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RESEARCH PAPER

Evaluation of User Satisfaction with Garbage Handling Systems in Selected High-Rise Building of Islamabad City Developing: Case for Waste Smart Highrise Buildings in Pakistan

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ABSTRACT

Urbanization has led to vertical development with highrise and midrise buildings across cities. This phenomena gave birth to large scale waste generation in these buildings and hence required vertical waste management systems like garbage chutes. Since this phenomena was new in Pakistan, hence it was need of the hour to explore the end users satisfaction. Lignum tower as a residential tower in Islamabad city was chosen for the research exploration with sample size of 80 using purposive sampling. It was concluded that optimization in system and future expansion were missing. From administration side, lack of people sensitization and poor waste segregation and cooperation were reported. From occupants side, major issues included poor waste transportation, poor waste recycling, higher services fees, lack of communication and smell were reported.

KEYWORDS Design Optimization , Garbage Chutes, User Satisfaction, Vertical Growth, Waste Management

Introduction

Urbanization has been a large scale phenomena observed all across the globe. Cities attract the people because of different opportunities like employment and other services (Growth, 2020). This increasing trend of population in cities produces large number of household waste every day and in vertical buildings with apartments and offices create huge amounts of waste specially from disposable items and packing. In a recent study it was noted that they included papers, rags, and other biodegradable materials, as well as metal, bones, and glass, among other non-biodegradable materials as the major source of waste (Hadjieva-Zaharieva, Dimitrova, &Buyle-Bodin, 2003). Waste management without any doubt is considered as one of the most critical pressing issues of the urbanized modern life and needs extensive planning, execution, monitoring and management to ensure its optimization (Mulat, Worku, &Minyihun, 2019). specialized planning and system integration becomes necessary to manage this issue (Xiao, Luo, & Li, 2021). One of the key solution to this issue is to provide garbage chutes in the building where each floor has access to one or more points where the garbage is let out through a duct to one or more points on the ground or under ground floor to collect the waste and then remove out of the building. System helps manage, sort, collect and remove the waste from the buildings (Kuzhakova, Kolgashkina, &Shilkin, 2019). Pakistan has a very high rate of population and urbanization and hence have led to developing highrise buildings in each urban center of Pakistan and with that rise in waste management issue multifold in these buildings (Khan, Inglezakis, Ishtiaque, &Moustakas, 2019). Hence aim of this study was to select a recent urban center highrise building in capital city of Pakistan and explore the user satisfaction with respect to waste management using garbage chute as a major system deployed and identification of major issues.

Literature Review

A high-rise building is a tall building, as opposed to a low-rise building and is defined differently in terms of height depending on the jurisdiction. It is used as a residential, office building, or other functions including hotel, retail, or with multiple purposes combined. Residential high-rise buildings are also known as tower blocks and may be referred to as "MDUs", standing for "multi-dwelling unit". A very tall high-rise building is referred to as a skyscraper. High-rise structures pose particular design challenges for structural and geotechnical engineers, particularly if situated in a seismically active region or if the underlying soils have geotechnical risk factors such as high compressibility or bay mud. They also pose serious challenges to firefighters during emergencies in high-rise structures. New and old building design, building systems like the building standpipe system, HVAC systems (heating, ventilation and air conditioning), fire sprinkler system and other things like stairwell and elevator evacuations pose significant problems. Studies are often required to ensure that pedestrian wind comfort and wind danger concerns are addressed. In order to allow less wind exposure, to transmit more daylight to the ground and to appear more slender, many high-rises have a design with setbacks (Buczyńska, Cyprowski, &Szadkowska-Stańczyk, 2011). The transformations of high rise buildings is shown below in figure 01.

