

Assessment and Development of Framework of Building Maintenance Management Practices in Construction Industry of Pakistan

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Abstract: In a modern era where construction industry keeps on booming at high rate, the proportion of building maintenance is also growing in parallel because of increasing awareness of current need to manage condition of the building stock more efficiently. Not only the Life span of buildings can be increased by proper implementation of maintenance management practices, but premature failure of building elements can be catered as well. In the light of rapidly increasing demand of building stocks in a developing country like Pakistan, maintenance of buildings and the assessment of their management practices is the main objective of this paper. The study of this paper is based on assessment of maintenance processes, policies and practices by carefully inspecting residential and commercial buildings in Lahore. Data collection was done through field survey, interviews from the building users, visual inspections and photographic & Observational studies. The results showed that maintenance management practices of buildings are the most neglected part and buildings being in the state of disrepair become a continues threat to its users. Furthermore, this study has concluded all maintenance management practices by introducing an implementation framework for Construction Industry of Pakistan.

Keywords: Construction Industry, Maintenance framework. Maintenance management,

I. INTRODUCTION & BACKGROUND STUDY

Buildings being the most valuable assets of any nation provides its occupants shelter from different kind of environmental loads and facilities for work and leisure. All buildings are exposed to different sorts of weather attacks which keeps on deteriorating the building fabric. (C. Y. Yong, 2015) development of infrastructure with planned maintenance is the property of a developed country. (O. O. Ugwu, 2018) Physical infrastructure comprises a large portion of any country's venture whether they are public or private buildings. (Cobbinah, 2010) As stated by Abu Bakar, management has major role in construction industry as it enhances the number of GDP, as GDP has on average 5-9% of construction industry in developing countries. (Abu Bakar, 2002) Construction industry of Pakistan has flourished a lot in last ten years increasing the GDP from 230000 million Pkr in 2010 to 343183 million Pkr. (TRADING-ECONOMICS, 2019) Development of any country largely depends upon its proper planning and management for achieving high quality construction projects. (M. Haseeb, 2011) in Pakistan, the construction projects being complex in nature are always subjected to unseen circumstances and issues that may affect the quality and life of structures. (S. Shujaa Safdar Gardezi, 2014)

So, in the lieu of above-mentioned facts, building maintenance management has become hot research topic in recent era as construction sector is rapidly increasing globally. According to latest released report of Global Data Construction 2030, it is anticipated that volume output of construction industry will rise up to 85% by 2030, out of which 57% of all global growth will be driven by US, India and China. (Robinson, 10 November 2015). This rapidly increased growth in construction sector also driving maintenance management importance in buildings. Building management program was developed around 20 years back in developed countries but now developing countries are following the same trend. (Mohd Nasrun Mohd Nawi F. B., 2017) Building maintenance sector always have important stifling effect in construction department of Europe. (Bonanomi, 2016) Many countries throughout the world such as Nigeria, Malaysia, Africa, Ghana, Japan and many others are spending a large share of their resources on public buildings maintenance in order to increase economic value of their physical infrastructure. (Cobbinah, 2010) (Edmond W.M. Lam, 2010) (Lateef, 2010) (Zubairu, 1999) (Twumasi-Ampofo, 2017) (Eke Emmanuel Chidi, 2017) (TIJANI Saheed Abiodun, 2016) (Bakar, Tufail, Tufail, & Virgiyanti, 2011). The construction industry in Europe accounts for 40% activities in maintenance and repairing work. (Lordsleem) while this number of building maintenance activities have raised up to 50% in Britain. (Edmond W.M. Lam, 2010). In Europe, maintenance sector share for buildings is almost same than that of new constructions market while in Netherland, maintenance sector increases 15% annually because of ageing in Building stock. (Hermans, 1998)

Maintenance covers a huge number of elements under one bracket such as repair work, replacing, monitoring, inspection and testing etc. (OSHA, 22 Jul 2010) According to Chong Choon, Building Maintenance is defined as a chain of actions including technical and administrative measures, envisioned to take care of a structure in such an acceptable state where it can perform its original function optimally. (Chong Choon Full, January 2014). Maintenance work doesn't merely include physical execution of series of activities to be performed but it is also concerned with initiation, organization and financing of that actions as well. (Barrie Chanter, 2007) In the past, building maintenance considered to be a pointless activity because of its resource depleting

nature. (R. Kalumbu, 2016) But in recent era maintenance management department has been recognized as a way leading towards sustainable Construction goals. (R. Kalumbu, 2016) Any structure, its facilities and services all require different level of maintenance throughout its life. (E.M.A Zawawia S. K., 2011) Maintenance and operational are longest and expensive stages of whole building life cycle. (Michal FALTEJSEK, 2019). Any building has two types of lives; Structural life/ Physical life and economic life. Structural life termed to be a life span of building in which it remains able to fulfill its purpose of sheltering effectively while economic life is the time period of effective life of building before it is prone to replacement. (Seeley, 1987). So timely maintenance practices appreciate capital asset by enhancing building’s effective life directly. (Cobbinah, 2010) According to Olanrewaju Lateef, fundamental aim of maintenance is to extend the service life of a building that can be done by postponing the structural decay and fabric deterioration. (Lateef, 2010) Lack of periodic maintenance management practices can lead to any mishap as failure of structure, under continuous pressure of decaying and deterioration, which results into non- fulfilling the intended purpose of building. (Twumasi-Ampofo, 2017)

