**POST-OCCUPANCY EVALUATION OF CAMPUS HOSPITAL, NIT,  
TRICHY****Dr. K. Thirumaran\*<sup>1</sup> and Raja Singh<sup>2</sup>**

<sup>1</sup>Associate Professor, Department of Architecture, National Institute of Technology, Trichy, India.

<sup>2</sup>PG Student, Department of Architecture, National Institute of Technology, Trichy, India.

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**\*Corresponding Author****Dr. K. Thirumaran**

Associate Professor,  
Department of Architecture,  
National Institute of  
Technology, Trichy, India.

DOI: <https://doi.org/10.17605/OSF.IO/GYN29>**ABSTRACT**

The objective of this study is to present the findings of a Post-Occupancy evaluation of (POE) for the design considerations. This is based on the comfort and functional elements of a Hospital Building at National Institute of Technology, Tiruchirapalli, India. The Evaluation is performed on the basis of three data collection methods, including a Walk- through Inspection that is expert review to find the deficiency in

building design and its impact on comfort. A group discussion mainly with service providers like Doctors, Nurse and service people; so that their feedback about the building helps to obtain the pros and cons. The Questionnaire Survey was conducted with 75 users to identify their perception and the level of satisfaction with the indoor and outdoor quality environment of the building. The findings are tabulated and analysed to identify the performance of the building. From the output, recommendations are inferred to improve the performance of the hospital building. This study provides a systematic approach for evaluating the comfort and functional performance of the existing hospital building.

**KEYWORDS:** Hospital; Post-Occupancy Evaluation; Occupant Satisfaction; performance elements.

## INTRODUCTION

All over the countries, the prime educational institutions are aimed to execute the functions like teaching, research and community services. Other functions of Educational Institution could also be providing such as housing for students, health care, catering and other facilities which supports their core activities. These activities are generally carried out in well-designed buildings and become the significant component of the educational institution.

The hospital in the educational institution plays a major role in satisfying the healthcare needs of Students, Faculty and other staff and hence the performance of the building has direct impact on users. Health care is also an important need for students and faculties in any institutional campus. The quality of the hospital building in the educational institution is the prominent factor that could directly impact the student health care. The hospital at the educational institution should satisfy the comfort and functional elements that possibly affect the performance and productivity of its users.

The Post Occupancy Evaluation of hospital building helps us to fulfil the user requirements by increasing the performance of building, so as to reduce the discomfort of the patients and other users inside the building. *POE is defined as “the process of systematically evaluating the performance of buildings after they have been built and occupied for some time”* (Preiser, 1988). The POEs are proposed to add the suggestions on the construction and management decisions of the buildings. The POE process achieves the series of recommendations related to the modification of the techniques and procedures to serve the designed building.

The objective of this study is to present the findings of a Post- Occupancy evaluation of (POE) for the design considerations. This is based on the comfort and functional elements of a Hospital Building at National Institute of Technology, Tiruchirapalli, India. National Institute of Technology at Tiruchirappalli, Tamil Nadu, India (NITT) is an Educational Institution which aims to provide state-of-the-art Undergraduate, Postgraduate and Doctoral Programs (Technology., n.d.). The focus is on quality of built Environment of hospital building, its design considerations based on Planning, Circulation, Maintenance, Other facilities, Interior and Exterior Environment, Universal Accessibility, Thermal comfort, Visual Comfort and Acoustical Comfort. This study provides systematic approach for evaluating the comfort and functional performance of the existing hospital building.

### **Research methodology**

To accomplish the above mentioned objectives of this study, the following activities are conducted:

- Conducted a Walk- through Inspection that is expert review to find the deficiency in building design and its impact on comfort.
- Conducted a group discussion mainly with service providers like Doctors, Nurse and service people; so that their feedback about the building helps to obtain the pros and cons.
- The Questionnaire Survey was conducted with 75 users to identify their perception and the level of satisfaction with the indoor and outdoor quality environment of the building.
- The findings are tabulated and analyzed to outline the level of user's satisfaction with the performance of the building.
- From the output, recommendations are inferred to improve the performance of the hospital building.

### **Performance requirements of Hospital building**

This study concentrated on evaluating the comfort and functional performance requirements in the hospital building of National Institute of Technology campus. The comfort performance elements examined in this study consisted thermal comfort, visual comfort and acoustic comfort. Presier states that these comfort elements are considered as the environment setting for conducting the building activities. The functional performance investigated in this study spatial arrangement and human factors. Presier mentioned these functional elements are considerate with the good function between the building and user's activities.