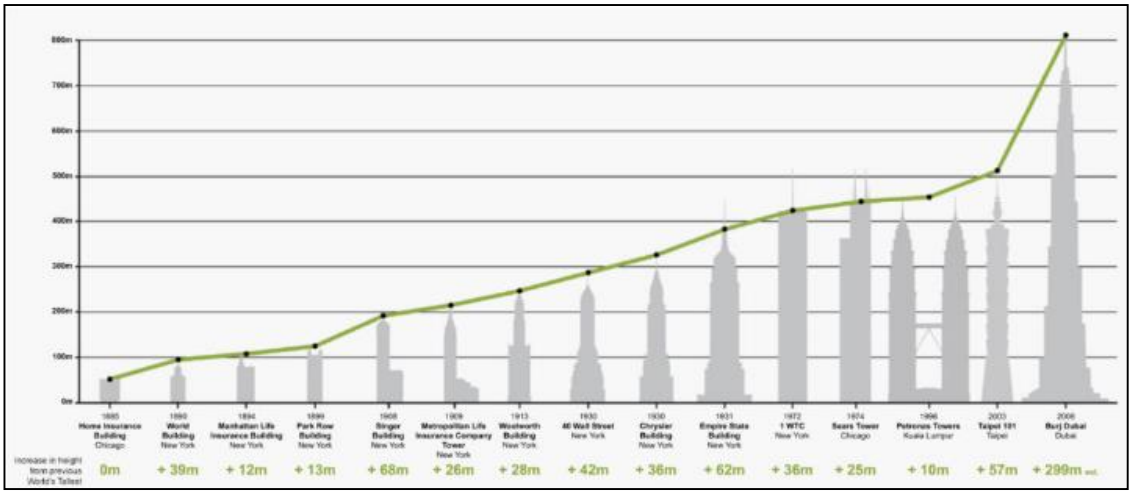

Figure 01 Transformation of high rise buildings & Tall structures (Britannica, 2018)

Due to increasing trend of urbanization the consumption of goods is also increase with high rate which leads towards the high level of waste generation that also required occupying by the environment, which creates issue related environment and health of the people (Foday, Xiangbin and Quangyen, 2013). Mostly the dump sides are located in nabourhood of urban areas in different developing countries. These small dump sides are creating different kind of deceases produced mosquitoes and other insects like flies and rodents etc. (Yoada, Chirawurah and Adongo, 2014). These lead to spread of infectious and communicable diseases. High-rise buildings are tall and there is different large number of floor. There are different methods of collection of garbage in High-rise buildings (Tannor, Attakora-Amaniampong, &Appau, 2022).. Chute system is one of them, which have installed in every floor for collection of garbage at central point. Chute system installed vertically in each floor. Residents of each floor use this chute for dumping of their garbage. Once the residents dump their waste into a chute, it falls into a centralized point where the garbage collector container is attached. These containers are move towards the dumping site time to time. Specific portion of the parking area in high-rise building is also provided where the number of collection dumpsters is placed in which the residents also place their garbage or any other organic wastes (Ashraf, Hameed & Chaudhary 2016). Garbage chutes are a popular feature in high-rise buildings that allow for convenient and efficient disposal of

waste materials handlers (Fakere, Folorunso, Arayela, &Adedeji, 2018). These structures have to be designed for the right purpose, scale and function and hence require extensive planning as shown below in figure 02.