Maintenance can be divided into two major type depending upon the predefined planned activities i.e. Planned maintenance and unplanned maintenance. (Cobbinah, 2010) Types of maintenance described by Ryan Cruzan in Figure are: (Cruzan, 2009) (Mobley, 2004). According to Abiodun and Wireman, Preventive measurement is a sustainable approach as it applies on pre-decided time intervals which consequently reduced probability of failure of intended performance of any building or item. (TIJANI Saheed Abiodun, 2016) (Wireman, 2008) According to Chin-man, Principles of long- maintenance plan can be classified into four major areas. i.e. Services, repair, replacement and upgradation. (Chin-man, 2002) Once the building fabric is treated with these maintenance principles up to a specified standard, then it allows the structure to serve its purpose effectively throughout its service life without disturbing its basic features. (Lateef, 2010) Life span of any structure largely depends upon the type and quality of maintenance chosen for that building. (Zubairu, 1999) according to Sunday, building life also depends upon building usage as well as the maintenance practices and policies followed in that. (Odaudu Ugbede Sunday, 2019) There is a strong relation between building component type and its service life span. As stated by Herman, Life span of a structural component may be upto 75 years and in Netherland this value is up to 100 years whereas life span of building services and external building components i.e. façade depends upon quality of maintenance as well as technological advancements in systems. (HERMANS, 1999) Choice of maintenance could also be influenced by other factors i.e. building age, its condition, value of the asset, urgency of work, future use etc. (OLUWATOYIN, 2014)

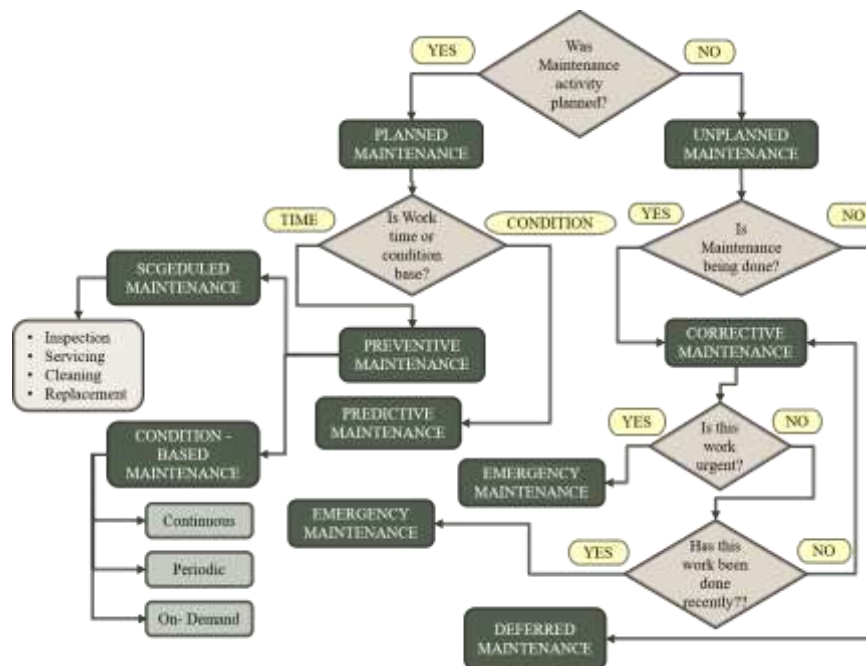


Fig 1: Types of Maintenance & Their Decision- Making, Sources; Cruzan, 2009, Mobley, 2004

Maintenance has significant economic benefits in service life of a building. As expenditure on maintenance of any structure ensures its maximum possible return over structural life while performing its duties of human comfort and satisfaction. (Cobbinah, 2010) As said by Celestine, also cited by Adenuga, Development of maintenance culture in any nation is one of the most powerful force that plays the role of catalyst in growth of its economic, social and technological advancements. (Celestine, 1989) (O. A. Adenuga, 2010) Maintenance is becoming a modern tool for sustainability in construction industry. (Cooper, 2008) Zubairu explained that sustainable approach in maintenance management is need of the hour which will not only reduce maintenance cost but also solves many issues related to maintenance without compromising the human comfort and satisfaction of building users. (Zubairu, 1999) In the past few decades, building maintenance has become quite important aspect in terms of cost efficiency of a project as well. The cost of building maintenance includes different types of cost components that are