#### ***Thermal comfort***

The thermal comfort of the building is considered as the prominent performance elements in any building service include the Hospital building. ASHRAE Standard 55 (2013) defines thermal comfort as *“the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation”*. The variables such as air temperature, relative humidity, wind speed, wall temperature in the indoor environment affects the thermal environment.

***Visual comfort***

The visual comfort of the space is about the sufficiency of light. The recent studies show that the sufficient level of lighting whether it may be natural or artificial, has the significant impact to the user and their level of satisfaction in the indoor environment of the designed space (Heschong, 2003; Leung & Fung, 2005). In the hospital building, the performance evaluations include the sufficient amount of natural lighting and artificial lighting at the indoor environment.

***Acoustic comfort***

The acoustic comfort means adequate level of noise in the indoor environment. If the level of noise is high, it may cause the mental stress and hypersensitivity sometimes lead to hearing loss. In hospital building, noise has significant impact on the patients' health and the staffs' wellbeing. The visitor's conversation and the noise from the hospital furniture's like wheel chair at the corridors and waiting areas produce a high level of background noise which cause psychological effects like stress, high blood pressure, insomnia, etc., to the patients as well as the hospital staffs'.

***Spatial arrangement***

The layout of the hospital building must provide for a number of apparent functional areas such as waiting lounge, patients ward, consultation rooms and pharmacy. The spatial arrangement always relate to the decisions made for the spaces between the functional entities in the building layout. In the case of the consultation room, the decisions include the location of waiting space for the patients; nearby rest rooms; access to the testing labs and pharmacy.

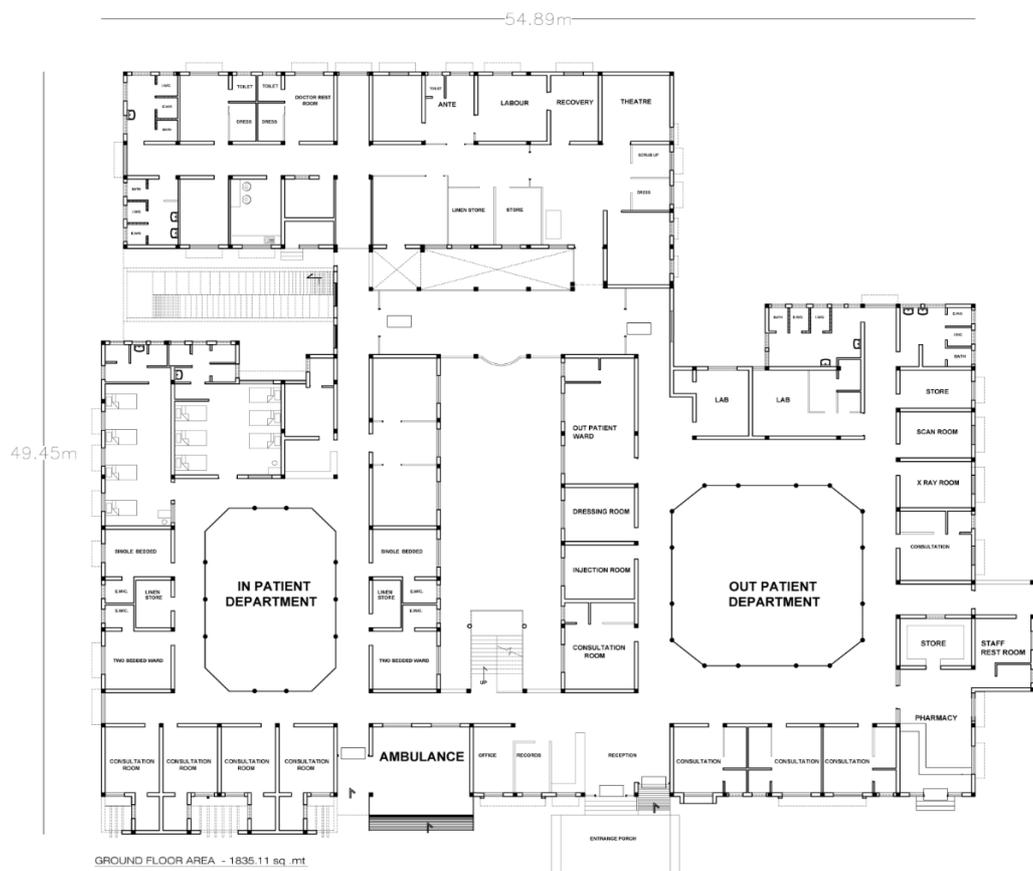
***Human factor***

The physiological needs of the occupants are always considered by the design professionals. The circulation space in the waiting area and the privacy in the patients ward are contributing factors in user's satisfaction. Most of the hospital buildings provide adequate circulation space, clear accessibility and privacy in the wards. The building designers should consider the suggestions of the patients and staff member.

