Study And Assessment For Damages And Maintenance Management of Residential Apartment In Pune City

Utkarsha Dhok[1], Dr. A. B. Ranit[2], Prof. A. G. Kale[3]
[1, 2] Dept of Civil Engineering (Construction Engineering & Management)
[3]Assistant Professor, Dept of Civil Engineering (Construction Engineering & Management)
[1, 2, 3] VYWS's PRMCOEM, Badnera-Amravati

Abstract- *Building management and maintenance has gained its importance after a series of disastrous building-related incidents all over the world. To facilitate the management of an apartment building, homeowners usually form an owners' association among themselves and / or appoint an external property management agent (PMA) to manage the building on their behalf.The aim of the article is to present the results of preliminary research of the defects in residential buildings occurring during the warranty period.For the examination of defects, statistical analysis was used, which revealed that more than half of the reports contained reasonable defects.Performance measurement is a helpful tool for taking corrective actions and controlling a project as far as this enables accurate time and cost forecasts during the first stages of the construction effort when the management team still has opportunities to make adjustments.This article examines the process of building maintenance and management in Pune with the aim of identifying factors causing poor maintenance in various types of buildings, and delivering a new improved process. The study focuses on the management of building maintenance, including setting up organizations, policies and quality standards. It makes extensive use of questionnaires and surveys as a means of data collection. The surveys cover all aspects of maintenance management in Pune, including occupant satisfaction, number of staff members and the strategies used in maintenance delivery. The framework of the process was then developed based on the outcome of the surveys. The process covers all major aspects suchas management, staffing, training and regulation that are useful in managing maintenance sections.*

Keywords- Building Maintenance, Rehabilitation, Maintenance, Damages, etc.

I. PROBLEM STATEMENT

Inefficiencies in building maintenance and its consequent effects cannot be neglected, as cases of building collapse, building abandonment, building short life span and inability of buildings to serve the purpose of their construction proliferate. Inadequate examination of building maintenance problems before commencement of maintenance works, Lack of maintenance manual, Lack of building survey reports and Non-involvement of concerned professionals during the design of building construction and maintenance projects are factors that enhance these inefficiencies in building maintenance. To tackle these challenges, building survey becomes a necessity.

II. OBJECTIVES

The aim of this project is to know the effect of damages on the apartments and the impact of maintenance management on building apartment projects. Also to evaluate the use of building survey as a tool for effective building maintenance program. To achieve the above stated aim, the following objectives must be pursued;

1. To study the current scenario regarding role of maintenance & repair management in residential apartments.
2. To analyze different causes of failure and damages in building and remedies to overcome them.
3. To find out critical maintenance factors and recommend remedies to them.
4. To maximize the aesthetic and economic values of building as well as increase the health and safety of occupants and to extend the useful life of building.

III. BUILDING CASE STUDIES

Many occupants in residential apartment projects in various parts of the city are often running into difficulties in resolving maintenance and repair works. So, it sometimes results in an increase in time and unknown costing of the repair work. Many previous case studies had been shown the various factors and methods to minimize the maintenance issues faced by the residents but still these issues sometimes are delayed to achieve a solution due to various reasons. It indicates that there is either lack of awareness of the suggested construction practices or there are limitations for the effective adoption of their suggestion. It may vary from each case study of the construction projects.

For the aim of this study, data is collected and used within the analysis to make conclusions. This primary data was collected by questionnaire survey forms that were distributed to the targeted respondents. In total, 25 responses were obtained throughout survey at the construction building projects severally between 12:00pm and 3:00pm. The data analysis was conducted throughout the lunch hour to accommodate the respondents who won't be free throughout operative times. The questionnaire was in a while revised supported the information and feedback provided by these people. Upon revision and end result of the form, questionnaire data analysis was commenced. Once all the information required had been obtained, it fully was analyzed. Supported the derived results, conclusions were drawn.

Section-B of the questionnaire asked respondents to provide their personal profile As far as their personal profile is concerned, the respondents were asked to provide information on the position held in the organization, their highest level of qualification, and if the qualification was accounting-related. These questions were deemed necessary to ensure that only the intended respondents participated in the study and that those participating were knowledgeable about the inventory-management practices of their entities.