operating cost, maintenance and repairing cost, adaptation and renewal cost. (Twumasi-Ampofo, 2017). As stated by Pintelon, Maintenance cost should be minimized while meeting the desired results at the end. (Pintelon, 2009). According to D. Silva Building maintenance cost would be much higher and difficult to keep the maintainability if this aspect neglected during design and construction phase of the building. (Nayanthara de Silva, 2004) It is recognized that in all facilities operating costs, maintenance cost secured the second largest expense element. (Róka-Madarász, January 2011) Building maintainability factor if considered in pre- Construction and during Construction phase, would be a cost-effective measure, while allowing the additionally saved resources in execution of new projects. (Wordsworth, January 2001) According to Barrie, in an Annual maintenance cost breakdown of buildings, utilities represent the largest portion 28% than all other sectors as fabric, services etc. (Barrie Chanter, 2007). Maintenance management can effectively improve the performance of any industry as maintenance cost has almost 15 – 40 % share in total production cost. (Javeria Younus, 9-10 May 2015) Shah Ali has researched that Maintenance cost is highly influenced by some dominant factors such as building services, Age of building, building materials, building area, third party vandalism and failure to perform timely maintenance. (Azlan-Shah Ali, 2010) Users are the pivot factors which determines the satisfaction level of building maintenance rather than the structure itself. (A. A. Olanrewaju, 2015) According to Copper, major factors that results as dissatisfaction of maintenance practices are unclear specification, vague objectives, unrealistic framework, variation in survey conducting experiences and inappropriate data. (Copper, 2015) Maintenance is needed to be done in order to save the building from decaying and deterioration which results due to some building defects that are irrespective of its age. (Farida Elshorafa, 2015) As stated by Chin-man, these defects can broadly be classified into three areas; Design Defects, Material Defects and Poor workmanship defects. (Chin-man, 2002). Some common Building defects are presented in table 1 as defined in Maintenance Guidebook, 2002. Dampness is also a major building defect which is a global level problem. As researched by Adedeji, moisture in the building promotes unhealthy indoor environment and termite attack in timber work. (Adedeji, 2016). In addition to that, dry rot, fungus, termite infestation, land movement or unavoidable settlements also causes building defects. (N.Ahzahar, 2011)

Table 1: Common Building Defect, Source: Maintenance Guidebook, 2002

1	Defects in Buildings	<ul style="list-style-type: none"> • Defective concrete, spalling or loose plaster in ceilings • Water seepage from external wall, window, roof, or from ceiling • Structural cracks in walls • Structural cracks in columns & beams • Non-structural cracks (usually in plaster or other finishes with cement sand rendering as base) • Defective external wall finishes/mosaic tiles/ceramic tiles/stone cladding/curtain wall
2	Defects in Building Services Installation	<ul style="list-style-type: none"> • Water Supply • Electricity Supply • Fire Services • Lift and Escalator • Air Conditioning/ Heating
3	Defects in Slopes and Retaining Walls	<ul style="list-style-type: none"> • Defects of slopes or soil-retaining structures • Signs of landslide danger
4	Water Seepage and Drainage Nuisance	<ul style="list-style-type: none"> • Underside of roofs (such as flat roof, podium roofs) and bottom of light wells • Ceiling with internal areas above • Water penetration through external wall defects • Seepage from defective pipe-works or sanitary fitments • Improper fillings around Windows frames • Deterioration of water stops at construction/ movement joints. • Blockage of drains by rubbish/sand collected in the system especially in bends or traps
5	Defects in Windows and External Appendages	<ul style="list-style-type: none"> • Rusting of metal parts • Damage by fungus or vegetation growth • Water seepage through the features • Corrosion or loosening of attachments

Management is basically accessing the performance of any process and maintenance management of any structure comes under the same category (Farida Elshorafa, 2015). As said by Adenuga, management is a living force that binds different fragments together and force to do the things p to a marked standard. (Adenuga, 2012) According to Ben, Accumulation of different management activities that determines the goals of maintenance planning and strategies is termed as maintenance management. (Mohammed Ben-daya, 2016) Maintenance management process includes four steps i.e. identification, assessing, planning and controlling. (CIBSE, 2008) Main purpose of Building maintenance is to keep the building in acceptable conditions for its intended usage. In order to enhance useful life of the building with minimum deterioration and breakdown throughout its life cycle, an excellent maintenance management practice is essential. (E.M.A Zawawia S. K., 2011) it is also stated by Lateef, that successful maintenance of any building lies in the strategical planning of building standards and technologies; (Olanrewaju Ashola Abdul Lateef, 2011) that needs to be operated on daily basis to make efficient. (ALZABEN, April 2015) Maintenance management has been rapidly changing both in public and private sectors because of rapid increase in technology and global economy. (M.F.M. Mukelas, 2012) A properly planned maintenance management framework and policy can ensure appropriate layout of final scheme which would turn out much beneficial for enhancing economic life of any building. (CIBSE, 2008) Figure 2 depicts types of maintenance and the Choice of most appropriate strategy carried out by maintenance manager as every structure is exposed to continuous changing and policy should cater each circumstance clearly. According to Márquez, Maintenance management framework is the conceptual structure that supports the management process in an efficient way. (A. Crespo Márquez, 2009). A conceptual framework of maintenance management enables the manager to evaluate the

