* (2006) demonstrate that air temperature, air movement and mean radiant temperature have significant effect on student thermal sensation in learning space. Shaughnessy *et al.* (2006) and Seppanen *et al.* (2006) indicate that a well designed ventilation system in a space provides quality indoor air, which results in improving the performance and productivity of the occupants.

- *Acoustical comfort*: Exchange of ideas through oral communication between the course instructor and the students as well as among the group of students is an essential learning activity in educational environments (Bradley, 2005). This learning activity could be adversely impacted when students fail to recognize all of the instructor's spoken communication as a result of inferior room acoustics or background noise originating from the heating, ventilating and air-conditioning systems. Crandell and Smaldino (2000) state that "inappropriate classroom acoustics can deleteriously affect not only speech perception, but also psycho-educational and psychosocial achievement. The speech perception deficits experienced by students highlight the need to strongly consider the acoustical conditions in listening environments used by such populations".
- *Fire safety*: The provision of, and the regular upkeep of fire safety systems in architectural design studio space is an essential concern for design professionals and facility managers to ensure the safety of the occupants. Watson (2000) indicates that there are three major fire safety objectives. The first objective is primarily concerned with preventing ignition of building materials and contents. This objective involves controlling ignition sources, controlling fuel characteristics and controlling fuel/heat interaction by maintaining adequate separation. The second objective focuses on controlling fire development. It involves detecting fires by means of heat, smoke and flame detectors, controlling combustion and limiting the rate of development and spread of fire. The third major objective aims at protecting the exposed occupant. This objective entails notifying the occupants of the building, providing avenues for egress and protecting the in-place occupants.

Functional performance requirements

- *Cubicle quality and layout*: The quality of the cubicles in the design studio has a greater impact on the comfortability of the space for its users. The workspace in the design studio is the individual student cubicle which, in turn, is affected by the furniture size, furniture comfort, walkways and cubicle arrangement (Leung and Fung, 2005). Architectural design studios are unlike classrooms. While classrooms are only used during designated lecture times, students spend most of their remaining times during the day and night in the studio space to complete their design projects. This is mainly attributed to the fact that design studio courses carry the highest number of units or credit hours in both architecture and architectural engineering curriculums. As the design studio is a shared space among all students, privacy is a very important issue to consider in the design studio spaces. Studio spaces should not be over crowded as crowdedness could diversely affects students' concentration (Demirbas and Demirkan, 2000).
- *Interior finishes*: In general, decorative elements are known to provide a comfortable environment to occupant. In educational environments, such elements could range from cushioned seats, shelves for books and periodicals, lighting levels that could be fine-tuned, carpets with vibrant colors, plants, portraits and bulletin boards (Leung and Fung, 2005; Sommer and Olsen, 1980). Common performance problems associated with interior finishes are color fading, spills, stains, evenness of surfaces, cleanability and erosion (Preiser *et al.*, 1988).

- *Brainstorming (group-gathering) space*: Apart from the design and drafting activities, the architectural design studio also host the theoretical aspect of these courses in form of lectures delivered to the students. The provision of instructional equipments like data viewers and white boards in brainstorming or group-gathering spaces can improve the general performance of the student by integrating the instructional requirement into the studio space. Students benefit enormously when a broad spectrum of communication tools is used in architectural educational environments (Mizban and Roberts, 2008).
- *Support services*: The expansion in the use of information technology has affected society and imposed demands on higher education to reshape their educational systems and utilize new technologies in their curriculum (Volery and Lord, 2000). It has been a practice in most schools of architecture to provide personal computers, plotters and printers to provide students with means to represent their work on a hardcopy form for submission and other requirements. Kalisperis and Pehlivanidou-Liakata (1998) have found that the utilization of computers in design studio courses has enabled students to develop multiple design solutions.

Phase II. Data collection

Walkthrough inspection. This phase involves conducting a walkthrough inspection of the architectural design studio to obtain a sense of the current conditions. The walkthrough inspection constitutes an initial assessment aimed at identifying the major technical and functional problems which may need a major or minor repair or replacement. It should be noted that prior to the arrival of the assessment, it is necessary to inform the organization and those occupants that will be affected by the exercise. This will pave way for a high level of understanding, tolerance and cooperation from the studio users. Once the notice from the evaluation team is received, the studio occupants as well as the organization are expected to facilitate the efforts of the evaluation team. Hence this will eventually save time and other difficulties that the post-occupancy crew might face. After the liaison efforts with the occupants are conducted successfully, then the POE team will be dispatched to the architectural design studio to carry out the assessment. The crew composition would depend on the configuration and the scale of the facility. The investigation could be documented by photos.