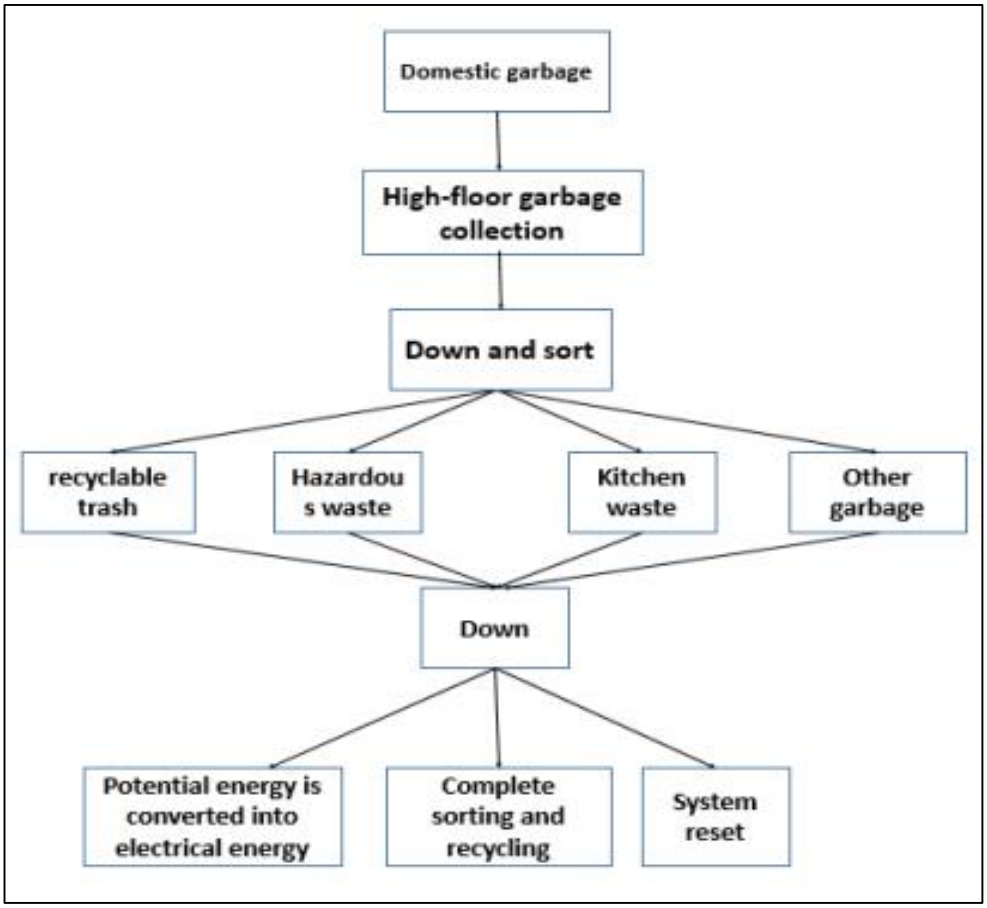

Figure 02 Design parameters for Chute Design

With reference to high rise buildings, multiple recent research studies have been explored and following major aspects were identified to be critical towards user satisfaction with garbage management system in high buildings (Wang, Chen, Wang, Wei, & Song, 2022) mainly include:

1. Environmental perception.
2. Environmental activity.
3. Environmental law.
4. Waste system integration in building design.
5. Waste segregation.
6. Waste collection.
7. Waste transportation.
8. Waste recycling.
9. Knowledge & awareness.
10. Waste management system equity.
11. Waste management system operational optimization.
12. Waste management fee.
13. Waste management system maintenance.
14. Waste management upgradation.
15. End user participation and evaluation.
16. End user satisfaction.
17. Waste management issues & gaps.

18. Overall waste management system performance.

Material and Methods

The overall research methodology followed is shown below in figure 03.