## Performance assessment of the Hospital building at NITT

### *Building description*

The hospital building at National Institute of Technology, Tiruchirappalli is located near from the most of the academic building and the student's hostels on the campus. NITT Hospital is the single-story building spread horizontally on the ground and facing west. Approximately, 150 patients visit the hospital per day. The gross area of the building is 1835 m<sup>2</sup>. This area is divided into three blocks as Outpatient Care Department, In-patient Care Department and Operational Block. Also the building comprised with the three courtyards in which two are accessible and one is non-accessible. The building spaces included Reception, Pharmacy, Consultation Rooms, Office Room, Courtyards, Single bedded Wards, Two bedded wards, Patients Room, Doctors Rest Room, Nurse rest rooms, Linen store, Toilet blocks, Oxygen Room, Etc. the hospital building was built and used since 2007 to serve the people who residing in the campus. During the month January 2017, the POE conducted and reported in this study. The feedback collected from the users (students, doctors, hospital staffs, faculties and their family member of the Institution) on the post occupancy condition of the hospital building. Figure 1 shows the layout of the hospital building.



**Figure 1: Layout of the hospital building.**

### ***Data collection methods***

The method of data collection has categorized into three segments for providing the complete report of the performance deficiencies found in the hospital building. The outcomes of evaluation methods from these three segments would provide the preferable solutions of the deficiency aspects of the building. The three segments of data collection methods are explained in the following:

### ***The Walkthrough Evaluation***

This was the preliminary step. Here the authors are expert evaluation people who went about the Hospital, Looked at the various areas of the Hospital for visual inspection. This is when the authors were doing a visual inspection of the premises from inside as well as outside. This was without any questionnaire or any instrument but they had Plan of the building to understand the layout, circulation, Arrangement & usage of spaces, Proximities etc. They also inspected the lighting, Ventilation, Acoustics, Services, User Behavior, etc. other than building design. The authors then came up with the potential areas which could be evaluated through the study.

### ***Group Discussion***

The group discussion was made with the frequent users of the hospital building at the Institution campus to get their feedback on the quality of the building. In the group discussion, the users were explained the significant aspects of the hospital building and how that would provide the healthcare on their wellbeing. The users in the group discussion included the doctors, nurses' and patients (students, teaching and non-teaching staffs of the institution and their family members). Those users were requested to express their view points of defects in the building performance. From the discussion, the various types of problems were identified. The results of this discussion guide to develop the user satisfaction survey.

### ***User satisfaction survey***

The user Satisfaction survey was carried out to know how users perceive the Functional and Comfort considerations of the Hospital. The functional elements focused on the spatial arrangement and human factor and the technical elements included thermal comfort, visual comfort and acoustic comfort. The User Survey had 32 Questions. Mostly all Questions were on a Five Point Scale of Likert. The option 1 was Very Much and the Option 5 was Not At All except their Contact detail, last visit to hospital and their suggestions.

### *Data analysis*

The Questions were put up online using a web-based tool called Google Forms. (Link <https://goo.gl/forms/P2qnRmzzn0LjpDE22>) Boards were put up in the Hospital. Small cards with the link were also distributed. This yielded about 75 answers. Questions are framed in focus to understand the satisfaction level of users in two main aspects as Functional and comfort in design considerations of the hospital. From questionnaire, 17 questions helps us to understand user satisfaction in Functional aspects like Planning, Circulation, Maintenance, Other facilities, Interior and Exterior Environment, Universal Accessibility etc. and 10 questions were based on Comfort aspects like thermal, acoustic, Visual comfort etc. This data was later analysed using Word processing and Data Processing Spreadsheets.