Development and administration of a questionnaire survey. This phase entails developing and administering a questionnaire survey to obtain the users' perceived level of satisfaction with various technical and functional performance requirements in the architectural design studio facility. A questionnaire is a research instrument that provides a means for collecting information that can be tabulated and discussed (Taylor-Powell, 1998). McColl *et al.* (2001) states that questionnaire surveys "aim to gather valid, reliable, unbiased and discriminatory data from a representative sample of respondents".

The questionnaire survey has to be prepared based on the walkthrough inspection and the reviewed literature. All the important pedagogical and comfort issues need to be included in the questionnaire. This will result in obtaining a reliable and comprehensive evaluation outcome. The survey questions have to be presented in a simple and easily understandable manner, in order for the respondent to understand

the issues well and respond correctly. Additionally, the developed questionnaire survey should be pilot-tested through consultation with few of the potential respondents. The pilot-testing of the questionnaire survey serves the purposes of testing the clarity and readability of the identified performance indicators, pointing out locations of ambiguities, incorporating additional possible performance indicators, and estimating the time needed for filling out the survey.

Table I illustrates a questionnaire survey developed by the authors. In the developed questionnaire survey, the authors have identified a total of 33 technical and functional performance elements to assess the specific qualities and performances for the identified categories of performance requirements. Respondents to the questionnaire survey will be asked to select one evaluation term for each of the listed performance indicators. The evaluation terms used range from "Strongly Satisfied", "Satisfied", "Dissatisfied" to "Strongly Dissatisfied". The authors favor the use of four-point rating scale that has no neutral midpoint, over the use of a five-point likert scale. A four-pint rating scale compels the respondent to the questionnaire survey to pledge to a positive or negative assessment of the element of performance being assessed (Preiser *et al.*, 1988).

Moreover, the authors suggest that a room for extended and free expressions, open-ended section could be provided at the end of the developed questionnaire survey to encourage the users of the architectural design studio facility to voice their concerns on any additional performance indicators that were not included in the developed questionnaire. However, the outcomes of this open-ended section should be analyzed separately owing to its qualitative nature.

Interviews with the users of the studio space. Occasionally, the data obtained through the questionnaire and walkthrough surveys may not provide a comprehensive coverage of the extent of the deficiencies found in the architectural design studio facility. Therefore, this phase focuses on conducting a series of interviews with a selected sample of students and studio instructors as being the immediate and permanent users of the studio space. In these interviews, the purpose of the assessment along with the technical and functional performance requirements will be described to the respondents. The interviewees will be asked to voice their perceptions for each of the identified performance requirements and the quality of the designed environment in the architectural design studio. The authors asserts that the outcomes obtained from the interviews will serve to validate the claims in the questionnaire surveys and at the same time, provide a basis for proper conclusion and subsequent recommendations of measures required to alleviate the current problems. The potential interviewees need to be selected and contacted prior to the commencement of the interview process. It is also important to ensure that all studio locations are represented through the selected sample of students who use the various zones of the studio space, as some problems are confined only to certain areas or zones of the studio space.

Phase III. Data processing, analysis and interpretation

"Good data is a potential treasure trove – it can be mined by scientists at any time – and thus an important part of any scientific investigation is accurate and consistent recording of data and the methods used to collect that data" (Egger and Carpi, 2008). Sources of raw data include data that may be on the questionnaire survey forms, interview notes or tapes, time logs of activities, videotapes, and photos (Preiser *et al.*,