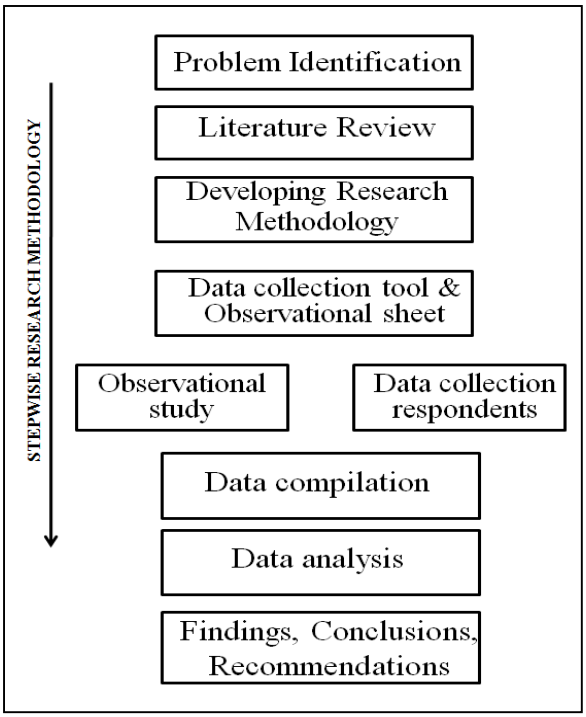

Figure 03 Research phases and major steps

In order to carry forward the research, an observational sheet was developed and used to complete observational study based on the variables explored in review of literature. A questionnaire was also used to collect data from respondents in both services side and occupants then was compared with each other. Sample size kept was 80 with purposive sampling.

Results and Discussion

Researcher used a formal application and met the administration in November, 2021 and later got permission to carry on the research. Location and physical details of the tower selected are shown below:

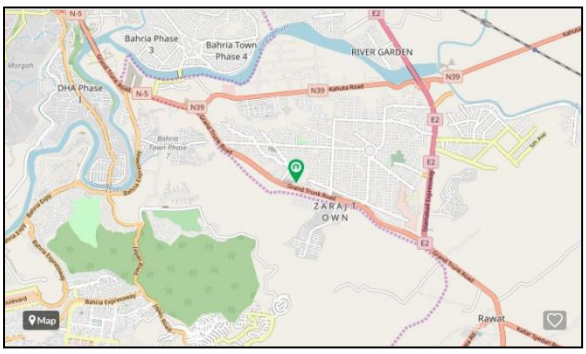

Figure 04 Location map of Lignum Tower (Google Maps, 2021)

Figure 05 Location map of Lignum Tower with Google Earth maps (Google Earth, 2021)

Figure 06 Birds eye view of Lignum Tower with Google Earth (Google Earth, 2021)

Figure 07 Perspective views of the Lignum Tower

As shown above in the figure 04 to 07, the Lignum tower is a highrise residential tower complex located in DHA Islamabad. It is considered as one of the tallest residential landmark of the local vicinity and has been considered as a symbol of vertical growth of the city and its expansion. The initial observational study initiated with meeting the administration of the building as well as visiting the building with respect to the garbage chutes documentation. Later data was also collected from the administration.

Figure 08 Researcher briefing about research exploration and interviewing an engineer on site duty in administration office administration office

Figure 09 Open garbage chute site with access door opened for visit & dumped waste inside

Figure 10 Researcher segregating waste in garbage chute & outside collection bins