Users Feedback on their perception of the Hospital helped us to complete the survey. With those answers, Satisfaction indices were calculated as follows (Mohammad A. Hassanain, 2016)

$$\text{Satisfaction Index } (I) = \frac{\sum_{i=1}^5 (a_i)(x_i)}{5 \sum_{i=1}^5 x_i} \times 100\%$$

where  $a_i$  is the constant representing the weight assigned to  $i$ , and  $x_i$  is the variable representing the frequency assigned to  $i$ . The response for  $i$  is 1, 2, 3, 4, 5 and is illustrated as follows:

- .  $x_0$  = frequency of “Very Much” response corresponding to  $a_0 = 5$ .
- .  $x_1$  = frequency of “Good” response corresponding to  $a_1 = 4$ .
- .  $x_2$  = frequency of “Poor” response corresponding to  $a_2 = 3$ .
- .  $x_3$  = frequency of “Very Poor” response corresponding to  $a_3 = 2$ .
- .  $x_4$  = frequency of “Not at all” response corresponding to  $a_4 = 1$ .

Aiming for higher levels of user satisfaction with the quality of the built environment in the university campus, the authors considered that any element of performance with satisfaction index value below 70% to be defective in performance. Thus, the authors adopted the following scale to establish the level of satisfaction for each element of performance:

- . If the satisfaction index value is above 85%, then the respondents are “Strongly Satisfied (SS)”.
- . If the satisfaction index is between 70.1% and 85%, then the respondents are “Satisfied (S)”.

- . If the satisfaction index is between 55.1% and 70%, then the respondents are “Dissatisfied (D)”.
- . If the satisfaction index is below 55%, then the respondents are “Strongly Dissatisfied (SD)”.

### *Findings of the assessment*

After the data have been tabulated and processed, the satisfaction indices were formulated for the technical and functional elements in the user satisfaction survey. The respondent’s rate of satisfaction identified with 10 technical and 17 functional elements of performance as shown in the respective tables 1 and 2.

**Table 1: Technical elements of performance along with satisfaction indices and rate of satisfaction.**

Technical Elements of performance	Evaluation terms					Satisfaction index (%)	Rate of Satisfaction
	1	2	3	4	5		
<b>Visual Comfort</b>							
1. Artificial lights in the ward	8	11	18	4	0	71.22	S
2. Glare inside the hospital	1	8	13	10	7	67.18	D
3. Visual Privacy	4	9	15	5	6	60	D
<b>Acoustic Comfort</b>							
4. Noise Disturbance inside the hospital	3	0	14	12	15	76.36	S
5. Noise Disturbance from the outside like honking etc.	1	3	11	12	16	78.14	S
6. Noise from adjacent rooms	2	2	13	15	6	71.05	S
<b>Thermal Comfort</b>							
7. Heat through windows	2	2	19	10	8	69.76	D
8. Room/Ward Temperature	9	12	21	4	3	68.16	D
<b>Other Comfort</b>							
9. Toilet smell	2	1	9	12	13	77.84	S
10. Rain water splash into room	2	1	16	13	9	72.68	S

Note: 1(very much),2,3..5(not at all)

**Table 2: Functional elements of performance along with satisfaction indices and rate of satisfaction.**

Functional Elements of performance	Evaluation terms					Satisfaction index(%)	Rate of Satisfaction
	1	2	3	4	5		
1. Convenience in Parking Facility	24	19	20	11	1	74.4	S
2. Provision of facility to lock bicycle in parking shed	14	13	15	19	14	58.4	D
3. Entrance door restricts use of Ramp and Stairs are used instead	10	5	17	6	6	63.18	D
4. Provision of handrail in Ramps	23	10	7	1	2	36.28	SD
5. No Accessibility to use the Pharmacy shop from outside	23	15	16	5	16	53.6	SD
6. Design of Pharmacy shop as room than counter	21	15	20	8	11	52.8	SD
7. Provision of locking facility in the ward for belongings	15	8	11	6	2	46.67	SD
8. Distance of the bed from the toilet	5	8	15	9	1	63.68	D
9. Comfortable Ceiling height	13	15	13	0	0	80	S
10. Provision of chairs outside each doctor's room	17	26	13	12	7	50.93	SD
11. Flooring	1	2	13	34	25	81.33	S
12. Cleanliness in Hospital	39	23	11	2	0	86.4	SS
13. Healing in Hospital Internal Environment	7	7	17	5	5	62.93	D
14. Purpose of fountain and Landscaped courtyard to feel relax and good	17	21	15	9	5	70.75	S
15. Accommodation facility for friends/family to stay when patient is admitted	3	4	11	7	15	46.5	SD
16. View of exterior from windows	3	6	12	6	13	50	SD
17. Impact of exterior landscaping	6	7	13	4	6	61.67	D

**Technical performance requirements**

The findings of the assessment of the technical performance requirements are discussed in the following:

**Thermal comfort:** In this category, the two performance elements are included, namely, heat through window and room/ward temperature in the hospital building. The satisfaction index value registered that the 35 respondents were dissatisfied with the 2 identified elements, as shown in Table 1 with the average satisfaction index value of 69%.