maintenance practices of a building with best practice and be able to refine their management approaches to the best practice standards. (Arazi Idrus, 2010) In order to have good maintenance management of buildings its framework is necessary which needs to be followed by the users and at the end it should also provide satisfaction level to them. (Kwon, 2011). In recent era it is an accepted fact by many authors that maintenance policies need to be linked with other resources of any organization such as man, materials, monetary, machinery, the tools, techniques, strategies and their frameworks. Maintenance management should be effective enough to achieve its purpose that can only be done by continuous improvement in its management process. (ALZABEN, April 2015) Otherwise its of literally no use if it's not up to the mark rather it will an additional burden to the budget in terms of maintenance cost, as said by Lau. (Wai Kin Lau, 2011) According to Lee, maintenance management is a great source for reducing the gaps between top management at strategy stage and the maintenance staff at execution stage to make efficient maintenance operation level. (Hackman Hon Yin Lee, 2009). Horner also gave a strategical framework for selecting most appropriate management strategy for different building elements individually. And he stated that finding most suitable cost-effective maintenance strategy for buildings is extremely difficult. (R.M.W. Horner, 1997) So in lieu of the above stated facts and importance of building maintenance and its framework, aim of this research is to develop a maintenance management framework for construction industry in Pakistan based upon the facts collected through field survey.

Building maintenance framework requires different tools and techniques which are essential to follow to perform the required operation. BELCAM (Z. Lounis, 2000) recent approaches for good management framework that has more economical benefits is to shift short term planning into long term strategies. (Bakar, Tufail, Tufail, & Virgiyanti, 2011) In maintenance management plan, team integration is the main power of any industry to overcome maintenance cost and defects during operation. (Mohd Nasrun Mohd Nawi N. Y., 2015)

II. MATERIALS & METHODS

A. Research Methodology

The purpose of this research was to find out the maintenance management practices of construction industry in Pakistan. The overall scope was bounded to the vicinity of Lahore that is the heart and commercial hub of Pakistan. This research being based on case study approach, is comprised of Qualitative research design which was consisted of site surveys, semi structured interviews and Direct Observation method for data collection. These methods were used to not to collect, analyze and interpret the data but to infer conclusions from the data.

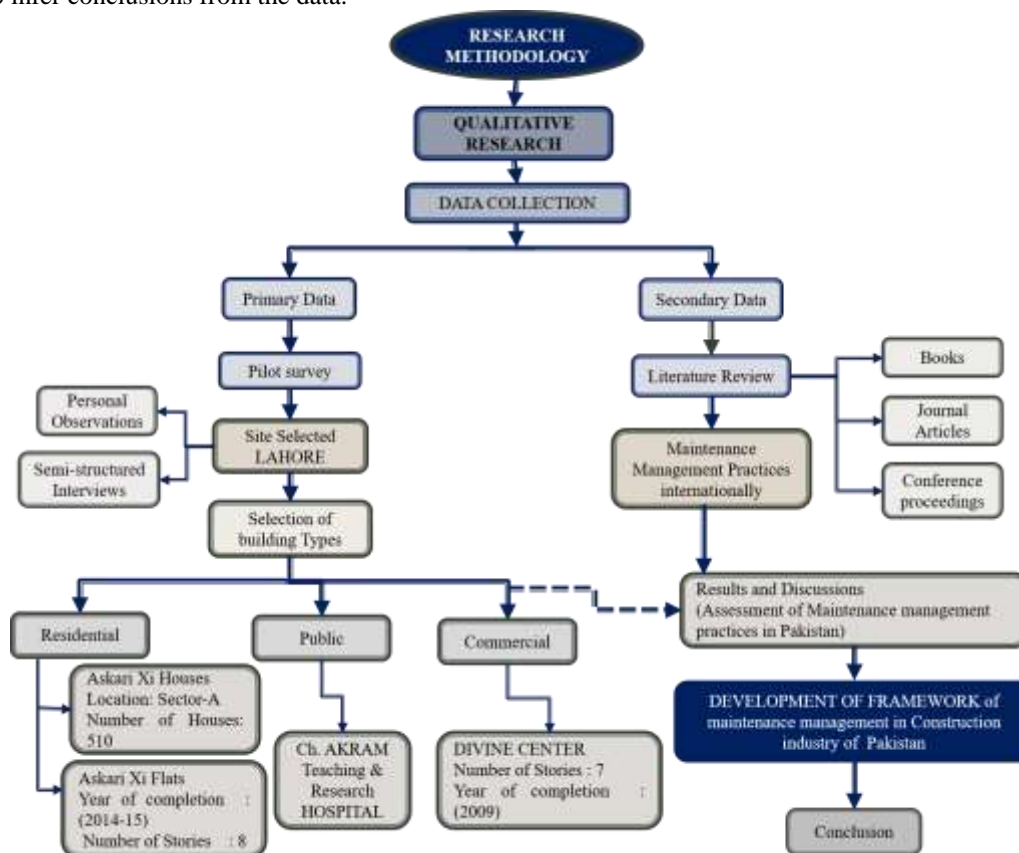


Fig 2: Research Methodology, Source; Author' Construct

In Lahore, three major types of buildings were identified i.e. residential, commercial and public, and out of each type number of buildings were further selected for data collection as mentioned in figure 2. Those buildings were selected that were completed within a decade ago only in order to identify actual reasons of early deteriorations and maintenance need of buildings. Personal