Elements of performance requirements	Evaluation terms SS	S	D	SD	Mean	Rate of satisfaction
Visual comfort						
01 Adequacy of lighting at your workstation	4	15	7	0	2.88	S
02 Adequacy of lighting at the brainstorming (group-gathering) space	4	11	9	2	2.65	S
03 Overall perception of the quality of lighting in the studio	2	18	6	0	2.85	S
Thermal comfort						
04 Space temperature during morning times	7	9	8	2	2.81	S
05 Space temperature during evening times	6	7	9	4	2.58	S
06 Overall perception of the thermal environment in the studio	5	7	11	3	2.54	S
Acoustical comfort						
07 The level of noise generated in the studio space	1	11	7	7	2.23	D
08 The level of noise generated from outside the studio	4	9	6	7	2.34	S
09 Overall perception of the acoustical environment in the studio	0	13	7	6	2.30	S
Fire safety						
10 Ease to identify emergency exits for occupants and visitors	3	15	7	1	2.77	S
11 Ease of evacuating the building in case of fire emergencies	2	15	8	1	2.69	S
12 Ease to identify and reach the fire alarm system	2	10	9	5	2.35	S
13 Quality and perception of fire safety systems in the building	0	14	11	1	2.50	S
Cubicles' quality and layout						
14 The cubicle size and adequacy for all drafting and design activities	3	7	14	2	2.42	S
15 Flexibility of the drawing board in terms of vertical adjustment	3	9	8	6	2.35	S
16 Type of chair where you set	0	0	9	17	1.35	D
17 The table height in the cubicle	1	14	8	3	2.50	S
18 Sense of privacy while working at the cubicle	4	10	5	7	2.27	S
19 Adequacy of space within the cubicle to permit having discussions	4	7	7	8	2.30	S
20 Adequacy of personal storage space in each cubicle	1	6	9	10	1.92	D
21 Width of walkways between cubicles in the studio	5	12	9	0	2.85	S
22 Overall perception of the quality of the cubicles	0	9	12	5	2.15	D
Interior finishes						
23 Color of cubicle's interior partition.	2	4	8	12	1.85	D
24 Quality of cubicle's interior partition finish	1	7	6	12	1.88	D
25 Quality of floor finish in the studio	1	9	6	10	2.04	D
26 Quality and presentation of wall finishes	1	12	10	3	2.42	S
Brainstorming (group-gathering) space						
27 Adequacy of the brainstorming (gathering) table to accommodate group discussion	1	5	11	9	1.92	D
28 Adequacy of the white board in the studio	4	10	9	3	2.58	S
29 Suitability of the slide projector and screen	6	11	3	6	2.65	S
Support services						
30 Adequacy of printers and plotters in the studio.	0	16	7	3	2.50	S
31 Adequacy of help provided in cases of technical problems with IT equipment	0	3	9	14	1.58	D
32 Ability to control access for non-members of the studio	2	6	6	12	1.92	D
33 Overall perception of the quality of the studio space	0	13	12	1	2.46	S

Notes: SS = Strongly Satisfied; S= Satisfied; D= Dissatisfied; and SD = Strongly Dissatisfied

Table I.
Performance requirements in the questionnaire survey for the performance appraisal of the architectural design studio facilities

1988). Processing of raw data requires a sense of responsibility, creativity, experience to interpret data and meticulousness to extract the required information and present it in a comprehendible form such as diagrams, reports, or tables. The data analysis and interpretation phase involves analyzing and interpreting the collected POE information to develop a response suitable within the context of the objective and the situation of the facility under investigation. Preiser *et al.* (1988) indicate that the reason for analyzing the data obtained through the utilization of various data collection methods is to distinguish and categorize response patterns and trends among the findings of a POE. The results of the data processing phase could be simple tabulations of frequencies or standard deviation. Interpretation of findings serves to develop sets of feedback about the post-occupancy conditions of the building under review. Cohen *et al.*(2001) indicates that such feedback would be useful in the briefing, design, construction, operation and alteration of buildings.

Phase IV. Development of a plan of corrective actions

Finch (1999) comments that "if building performance evaluation is to have a significant impact on the design process it must serve more than a reporting function. It should not stop short of data capture and analysis: it should involve solution generation as well". Developing a POE plan of actions in the form of recommendations to improve the condition of the architectural design studio is one of the important phases in the entire study. These corrective actions may range from immediate fixes that will potentially resolve deficiencies without major expenditures or construction, minor modifications in the space, such as painting, relocating partitions, and changing furnishings and equipment, to major retrofitment of systems and modernization of the infrastructure (Preiser *et al.*, 1988). These corrective actions may be ranked in order of importance according to their feasibility of implementation.