The 25 useable questionnaires obtained from construction organizations. Fig. 1illustrates the number and percentage of the respondents for each section according to their designation, department, work experience, educational qualification and gender; also for quality management overview.

Particulars	Category	Frequency	Percentage
Designation	Employee	3	10.00
	Team Leader	4	13.33
	Quality Manager	3	10.00
	Project Manager	5	16.67
	Supervisor	4	13.33
	Management	4	13.33
	Other	2	6.67
Total		25	100

Fig 1. -Respondents Profile: Designation

IV. DAMAGES OF VARIOUS BUILDING COMPONENTS

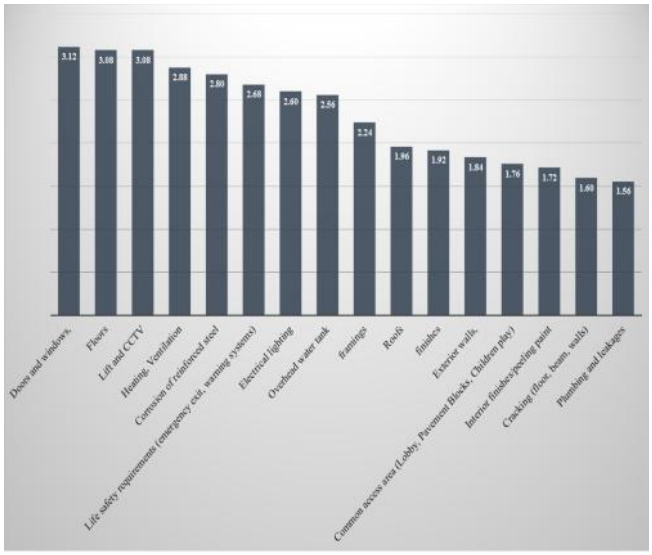
Damage to buildings is a sure thing to happen, both during the planning, implementation and usage period. Factors causing damage to buildings consist of building age, soil and ground water conditions, wind, earthquake, fire, lightning, material quality, pests, quality of planning, mismanagement, and changes in building functions. To maintain the condition of the building in order to keep functioning properly or in an effort to increase the form of the building and guard against damaging effects, maintenance of the building is needed. The aim of building maintenance is to preserve the building in its initial effective state and this must be started from building maintenance at organizational strategic level.

For the Section-C questionnaire is designed from the study of literature review which consists of 16 building components, categorized in four different severities namely, severe damage, considerable damage, slightly damage & undamaged and responses are collected from different building personals of selected sites. Respondents were asked to rate various building components on a 4-point Likert's scale as 1 for severe damage to 4 for undamaged. And the responses obtained were analyzed by finding out the mean and criticality index for each building component. To identify the criticality index for each building component, the factor criticality was defined as in the Table 1below:

Table 1- Criticality Assessment Criteria (Source: Wan Nadzri Bin Osman)

Range of Mean	Criticality Index	Criticality Level
1 to 2	1	Mostly damaged
2 to 3	2	Moderately damaged
3 to 3.5	3	Mildly damaged
3.5 to 4	4	Least damged

Building components critical analysis is a quantitative analysis of building components damages & faults, and ranking them in order of serious consequences on safety, damages and maintenance cost. The key benefit of this analysis is to provide the means to recognize high-criticality vs. low-criticality reduce the level of uncertainty and focus on high-priority maintenance tasks. The analysis also helps select the best and most economic maintenance strategy, prioritize work orders and decide on insurance and the demand on critical building components.



After collecting all the necessary data and doing all the procedures, out of sixteen, seven factors are find out to be major contributing in maintenance and repair. This is obtained by means of criticality index, as shown in table 5.7.