Figure 11 Removed waste temporary dumping site next to parking

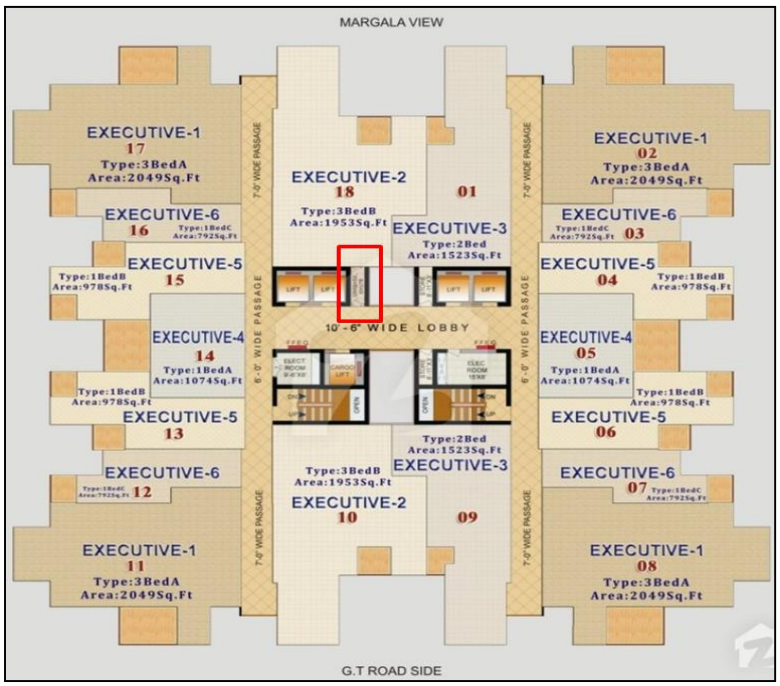

Figure 12 Architectural plan of ground floor and above till 10th floor

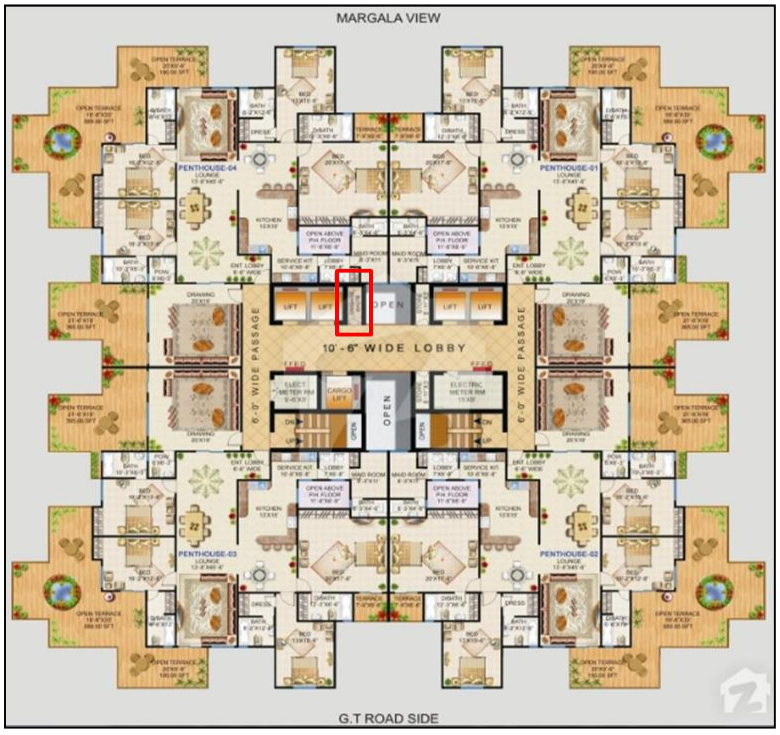

Figure 13 Architectural plan of 11th floor and above till 20th floor

Based on the gathered data and exploration of the overall waste management system incorporated into the building, it was a multiphase and multistage waste management system used. As per the MEP engineer on site, building has two main garbage chutes accessible on each side of the building and are also connected on each floor where occupants and apartments have been developed. Each has opening on each floor where the residents and occupants put their solid waste and these then with help of gravity collect all the waste in the basements. Solid waste is collected in the basement into containers which are taken away from the buildings twice a day. Residents were responsible for putting the solid waste into the chutes and avoiding any choking inside and overall making the waste

into chunks so that chutes do not get chocked. Garbage chutes were operational at the time of visit and were managed well by the administration. Observational study checklist is shared below in table 01.