observation was done for data collection in all the buildings that were under study and semi-structured interviews were conducted from the occupants/ Users of that building. The interviewees were asked about the availability of basic facilities and the current conditions of that facilities. They were asked to inform about maintenance issues and suggestions to improve the maintainability of the Local buildings. Interview technique Chosen for this research was semi-Structured so that interviewee could openly express their concerns as well as suggestions regarding building maintenance while keeping in view the focus of current research.



Figure 3: Site plan of Residential Buildings Survey, Askari-Xi.

III. DATA ANALYSIS AND DISCUSSIONS:

Physical condition of all buildings was observed closely. In houses deteriorated conditions mostly were wall cracks, cracks on parapet and external finishes peeling as shown in fig 4, 5 and 6. Physical condition of apartment buildings has been shown in fig 7-10 which includes fungus growth and damaged pavers. Fig 11 -14 are depicting the condition of commercial plaza which was mostly damaged due to water seepage. Public building was in most miserable condition with number of defects and major of them was sanity issue. Pipe leakage and water seepage in expansion joints caused cracks on walls that become a threat to patients because of negligence as shown in fig 15-19.



Fig. 4: External Finishes Peeling of a House under Survey, Source; Author's Fieldwork 2019



Fig. 5: Cracks On Parapet of Residential Building, Source; Author's Fieldwork 2019



Fig. 6: Structural cracks on Walls of Residential Building, Source; Author's Fieldwork 2019



Fig.7: Apartment Building survey, Askari- Xi, Source; Author's Fieldwork 2019



Fig.8: Fungus growth on walls of Apartment Building, Source; Author's Fieldwork 2019



Fig.9: Damaged substructure of Apartment Building, Source; Author's Fieldwork 2019



Figure 10: Damaged Pavers of Apartment Building, Source; Author's Fieldwork 2019



Figure 11: Commercial Building Survey, Divine Center, Lahore, Source; Author's Fieldwork 2019



Figure 12: Concrete sapling due to water seepage in commercial plaza, Source; Author's Fieldwork 2019



Figure 13: Wall Finishes peeling due to water seepage, Source; Author's Fieldwork 2019



Figure 14: fungus growth and damaged sanitary fittings, Source; Author's Fieldwork 2019



Figure 15: Dampness in Ch. Akram Hospital, A public building survey, Source; Author's fieldwork, 2019



Figure 16: Hairline cracks due to water seepage in wards, Source; Author's fieldwork, 2019



Figure 17: Sanitary fitting leakage above false ceiling, Source; Author's fieldwork, 2019



Figure 18: structural cracks on walls, Source; Author's fieldwork, 2019



Figure 17: Water seepage in Expansion joints, Source; Author's fieldwork, 2019

The data collected from different techniques were compiled and analyzed in a tabulated form that is presented below in table 2. Different types of defects commonly occurred in buildings in Lahore were observed and the percentage of each defect regardless of their causes were calculated.

Table 2: Percentage of Defects Observed in Buildings Under case Study, Source: Author

	Common Defects Observed in the Buildings in Lahore	Percentage of Maintenance required in Different building types		
		RESIDENTIAL (%)	COMMERCIAL (%)	PUBLIC (%)
1	Structural Cracks in walls	70	55	50
2	Structural Cracks in beams	30	40	40
3	Water seepage from external envelope	60	55	50
4	Non-Structural Hairline Cracks in Paints	75	70	70
5	Debonding and damage of external wall finishing	30	40	40
6	Color fading/ variation in wall finishing	20	25	25
7	Damaged False ceiling	60	55	60
8	Sagging in Beams and slabs	15	20	20
9	Cracks in Parapet	55	5	5
10	Peeling paint	60	55	55
11	Plaster rendering	50	30	30
12	Damaged Floor finishing	30	40	45
13	Damaged flooring of stairs	5	35	40
14	Broken / Damaged Tough pavers Parking Flooring	0	30	35
15	Floor Subsiding and sinking	40	30	25
16	Jamming Doors and windows	65	50	55
17	Gaps in Expansion joints	0	20	20
18	Public health pipe leakage	60	60	50
19	Blockage of drainage pipes	30	60	80
20	Dampness in walls	80	50	60
21	Heating of switches and wire	15	50	40
22	Broken/ damaged switch boards	20	40	60
23	Stoppage and excessive overrun of lifts	0	70	50
24	Fugus growth	30	50	50
25	Termite attack	60	10	10