In term of critically index, three of the building components namely Doors and windows, Floors, Lift and CCTV can be categorized at moderate level. Five of the building components namely Heating Ventilation, Corrosion of reinforced steel, Life safety requirements (emergency exit, warning systems), Electrical lighting, Overhead water tank and framings can be categorized at mild level. And seven of the building components considered as critical namely:

1. Roofs (Mean=1.96)
2. Finishes (Mean=1.92)
3. Exterior walls (Mean=1.84)
4. Common access area (Lobby, Pavement Blocks, Children play) (Mean=1.76)
5. Interior finishes/peeling paint (Mean=1.72)
6. Cracking (floor, beam, walls) (Mean=1.60)
7. Plumbing and leakages (Mean=1.56)

According to the responses obtained, it can be said that there are some building components which contribute more to the maintenance and repair of building. By taking appropriate actions to those components useful life of building can be extended and safety of occupants increased.

The highest mean score for Damage of Various Building Components for the whole data set as perceived by the construction stakeholders is 3.12 where the respondents believed that doors & windows are very less critical as damage is concerned. The minimum score is 1.56 where the respondents believed that plumbing & leakages is the most critical building component as damage is concerned. Overall mean for the whole data set is 2.34, which could be considered at mild level.

V. GOVERNING FACTORS AFFECTING BUILDING DEFECTS & FAILURES

Failures and defects are common phenomena in construction industry. Negative impacts may arise towards cost, duration and resources of project. Failures and defects can cause unnecessary expenditure and delays. They are also generating controversies among parties involved. Furthermore, if this situation is left unanswered and untreated, it will lead to more serious problems in the future upcoming construction projects in Pune, Maharashtra. Therefore Section-D of the questionnaire is aimed to identify contribution factors to building defect and failures, which frequently occur in construction project especially in Pune region in order to minimize time and cost involved. The data is collected from questionnaire from various personals in construction industry. This section is succeeds in identifying the common contribution factors of structural defects and failures in construction project.

The aim of this section is to identify and rank the factors affecting the defects occurrence in the construction stage of the residential apartment buildings in Pune region. A survey was conducted with 25 respondents working for construction firms as design engineers, supervisors and project managers. This section is the attempt at identifying factors affecting defect occurrence in the construction stage of residential apartment buildings of the developing countries. The findings will be useful for the construction firms and regulatory bodies to deal with the critical factors affecting defect occurrence and device such policies that improve the design and construction of residential buildings.

Based on the research, a total of 20 factors affecting building defect & failure from Fig. 2 were found in the literature which caused the building defect. The factors affecting the defects in the buildings scored on a five-point Likert Scale based on their significant, as 1 for disagree and 5 for strongly agree. Then relative weight is calculated & after calculating the relative weight, the factors are given Rank from 1 to 20 in order of importance. And in this way the most effective main factors affecting building defects during the construction stage were identified.

Fig. 2 above shows the calculations for mean, standard deviation and relative weight given to each factor. On the basis of that factors are given the Rank, such that higher the value of relative weight, Rank will be 1 and so on.

Therefore factors were given the rank from 1 to 16. The below Fig. 3 is used to arrange the factors in order of their importance based on the rank obtained.

ID	Building Defects & Failures	1	2	3	4	5	Mean	Relative Weight (%)	Rank
D-1	Construction Materials Failure or Component Failure	2	3	3	13	4	3.56	71.2	16
D-2	Building Type and Change in Use	3	4	5	7	6	3.36	67.2	19
D-3	Speedy completion or poor-quality work	1	6	6	7	5	3.36	67.2	20
D-4	Absence of engineer in most of the construction phases	2	3	4	7	9	3.72	74.4	12
D-5	Lack of inspection and material testing.	1	4	5	7	8	3.68	73.6	14
D-6	Overloading of building during the construction stage	2	3	4	8	8	3.68	73.6	15
D-7	Use of new and untested materials	1	2	5	8	9	3.88	77.6	8
D-8	Poor roof water drainage system	2	3	4	7	9	3.72	74.4	13
D-9	Neglecting inspection results and their recommendations in implementing corrective actions during job execution	1	2	2	9	11	4.08	81.6	5
D-10	Communication gap between contractors and design professionals	1	3	4	8	9	3.84	76.8	9
D-11	Using of corroded steel or second-hand reinforcement steel	4	4	2	7	8	3.44	68.8	18
D-12	Human-side interventions and expression of opinion without knowledge	2	3	2	9	9	3.8	76	11
D-13	Corruption	1	1	3	9	11	4.12	82.4	4
D-14	Lack of Supervision	2	2	2	8	11	3.96	79.2	6
D-15	Faulty Design	1	1	1	9	13	4.28	85.6	1
D-16	Climatic Condition	3	3	2	11	6	3.56	71.2	17
D-17	Lack of Maintenance	2	3	2	8	10	3.84	76.8	10
D-18	Wrong Waterproofing	1	1	2	10	11	4.16	83.2	3
D-19	Vandalism	2	2	2	9	10	3.92	78.4	7
D-20	Lack of Proper Cleaning	1	1	1	10	12	4.24	84.8	2