Table 1
Observational study – Checklist

S.No	Aspect	Remarks
1	Environmental perception	Yes. Environmental concerns were considered and also became part of the overall design solution.
2	Environmental activity	Yes. Overall multiple environmental set of activities related to waste management were defined and followed.
3	Environmental law	NO. No proper standard was followed in operational side. In the design of the chute, it was observed since there were many vacant apartments so with higher influx chutes may get chocked.
4	Waste system integration in building design	Yes. Garbage chutes were provided and were functional.
5	Waste segregation	No. All the forms of waste in the soldi waste category were dumped all together.
6	Waste collection	Yes. All solid waste got collected at one basement point within steel moveable containers.
7	Waste transportation	Yes. Collected waste was taken out from the building twice a day and temporarily kept in a separate space where they were later taken by another waste collection system.
8	Waste recycling	No. No recycling was used.
9	Users knowledge & awareness	Yes. Overall the team engaged with the operational side were aware about the system, its complexities and issues. They wer doing an effort to ensure the gaps and issued could be addressed in time.
10	Waste management system equity	Yes. All the apartments were equally charged.
11	Waste management system operational optimization	No. The existing system was the same as planned and executed and later has not been updated.
12	Waste management fee	Yes. All apartments were charged.
13	Waste management system maintenance	Yes. Operational and administration team were engaged in this work and they actively work on managing the waste system including garbage chutes functionality.
14	Waste management system up gradation	No. Since its design and construction, same system is deployed and have not been updated / upgraded.
15	End user participation & evaluation	No. Only waste is generated by the end users, occupants and residents in the buildings but they have no major input in the overall waste management system. They only inform the administration incase of any issue.
16	End user satisfaction	Partial.

17	Waste management issues & gaps	There were many issues observed during the visits. One of the major issues was lack of segregation which mixed the waste of all forms into the same collection point. Then there was another issue of garbage chute choking incase multiple occupants on one floor or at multiple floor put the waste in the chute at teh same time. At one time, it was observed that waste collection steel contained got filled and was very hard for the team deployed to remove it from the place and all the garbage got spilled over the floor.
18	Overall performance	Yes. The system is operational, maintenance is done but optimum performance or optimization and up gradation was missing. With existing number of people, it is yet manageable but with fully occupied it will create issues of operational management.

In an overview, the system was functional but the occupancy rate of the building was comparatively less. Hence with optimum usage, the existing system will fail and will have many issues. The existing system was not optimized while it was designed. The system was designed for almost 12 floors while the existing building was 20 floors. Hence the system had almost double the burden but due to limited occupancy, the issue has not been popping up and impacting the lives of the people living in the building. Later feedback from the administration side was also gathered as shown below in table 02.

Table 2
Checklist feedback – Administration

S.No	Aspect	Administration Remarks
1	Environmental perception	Yes. Environmental concerns were important to us.
2	Environmental activity	Yes. We follow defined set of activities as planned and also do allied activities in case of any issue faced by residents.
3	Environmental law	No. It has not been defined but we follow hygiene principles.
4	Waste system integration in building design	Yes. A whole waste management system has been developed and maintained.
5	Waste segregation	No. It is the responsibility of the residents or occupants but people do not follow these aspects briefed to them when they occupy the building.
6	Waste collection	Yes. All solid waste is collected in basement in steel container set at the bottom of the garbage chutes.
7	Waste transportation	Yes. A proper system for waste removal from building, temporary storage and then final removal has been used.
8	Waste recycling	No. No we do not follow any such aspect. We do however are searching for options to segregate and sell waste.
9	Users knowledge & awareness	Yes. Overall the team engaged is trained and have experience of this system and work.
10	Waste management system equity	Yes. We charge apartments occupants for running and managing the system.

11	Waste management system operational optimization	No. No such need has been identified as such.
12	Waste management fee	Yes. All apartments were charged.
13	Waste management system maintenance	Yes. Regular maintenance and operational management is performed.
14	Waste management system up gradation	No. We are considering removal fo waste thrice a day to improve the system.
15	End user participation & evaluation	No. Only waste is generated by the end users, occupants and residents in the buildings.
16	End user satisfaction	Yes. They are satisfied and have very less complaints.
17	Waste management issues & gaps	We usually face issues of chutes choking when waste is not put in parts or small portions and they get stuck in the way. Smell is another factor which we are now working to get resolved.
18	Overall performance	Yes. Overall performance of the system is good and is also working fine.