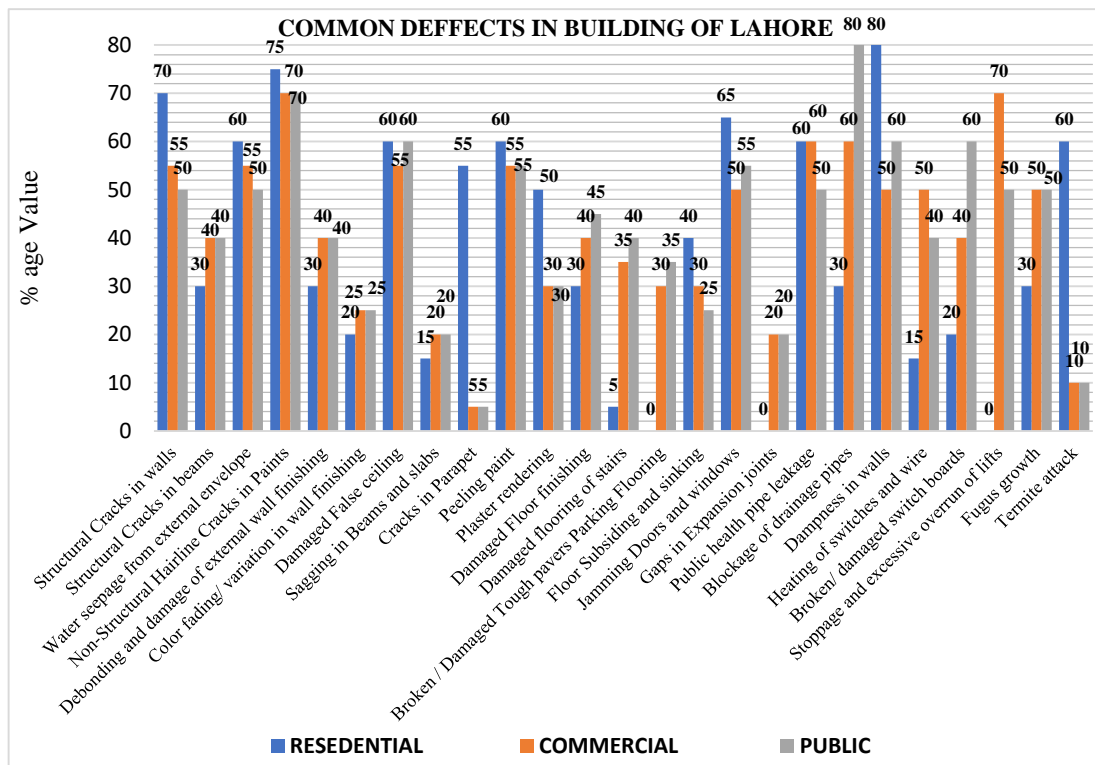


Figure 18: Histogram representation of Common Defects Observed in Lahore's Buildings, Source; Author.

According to the conducted survey, Dampness is the major issue in all building types in Lahore which requires maximum maintenance that is 80%, 50% and 60% in residential, commercial and public buildings correspondingly. Non- structural hairline cracks are second defect which requires maintenance 75%, 70% and 70% in their respective building types as mentioned in table 2.



Figure 19: Percentage of Maintenance required in Residential buildings in Lahore, Source; Author

According to the research data, Hair-Line cracks and dampness are ranked as Top defected areas that required maximum maintenance in residential buildings in Lahore. After that doors and windows frames jamming and cracks in walls are ranked at 2nd position with 70% maintenance requirement. 3rd ranked has given to other defects as termite attack, sewerage pipes blockage, cracks in parapet, peeling paints etc as given in figure 4. But residential buildings under survey had overall facilities in pretty much good conditions which need for comfortable living.

The survey revealed that basic facilities like (Toilets, bathrooms, Water and electricity) were presented in commercial and public building were not in good conditions. Especially bathroom facilities in hospital building was extremely miserable because of blockage in drainage pipes. But in general, commercial buildings requires maximum 70% maintenance of lift overruns, stoppage and hairline cracks in walls as these areas are ranked top of the list for these building types as shown in figure 5. But in public building top ranked defect are blockage of drainage pipes which requires 80% maintenance as presented in figure 6. In commercial and public buildings one of the major concerns neglected in maintenance area is expansion joint leakage that required 20% maintenance.