Fig. 2Governing Factors Affecting Building Defects & Failures

The findings revealed ten most effective main factors during the construction stage. The first one being Faulty Design having relative weight of 85.6%. The major causes of structural failure are defective designs that have not determined the actual loading conditions on the structural elements. Inferior construction materials may also be the cause since the loads are calculated for materials of specific characteristics. Second is lack of proper cleaning, and then wrong waterproofing, corruption, Neglecting inspection results and their recommendations in implementing corrective actions during job execution, lack of supervision, vandalism, use of new and untested materials, communication gap between contractors and design professionals and lack of maintenance.

All elements of the building do not have 60 or say 100 years of life. Say an electric switch might have a life of 15 to 20 year or water proofing has a life of 10 to 15 year. Hence you also need to replace them as and when needed. Similarly painting have life of 1 to 5 years depending upon its type and hence you need regular painting to walls and mild steel elements like grill, etc.

I.D.	Factors affecting Building Defects & Failures	Relative Weight	Rank
D-15	Faulty Design	85.6	1
D-20	Lack of Proper Cleaning	84.8	2
D-18	Wrong Waterproofing	83.2	3
D-13	Corruption	82.4	4
D-9	Neglecting inspection results and their recommendations in implementing corrective actions during job execution	81.6	5
D-14	Lack of Supervision	79.2	6
D-19	Vandalism	78.4	7
D-7	Use of new and untested materials	77.6	8
D-10	Communication gap between contractors and design professionals	76.8	9
D-17	Lack of Maintenance	76.8	10
D-12	Human-side interventions and expression of opinion without knowledge	76	11
D-4	Absence of engineer in most of the construction phases	74.4	12
D-8	Poor roof water drainage system	74.4	13
D-5	Lack of inspection and material testing.	73.6	14
D-6	Overloading of building during the construction stage	73.6	15
D-1	Construction Materials Failure or Component Failure	71.2	16
D-16	Climatic Condition	71.2	17
D-11	Using of corroded steel or second-hand reinforcement steel	68.8	18
D-2	Building Type and Change in Use	67.2	19
D-3	Speedy completion or poor-quality work	67.2	20

Fig. 3- Governing Factors Affecting Building Defects & Failures in order of Importance

VI. OVERVIEW OF BUILDING MAINTENANCE MANAGEMENT

Building maintenance is a fundamental practice in facility management, which supports the longevity of a building. Increasing costs of maintenance practices is a challenge for facility management professionals. Given that, building maintenance decisions often comprise complex and conflicting criteria. The primary purpose of this section is to develop and rank a set of criteria needed for constructing a multi-criteria decision-making model for use in building maintenance processes. This study also has an exploratory aspect and tries to establish the decision-making and condition assessment practices currently used in facility management. Building maintenance constitutes essential practices to sustain the performance of buildings within required standards as well as decrease the impact of equipment and system failures. Therefore, building maintenance practices have a remarkable effect on the longevity of a building.