Discussion

As the quality of educational facilities has a greater impact on the student achievements in design studio facilities, the need for the provision of state-of-the-art educational facilities can never be over emphasized. Leaman and Bordass (2001), however, indicate that virtually all facilities have some sort of shortcomings to some degree. It may not be feasible to expect that all technical and functional aspects of the facility to perform as planned, designed and installed at all times during the facility life cycle. Nevertheless, facility managers can take an active role to reduce the consequences attributed to the identified deficiencies. The multi-phase systematic framework for the performance appraisal of architectural design studio facilities, presented in Figure 1, has exhibited logical steps and procedures that could be followed to conduct a POE of studio space. Hence, this will eventually leads to an improvement in the educational outcomes.

The technical elements of performance for architectural design studios deal with those issues related to health and safety in the studio space facilities. Various studies have confirmed the relationship between visual, acoustical, and thermal comfort in building. The frequent use of POE as a diagnostic tool to check problems and success related to environmental issues in studio facilities will no doubt reduce problems in the design studio facilities and improve pedagogical achievements. Design studios, being educational environments, in which design students spend higher percentage of their

time developing collections of art and design works, need to maintain an improved level of environmental comfort. The functional element of performance for architectural design studios deal with the fit between the building and the users' activities, which are mainly functional and spatial issues including cubicle quality and layout, interior finishes, brainstorming (group-gathering) space and support services. These issues are critical for the students' comfort, which need to be handled with all sense of responsibility.

The walkthrough inspection of the design studio would serve as a means for ascertain the physical conditions of the design studio facility. It would identify obvious durability and quality concerns from the evaluators' perspective. Usually, it is recommended that the questionnaire survey should be conducted among the immediate users of the design studio. If possible it is required that, the survey should be carried out in a form of group discussion, so that, the evaluator can be able to further explain all the areas that are difficult to comprehend by the students. Interviews with the immediate occupants of the design studio would serve to provide an avenue for voicing concerns that could be covered through the walkthrough inspection, or revealed through the questionnaire survey. On the collection of all related information on both technical and functional elements of studio performance in form of walkthrough inspection, questionnaire survey and interviews, interpretation of the data would be carried out to develop a plan of actions with the aim of improving the condition of the architectural design studio facility.

The authors presented the details and merits of the developed framework to a number of studio instructors for review and critique. It was concluded that the developed framework, through its four phases would be adequate to describe the performance and post-occupancy conditions of the design studio facility. The group of studio instructors recommended validating the developed framework through a case study, which they participated in as interviewees, to demonstrate its applicability.

A case study on performance appraisal of architectural design studios

This section consists of a case study conducted in relation to the developed multi-phase systematic framework for performance appraisal of architectural design studio facilities. The case study was conducted in the studios of the Architecture Department, College of Environmental Design at King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. The authors utilized a series of data collection methods including; photographic documentation, observations through walkthrough inspection, questionnaires and interviews. The questionnaire was administered among 26 students of architecture from different years ranging from sophomore to senior level (three freshmen, seven sophomore, and 11 junior and 5 senior students). The interviews were conducted among 15 students of architecture from different years ranging from junior to senior level as well as among 4 studio instructors of architecture.

Description of the studio area and its spaces

The studio spaces for design studio courses are located on the third floor in the building of the College of Environmental Design. This space occupies a rectangular area of 726.38 sq. m (11.65 $\times$ 62.35 m) as illustrated in Figure 2. The space is designed in alignment with structural system to allow free and flexible space with the rhythmic