**Acoustic comfort:** In this category, the three performance elements are included, namely, noise disturbance from inside the hospital, noise disturbance from the outside the hospital

like honking, etc. and noise from the adjacent rooms. The satisfaction index value determined that the 33 respondent were satisfied with the 3 identified elements, as shown in Table 1 with the average satisfaction index value of 75 %.

**Visual comfort:** In this category, the three performance elements are included, namely, artificial lights in the ward, glare inside the hospital and visual privacy. The satisfaction index value determined that the 28 respondents were dissatisfied with the 3 identified elements, as shown in Table 1 with the average satisfaction index value of 66%.

### ***Functional performance requirements***

The findings of the assessment of the functional performance requirements are discussed in the following:

**Spatial comfort:** In this category, the ten performance elements are included, namely, convenience in parking facility, provision of facility to lock bicycle in parking shed, entrance door restricts the use of ramps and stairs are used instead, provision of handrail in ramps, No accessibility to use the pharmacy shop from outside, design of pharmacy shop as room than counter, provision of locking facility in the ward for belongings, distance of the bed from the toilet and flooring. The satisfaction index value determined that the 73 respondents were Dissatisfied with the 10 elements, as shown in the Table 2.

**Human comfort:** In this category, the seven performance elements are included, namely, provision of chairs outside each doctor's room, cleanliness in hospital, healing in Hospital Internal environment, purpose of fountain and landscaped courtyard to feel relax and good, accommodation facility for friends/family to stay when patient admitted, view of exterior windows and Impact of exterior landscaping. The satisfaction index value determined that the 45 respondents' were Dissatisfied with the 7 elements, as shown in the Table 2.

## **CONCLUSION AND RECOMMENDATIONS**

This report focusses on Post- Occupancy evaluation of Hospital building at National Institute of Technology, Tiruchirappalli, Tamil Nadu, and India. User Satisfaction Survey, Walk-through Inspections and Focus group discussions were made to collect Data. The study is divided based on two main categories such as design considerations of hospital building with respect to Functional element and Overall comfort. Satisfaction Index values were found for each element and several recommendations are inferred from the study.

- Provision of locking facility for bicycle in parking shed is required.
- Steps have to be taken to help differently abled user to access the ramp.
- Handrails should be provided in Ramps
- Restriction to use Pharmacy from outside should be changed. Accessibility is needed from outside.
- Lockers should be provided for the users in the ward to keep their belongings.
- Number of chairs outside the Doctor's room for visitors has to be increased.
- Efficient use of Courtyards has to be enhanced so that it helps in healing.
- Accommodation for patients' friends and family has to be provided inside hospital.
- Connection between indoor and outdoor can be increased.
- Security Problems are to be taken care of.
- Doctor's rest room may be shifted to be in closer proximity with Consultation room.
- Shading Devices can be re-designed to provide better thermal comfort.

In this area, the scope of future research is to do a quantitative analysis with suitable apparatus to check the quantitative levels of Indoor Environmental Quality. These can be used, with further research to develop standards for the Hospitals.

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## APPENDIX

### NITT Hospital Post Occupancy Evaluation- Feedback Form

M.Arch Project for the subject: Post Occupancy Evaluation of Buildings.

The Purpose of this form is to understand how good has been the design of the Hospital Building with respect to the intended use.

This Data that you give will be open source and will help architects design and build Better Hospitals, More Responsive to user needs.

I have picked up the NITT hospital which is located within the campus.

This survey is open to anyone who has been to the hospital for OPD or been admitted to the hospital of NIT Trichy.

Your Feedback is going to help the future of Hospital Design.

- ✓ Name:
- ✓ Year and Stream:
- ✓ Email (optional) we will share the survey results.