I. D.	Questions	Responses			% Yes	% No	% N/A
		Yes	No	N/A			
E-1	Does maintenance of building require the use of building survey?	20	5	0	80	20	0
E-2	Does the problem of maintenance of buildings occurs as a result of improper specification?	12	9	4	48	36	16
E-3	Does the type and form of maintenance to be employed in the maintenance of building depend on the choice of the client?	10	10	5	40	40	20
E-4	Does any professional in the building industry qualified to undertake a building survey?	12	10	3	48	40	12
E-5	Can maintenance work in building be delayed because of lack of building survey?	8	15	2	32	60	8
E-6	Can proper survey reduce the cost of achieving an effective maintenance project?	21	3	1	84	12	4
E-7	Can proper maintenance of building enhance the lifespan of the building?	23	1	1	92	4	4
E-8	Can building be efficiently maintained without taking proper look at the building survey report?	8	15	2	32	60	8
E-9	One of the major objectives of applying the use of building survey in the maintenance of building is to control dilapidation of the building?	18	5	2	72	20	8
E-10	Does the building surveyor need to take into consideration, the use of maintenance manual before carrying out any maintenance operation?	16	6	3	64	24	12

Fig. 4- Overview of Building Maintenance Management

As summarised in Fig. 4, 80% of the respondents agreed that maintenance of building require the use of building survey and only 20% said no to the fact E-1. The fact that problem of maintenance of buildings occurs as a result of improper specification is agreed by 48% and disagreed by 36%, also few of the respondents i.e. 16% were found to be unaware about the same. Next was the type and form of maintenance to be employed in the maintenance of building depend on the choice of the client, this statement was agreed by 40%, disagreed by 40% of respondents and still 20% said not applicable.

48% of the respondents agreed that any professional in the building industry qualified to undertake a building survey, while 40% said No to the fact and 12% were not sure. Maintenance work in building can be delayed because of lack of building survey, this statement was disagreed by 60% and agreed by only 30% of the respondents, at the same time 8% were unaware about the fact E-5. Then 84% respondents agreed that proper survey reduce the cost of achieving an effective maintenance project, while only 12% said no and 4% said not applicable.

The most agreed statement by the respondents was that proper maintenance of building enhance the lifespan of the building, 92 % agreed the fact, while 4% disagreed & 4% said not applicable. Building be efficiently maintained without taking proper look at the building survey report, this statement was disagreed by 60% & only agreed by 32%, also 8% respondents were unaware. 72% agreed that one of the major objectives of applying the use of building survey in the maintenance of building is to control dilapidation of the building, 20% disagreed and 8% said not applicable. The building surveyor need to take into consideration, the use of maintenance manual before carrying out any maintenance operation, this was agreed by 64%, disagreed by 24% and 12% of respondents said not applicable.

VII. BRIEF SUMMARY OF THE STUDY

The first thing that was done during this study was to get a glimpse of the literature. From the literature review, we get to know the opinion of each author based on their study. Then project methodology was decided and questionnaire measure was carried out. Then the questionnaire survey was conducted for Apartment Buildings in Pune city. For the analysis total 25 responses were obtained, based on which the analysis & discussion on each section of the questionnaire was done.

It can, therefore, be concluded that building maintenance management should accurately be considered as unfolding how a system of maintenance endeavour might be prearranged to deal with a problem of building maintenance. There are a few factors that influence the decision to accomplish the maintenance work. There are the maintenance needs that is the principal aspire of maintenance is to protect a building in its early stage and some major rationale for maintaining building are retaining its significance and value of investments, maintaining the building in a condition that it persists to accomplish its purpose and presenting a good outer shell. Besides that, the efficient maintenance management system embraces many skills and efforts that include identifying maintenance needs and the accurate and spot on remedies. This study will bring more alertness to the public about the benefits of building maintenance management and why we need to have proper building maintenance management systems.

VIII. CONCLUSION

1) According to data analysis for building defects and failures, faulty design with highest relative weight of 85.6% is responsible for affecting building defects and failure.
2) Also lack of proper cleaning, wrong waterproofing, corruption and neglecting inspection result and their

recommendations in implementing corrective actions during job execution are factors responsible for building defect and failure.