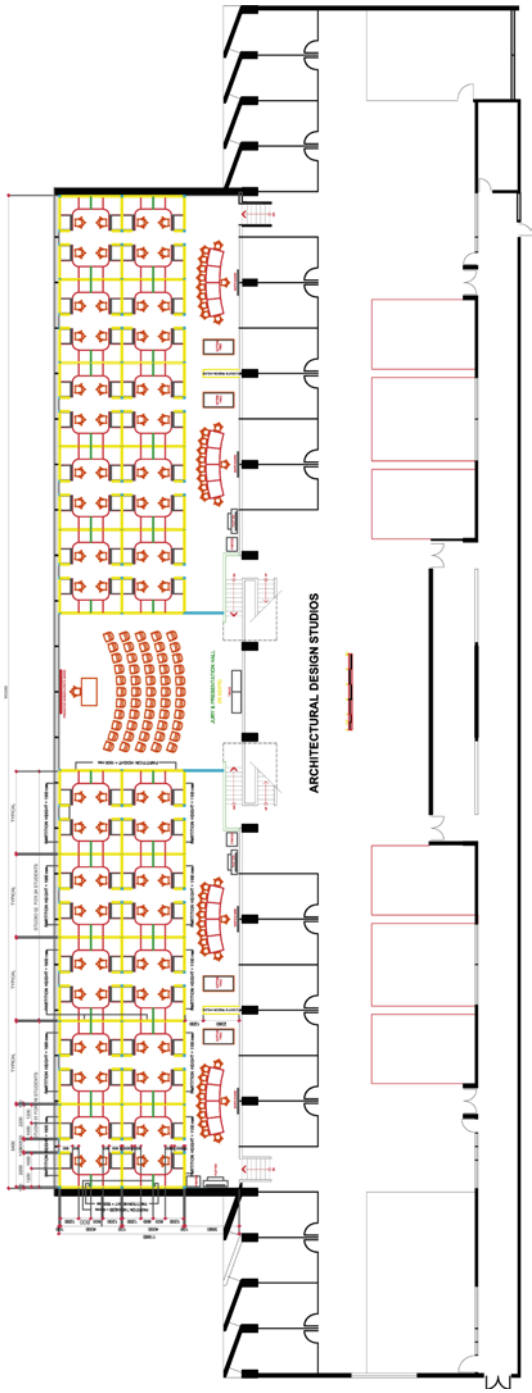

Figure 2.
Layout of the studio area

repetition of high beams articulating the volume above this large space by dividing into 11 imaginary sections. The studio space, as illustrated in Plate 1, is configured without any interruption by columns since the structural system of the building consists of a grid of (11.65 × 5.67), which allows this space to be organized along 11 consecutive modules. The rectangular space is aligned parallel with the main axis of the building and its length is aligned with the north-south axis. The studio space contains 40 cubicles which can accommodate 80 students of architecture from different years (i.e. freshman, sophomore, junior and senior). Accordingly, the space as well as the cubicles is divided into four zones in relation to the number of students each semester. The studio space also contains one large seminar area with projection and board facilities, and three smaller gathering spaces for group studies, discussions, brainstorming as well as intermediate juries or pin-ups. The cubicles are L shaped worktops with facilities for drawing, storage shelves and computers for two students. Each cubicle occupies a space of 5 sq. m.

Data collection and analysis

This section demonstrates the data collection processes through conducting walkthrough inspection, questionnaire survey and interviews.

Walkthrough inspection. The walkthrough inspection was conducted by the authors. The users of the studio space (i.e. studio instructors and students) were informed prior to the evaluation, to enable the high level of understanding, tolerance and cooperation from the studio users. The exercise was conducted on regular design

Source: Photo by Murat Cetin

Plate 1.
General view of the studio spaces

studio class days to reflect the real situation. The following observations are made during the walkthrough inspection:

- The cubicles in the studio space provide individual and group study area as well as storage spaces to individual students.
- The cubicles provide IT facilities to students. However, the cabling in some cubicles is not well hidden within the partitions.
- Although the thermal, acoustical and safety components of the proposed performance framework are satisfied, the visual component appears to be below the required level in the sense that day lighting is insufficient in cubicles near the walls.
- The layout of studio area may not encourage free circulation between cubicles.
- The institution provides various technical services such as printers, plotters as well as free consumables such as paper, model materials.