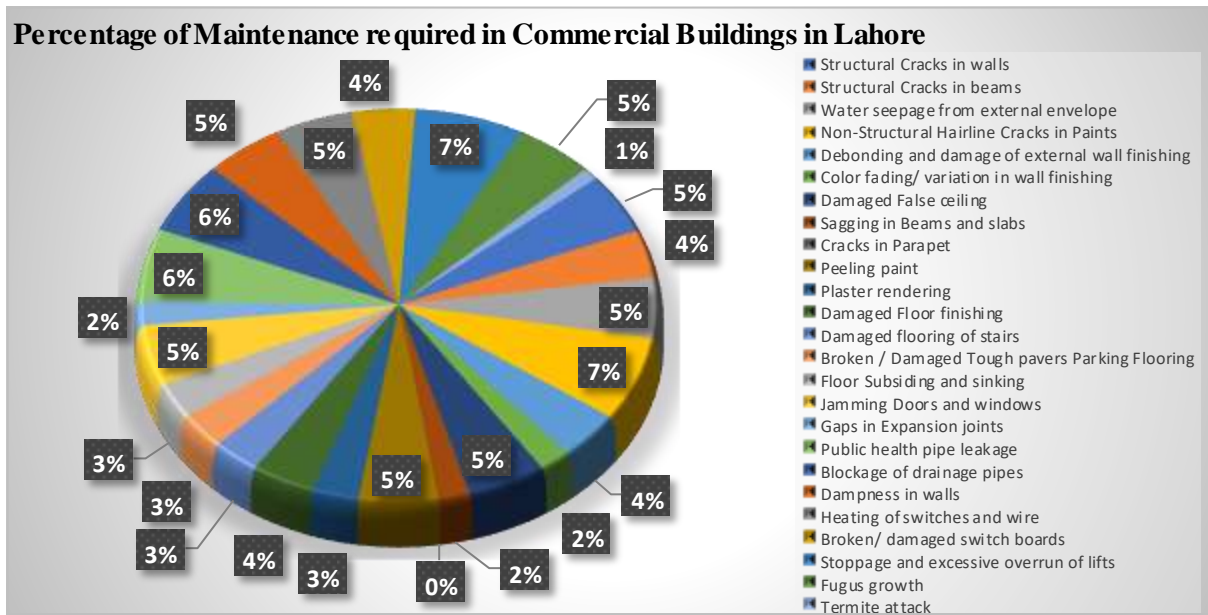


Figure 20: Percentage of Maintenance required in Commercial buildings in Lahore, Source; Author.

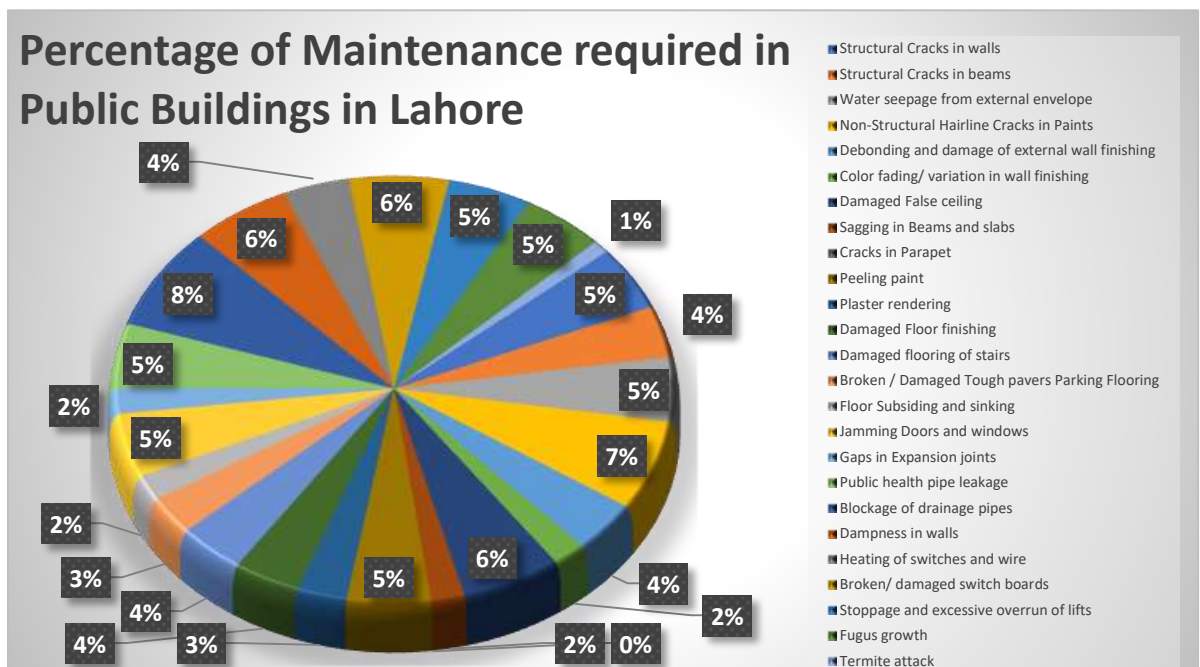


Figure 21: Percentage of Maintenance required in Public buildings in Lahore, Source; Author.

IV. FRAMEWORK DEVELOPMENT FOR MAINTENANCE MANAGEMENT

A conceptual framework was developed for building maintenance management in construction industry in Pakistan as shown in Fig. 24, by reviewing the literature and incorporating facts about maintenance practices in Lahore. This framework consisted of 4 major steps that are:

1. Maintenance Establishment
2. Maintenance Planning
3. Maintenance Management Implementation
4. Maintenance Review

The first steps deal with the policy, strategies and overall maintenance guidelines to achieve the best product at the end. Second step is basically to make strategic development plans as well as short-term and long-term maintenance schedules. Step three involve condition monitoring and complete job records while the last step is about feedback, monitoring and reviewing reports and data. This framework is basically a strategical planning that should be followed by construction sector in order to achieve the level which will further ensure the completion of maintenance goals.