3) According to 25 respondents Proper maintenance of building enhance the lifespan of the building.
4) Most critical component for damages with criticality index 1 are roofs, exterior walls, finishes, interior finishes/peeling paints, plumbing and leakages, cracking(floor beam, wall) and common access area (lobby, pavement blocks, children play).

IX. ACKNOWLEDGEMENT

I am highly grateful to thank my guide,Dr. A.B.Ranit, Prof. A.G.Kale, Department of Civil Engineering (CE&M), PRMCOEM Badnera- for their constant intellectual support in the form of innovative ideas and valuable guidance. Their expert suggestions and scholarly feedback had greatly enhanced the effectiveness of this work.

REFERENCES

[1] N. Ahzahar, N.A. Karim, S.H. Hassan, J. Eman; "A Study of Contribution Factors to Building Failures and Defects in Construction Industry"; The 2nd International Building Control Conference 2011; PP 249-255.

[2] Wan Nadzri Bin Osman, Zulkifli Mohamed Udin and Dani Salleh; "Adoption Level of Sustainable Construction Practices: A Study on Malaysia's Construction Stakeholders"; Journal of Southeast Asian Research; Vol. 2012 (2012), Article ID 270273.

[3] Nima Amani, Nasly Mohamed Ali, Abdul Hakim Mohammed, Roslida Abd Samat; "A Survey On The Implementation Of Facilities Maintenance Management System Of Building In Iran"; Malaysian Journal of Civil Engineering; 2012; PP 85-95.

[4] Marcin Gajzlera; "The Support of Building Management in the Aspect of Technical Maintenance"; The 2nd International Conference on Rehabilitation and Maintenance in Civil Engineering; 2013; 615 – 624.

[5] R S Velmurugan, Tarun Dhingra; "Maintenance strategy selection and its impact in maintenance function"; International Journal of Operations & Production Management; Vol. 35 No. 12; 2015; PP 1622-1661.

[6] Iheama, N. B., Alinta-Abel, U. and Ezeokoli O. F.; "Assessment Of Building Survey As A Tool For Building Maintenance Program A Study Of Awka, Anambra State"; International Journal of Civil Engineering, Construction and Estate Management; Vol.5, No.1; March 2017; PP 1-15.

[7] 7] Aliyu Ahmad Aliyu, Sule Alhaji Bello, Maryam Salihu Muhammad, Ibrahim Musa Singhry, and Mohammed Girgiri Bukar; "An Assessment Of Building Maintenance Management Practice For Abubakar Tafawa Balewa University Teaching Hospital, Bauchi"; Research Gate Publication; • July 2016.

[8] Mohd Nasrun Mohd Nawi, Faizal Baharum, Siti Halipah Ibrahim and Salman Riazi Mehdi Riazi; "A review study of maintenance and management issues in Malaysian commercial building towards sustainable future practice"; The 2nd International Conference on Applied Science and Technology 2017.

[9] Snehal N Mandlik, Prof. Hemant H Salunkhe; "Analysis and Management of Maintenance and Repair Works in Residential Building"; International Journal Of Engineering Applied Sciences And Technology, 2019; Vol. 4, Issue 3, ISSN No. 2455-2143, Pages 432-437.

[10] Vikrant. M. Singh, A. T. Pawar; "Analysis and Construction Management of Maintenance and Repair Work in Residential Building by Mobile Application"; International Research Journal of Engineering and Technology (IRJET); Volume: 07 Issue: 06, June 2020; pp. 5640-5643.

[11] Hamed Taherdoost; "Different Types of Data Analysis; Data Analysis Methods and Techniques in Research Projects"; International Journal of Academic Research in Management (IJARM); Volume 9, Issue 1; 2020; PP. 1-9.

[12] Elysé Masengesho, Nadine Umubyeyi, Theoneste Bigirimana, Marie Judith Kundwa, Theogene Hakuzweyezu, Rosette Niyirora, Charles Ntakiyimana, Nura Ineza; "Impact Of Maintenance Operations In Buildings Performance, Kigali Commercial Buildings Case Study"; International Journal of Civil Engineering, Construction and Estate Management; Vol.9, No.1; 2021; PP1-20.