Questionnaire survey. The developed questionnaire was administered to the students using the architectural design studio. The students enthusiastically and rigorously filled the given questionnaires. A total of 26 responses to the questionnaire survey were obtained. The respondents to the questionnaire survey were asked to mark in their degree of satisfaction (how do they feel) with the listed elements of performance requirements, through selecting one of four evaluation terms provided. The questionnaire survey included an identified 33 elements of performance. These elements were classified under eight performance categories, including visual comfort, thermal comfort, acoustical comfort, fire safety, cubicles' quality and layout, interior finishes, brainstorming (group-gathering) space and support services. The evaluation terms used, along with their corresponding weight, were "Strongly Satisfied" with four points, "Satisfied" with three points, "Dissatisfied" with two points, and "Strongly Dissatisfied" with one point. The mean response for each element of performance was calculated as follows:

- *Step 1*: The number of responses for each evaluation term will be multiplied by the corresponding weight of that evaluation term.
- *Step 2*: The sum of the products of multiplication from Step 1 will be divided by the number of persons responding to the questionnaire survey.

To be able to quantify the degree of satisfaction for each element of performance, the authors have adopted the following calibration:

- If the mean response is below 1.25, then the respondents are "Strongly Dissatisfied".
- If the mean response is between 1.25 and 2.25, then the respondents are "Dissatisfied".
- If the mean response is between 2.25 and 3.25, then the respondents are "Satisfied".
- If the satisfaction index is above 3.25, the respondents are "Strongly Satisfied".

The occupants' rates of satisfaction with each of the identified 13 elements of technical performance requirements and 20 elements of functional performance requirements are included in Table I. A summary of the mean responses for the technical and functional

performance requirements and the associated rates of satisfaction are documented in Table II.

Analysis and interpretation of the data collected through the questionnaire survey reveals in fact that there is a significant concern about the quality of the facilities provided in the design studio space. Although few respondents to the questionnaire survey indicate certain level of satisfaction with the technical aspects, the majority seems to be significantly dissatisfied with the functional performance requirements of the studio space, and cubicles in particular. The occupants' rates of satisfaction for each of the performance categories are listed as follows.

- *Visual comfort*: This performance category consisted of three performance elements; namely, adequacy of lighting in the cubicles, adequacy of lighting at the brainstorming area and the users' overall perception of the quality of lighting in the studio. The mean response from the sample students who completed the survey indicated that they were "satisfied" with the identified performance elements in this category as detailed in Table I, with an average satisfaction rate of 2.79 as illustrated in Table II.
- *Thermal comfort*: This performance category consisted of three performance elements; namely, space temperature during morning times, space temperature during evening times and the users' overall perception of the thermal environment in the studio. The mean response from the 26 students who completed the user satisfaction survey indicated that they were 'satisfied' with all of the listed performance elements in this category as detailed in Table I, with an average satisfaction rate of 2.64 for this technical performance category as illustrated in Table II.
- *Acoustical comfort*: Three performance elements were identified and assessed in this category. These are the level of noise generated in the studio space, the level of noise generated from outside the studio space and the students' overall perception of the acoustical environment in the studio. The mean response from the sample 26 students who completed the questionnaire indicated that they were 'satisfied' with two out of three performance elements listed as shown in Table I, with an average satisfaction rate of 2.29 for this category as illustrated in Table II.
- *Fire safety*: This performance category included four performance elements, namely, the ease to identify emergency exits, ease of evacuating the building, the

Table II. Summary of the mean responses for the performance requirements and their associated rate of satisfaction for the architectural design studio

No.	Performance requirements	Mean response	Rate of satisfaction
1.	Visual comfort	2.79	S
2.	Thermal comfort	2.64	S
3.	Acoustical comfort	2.29	S
4.	Fire safety	2.58	S
5.	Cubicles' quality and layout	2.23	S
6.	Interior finishes	2.05	D
7.	Brainstorming (group-gathering) space	2.38	S
8.	Support services	2.12	D
Overall average		2.39	S

ease to identify and reach the fire alarm systems and the students' perception of the quality of fire safety systems in the building. The mean response indicated that the surveyed students were 'satisfied' with the listed elements in this category as presented in Table I, with an average satisfaction rate of 2.58 as illustrated in Table II.