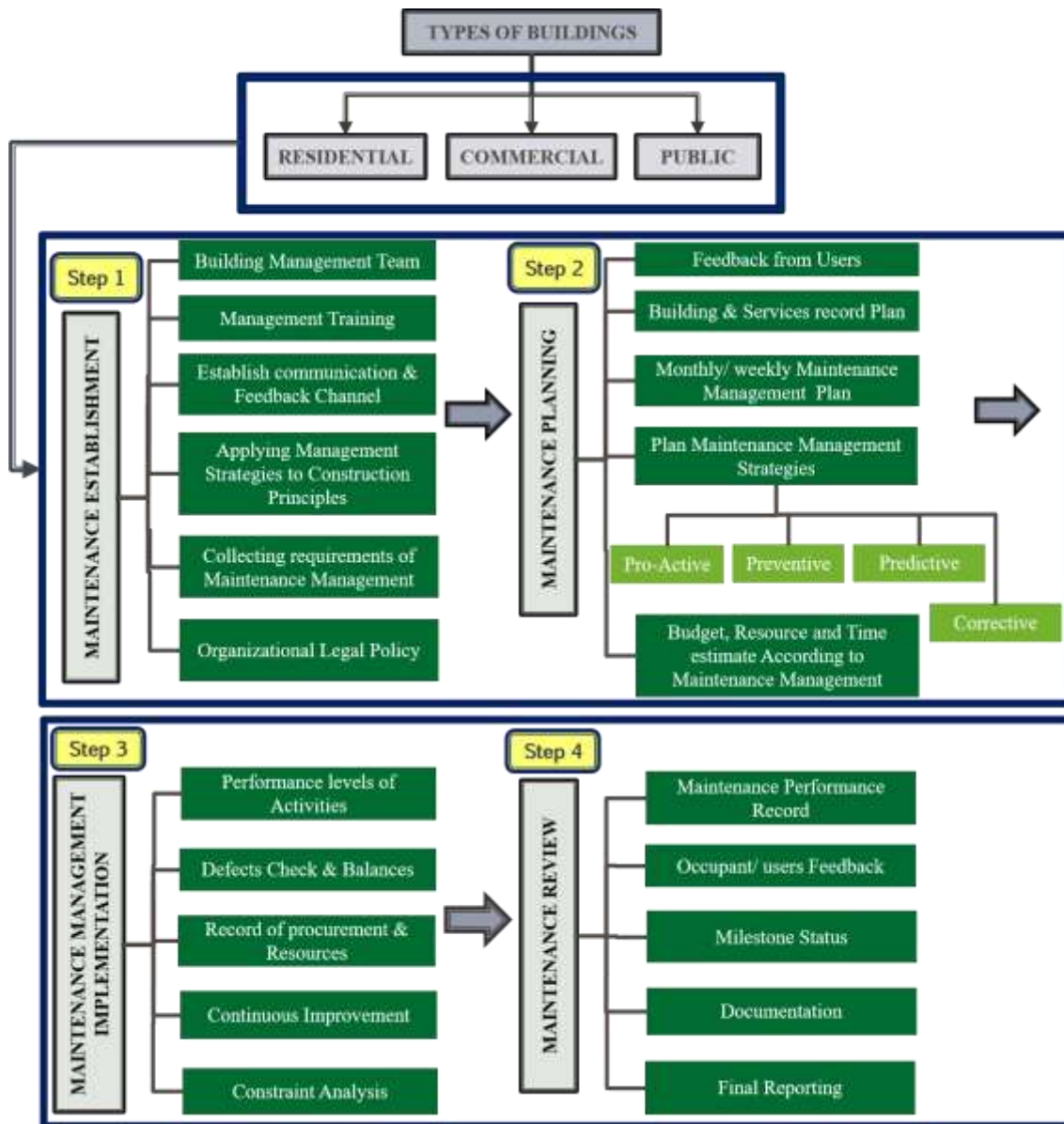


Figure 22: Conceptual Framework for Building Maintenance Management in Construction Industry, Source; Author's Construct.

V. CONCLUSIONS & RECOMMENDATIONS

This study shows that different types of building as residential, commercial and public require proper maintenance plan as they are deteriorating at large speed. Its reasons include poor workmanship and Design defects. Another major issue is the absence of maintenance culture in occupants and overall construction industry of Pakistan. The overall research showed that maintenance management practices of buildings are the most neglected part and buildings being in the state of disrepair become a continues threat to its users. The major finding of this research is there is lack of effective maintenance management policy at national level to compel the users of any building for its maintenance responsibility. The study concluded by development of a conceptual framework that should be followed by maintenance departments and personnel to achieve predefined building maintenance goals and objectives while rising the bar of maintenance management practices in construction industry of Pakistan.

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