1. Is the facility for parking bicycles convenient?\*

Very Much  1  2  3  4  5  Not at all

2. Do you need a place to actually lock your bicycle in the hospital parking shed?\*

Very Much  1  2  3  4  5  Not at all

3. [For Differently Abled students or for anybody who could not walk easily due to injury]:  
Does the door at the ramp discourage you to use it, and you have to use the stairs instead?

Very Much  1  2  3  4  5  Not at all

4. [For Differently Abled students or for anybody who could not walk easily due to injury]:  
Do you feel that the ramp needs a handrail?

Very Much  1  2  3  4  5  Not at all

5. Would you prefer to use the Pharmacy shop from the outside? \*

Very Much  1  2  3  4  5  Not at all

6. Would you prefer if the Pharmacy shop was more like a counter than a room in which you have to enter? \*

Very Much  1  2  3  4  5  Not at all

7. Do you find the Hospital floor Clean when you enter the Hospital? \*

Very Much  1  2  3  4  5  Not at all

8. Does the floor slip? \*

Very Much  1  2  3  4  5  Not at all

9. Do you feel that there should be more chairs outside each doctor's room? \*

Very Much  1  2  3  4  5  Not at all

10. [For anybody who has been admitted to the hospital, even for a day]: Is the room (ward) temperature ok?

Very Much  1  2  3  4  5  Not at all

11. [For anybody who has been admitted to the hospital, even for a day]: Do you hear noise of Honking or any other noise from outside?

Very Much    1    2    3    4    5    Not at all

12. [For anybody who has been admitted to the hospital, even for a day]: Does the noise disturb you?

Very Much    1    2    3    4    5    Not at all

13. [For anybody who has been admitted to the hospital, even for a day]: Are you satisfied with the distance of the bed from the toilet?

Very Much    1    2    3    4    5    Not at all

14. [For anybody who has been admitted to the hospital, even for a day]: Does the toilet smell come to the bed?

Very Much    1    2    3    4    5    Not at all

15. [For anybody who has been admitted to the hospital, even for a day]: Do you get a good view of the outside from the window?

Very Much    1    2    3    4    5    Not at all

16. [For anybody who has been admitted to the hospital, even for a day]: If yes, is it of something pleasing like a tree or landscaping?

Very Much    1    2    3    4    5    Not at all

17. [For anybody who has been admitted to the hospital, even for a day]: Does the noise from the adjacent room come to your room?

Very Much    1    2    3    4    5    Not at all

18. [For anybody who has been admitted to the hospital, even for a day]: Do you feel visual privacy? (Or can anyone peep into the ward?)

Very Much    1    2    3    4    5    Not at all

19. [For anybody who has been admitted to the hospital, even for a day]: Do you feel that the internal environment of the hospital helps you in Healing?

1    2    3    4    5  
Very Much                  Not at all

20. [For anybody who has been admitted to the hospital, even for a day]: Is there a place for you friend/family to stay with you while you are admitted?

1    2    3    4    5  
Very Much                  Not at all

21. [For anybody who has been admitted to the hospital, even for a day]: Does the ceiling height make you comfortable?

1    2    3    4    5  
Very Much                  Not at all

22. [For anybody who has been admitted to the hospital, even for a day]: Is there too much Sun coming from the window?

1    2    3    4    5  
Very Much                  Not at all

23. [For anybody who has been admitted to the hospital, even for a day]: Is there a glare of the sun?

1    2    3    4    5  
Very Much                  Not at all

24. [For anybody who has been admitted to the hospital, even for a day]: Are you satisfied with the artificial lights in the ward?

1    2    3    4    5  
Very Much                  Not at all

25. [For anybody who has been admitted to the hospital, even for a day]: Does rainwater splash into the room?

1    2    3    4    5  
Very Much                  Not at all

26. [For anybody who has been admitted to the hospital, even for a day]: Do you need some kind of a locking facility in the ward for your belongings?

1    2    3    4    5  
Very Much                  Not at all

27. Do you feel that the fountain and the landscaped courtyard help you relax and feel good?

1    2    3    4    5  
Very Much                  Not at all

28. Any other suggestion with respect to the physical environment of the hospital?

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29. When did you last visit the hospital?

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30. Describe Yourself?

Student

Faculty

Technical Staff

Non-teaching Staff

Outsider

Others \_\_\_\_\_

31. Your association is with?

NIT Trichy

IIM Trichy

IIT Srirangam

Outsider

Other

32. Would you like to be updated with the results of this experiment? If yes, please provide your

contact \_\_\_\_\_

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