- *Cubicles quality and layout*: This performance category consisted of nine elements; namely, the cubicle size and adequacy for all drafting and design activities; flexibility of the drawing board in terms of vertical adjustment; type of chair, the table height; sense of privacy while working at the cubicle; adequacy of space within the cubicle to permit having discussions; adequacy of personal storage space in each cubicle; the width of walkways between cubicles in the studio and the students' overall perception of the quality of the studio. The mean response from the 26 students who completed the survey indicated that they were "Dissatisfied" with three of the identified elements as presented in Table I, with an average satisfaction rate of 2.23 for this performance category as illustrated in Table II.
- *Interior finishes*: This performance category included four elements; namely, color of cubicle's interior partition; quality of cubicle's interior partition finish; quality of floor finish in the studio; quality and presentation of wall finishes. The mean response from the sample students who completed the questionnaire indicated that they were "Dissatisfied" with three elements as indicated in Table I, with an average satisfaction rate of 2.05 for this category as illustrated in Table II.
- *Brainstorming (group-gathering) space*: This performance category consisted of three elements; namely, adequacy of the brainstorming (gathering) table to accommodate group discussion; adequacy of the white board in the studio and suitability of the slide projector and screen. The mean response indicated that they were 'satisfied' with two performance elements, as presented in Table I, with an average satisfaction rate of 2.38 for this category as illustrated in Table II.
- *Support services*: This performance category consisted of four performance elements; namely, adequacy of printers and plotters in the studio; adequacy of help provided in cases of technical problems with IT equipment; ability to control access for non-members of the studio and the students' overall perception of the quality of the studio space. The mean response from the sample 26 students who completed the questionnaire indicated that they were "Satisfied" with two of the elements, as indicated in Table I, with an average satisfaction rate of 2.12 for this category as illustrated in Table II.

The overall level of satisfaction with the architectural design studio is "satisfied" with an average satisfaction rate of 2.39 as illustrated in Table II.

Interviews with the users of the studio. The interviews with a selected sample of students revealed the following issues:

- The users appreciate the facilities provided by the institution, yet they are concerned about the maintenance and upgrading of these facilities.
- Most of the students feel advantaged because of their allocated cubicles. Thus, they have their personal space throughout their education.

- The sense of privacy provided by the layout of the cubicles is pleasant for some students.
- The tightness of the cubicle space is frequently mentioned in the interviews as a factor that hinders better communication.
- The cubicles were considered to be more appropriate for conventional drafting rather than computer drafting by a few students.

The interview with the instructors also emphasized the fact that the availability of cubicles is a very important advantage yet the layout poses few communication and circulation problems and therefore, the layout of the studio needs to be improved. The interviews served to show that studio space provides various facilities to its users and have a good potential despite few points that fails to meet the user expectations.

In concluding the case study, the authors assert that observation from the walkthrough inspection, the findings from the questionnaire survey and the users' comment through the interviews not only confirmed but also complemented each other. In other words, analysis of data obtained through these three data collection methods confirms the general satisfaction with the current organization of studio space through the existing cubicles. However, a number of recommendations could accommodate a potential for improvements to fulfill the requirements as well as expectations. The case study investigated the post-occupancy conditions of the studio space with the aim of identifying performance problems and devising remedial measures. The suggested action plan concentrates on improving the technical and functional performance requirements of the studio space.

Conclusions

Owing to the fact that a particular facility has unique performance requirements depending on the expected functions of the facility, it is pertinent to investigate the post-occupancy conditions with the aim of identifying performance problems and devising remedial measures. The paper presents an indicative multi-phase systematic framework for the performance appraisal of architectural design studio facilities. This framework consists of four sequential phases, where each phase sets out a number of tasks to be conducted. The understanding of the actual status of technical and functional elements of performance prior to the implementation of the developed framework is critical for the reliability of the results obtained. Review of the success of the plan of actions devised to improve the performance of the design studio facility, is an added value to the operational efficiency of the facility. The developed framework will assist in truncating the time required for carrying out the evaluation by solving the enormous of research planning phase of the evaluation. The framework provides a systematic approach for evaluating the major performance requirements of architectural design studio facilities. The paper also presents the findings of an indicative assessment of the post-occupancy conditions of one of the architectural design studio facilities of King Fahd University at Petroleum and Minerals, Dhahran, Saudi Arabia, as a case study to demonstrate the applicability of the developed framework. This paper is of practical value to space planners, design professionals, facility managers and administrators involved in the planning, design, operation and management of such facilities.

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Further reading

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Corresponding author

Mohammad A. Hassanain can be contacted at: mohhas@kfupm.edu.sa