As shown above in table 02, the administration checklist completed also matched with observational study. There were few exceptions where administration shared very less complaints. Hence, overall the observational data did correlated with the feedback from the service providers. Overall system followed in the building is as follows:

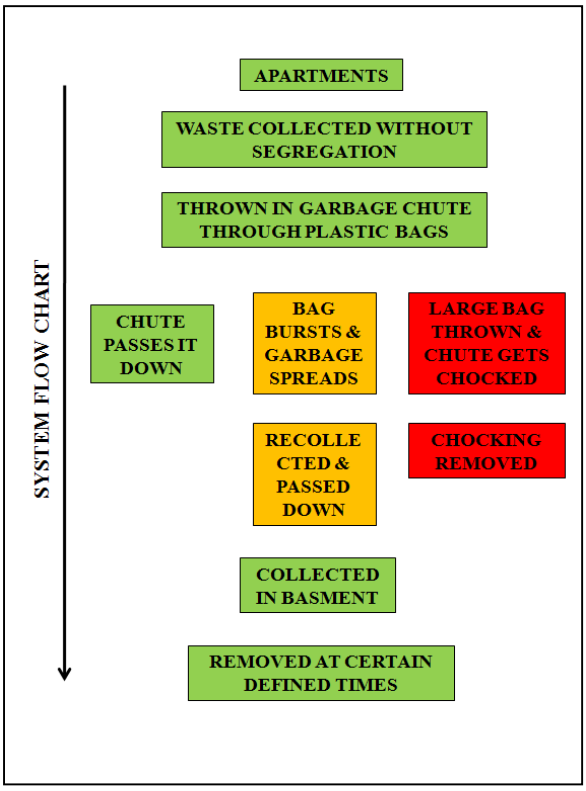

Figure 14 Existing system followed in the selected highrise building

It was concluded that at each level each, apartments collect their own waste and bring them to the garbage chute point and from there after opening their respective window

to throw in the garbage into the chute main pipeline. If the size of the garbage bag is appropriate, it will slide down through it without choking otherwise it gets chocked. In case multiple people have put the garbage at the same time, it acted as a bottle neck while it was observed during multiple visits of the observation and floors when the researcher explore how the waste was collected. It was also concluded that the waste collected was not properly segregated and all different forms of waste are combined together in one bag which is made of plastic and was used to throw the garbage into the chute which even splits open or gets hampered leading to spreading of the garbage as well as the smell across the floor. Hence it was concluded that the existing system had multiple bottlenecks included in the garbage shoot design as well as this sensitization of the people leading to poor optimization of the garbage waste system. Later respondents / endusers data was collected as shown below in table 03.

Table 3
Respondents data percentages

Sr	Questions for occupants	Highly Unsatisfied	Unsatisfied	Moderate	Satisfied	Highly Satisfied
1	How far are you satisfied with the environmental perception of the waste management system used in the building?	5%	11%	8%	69%	8%
2	How far are you satisfied with the environmental activities done in the waste management system used in the building?	3%	14%	19%	56%	9%
3	How far are you satisfied with the environmental law followed in the waste management system used in the building?	4%	5%	81%	5%	5%
4	How far are you satisfied with the Waste system integration in building design ?	8%	11%	19%	48%	15%
5	How far are you satisfied with the current Waste segregation system?	5%	5%	16%	51%	23%
6	How far are you satisfied with the current Waste collection system ?	20%	18%	16%	40%	6%
7	How far are you satisfied with the current Waste transportation system ?	8%	53%	19%	15%	6%
8	How far are you satisfied with the current Waste recycling ?	45%	25%	19%	6%	5%
9	How far are you satisfied with the current Users knowledge & awareness about the waste management system in the building ?	0%	5%	8%	48%	40%
10	How far are you satisfied with the current Waste management system equity ?	6%	44%	26%	19%	5%
11	How far are you satisfied with the current Waste management system operational optimization ?	4%	9%	15%	69%	4%
12	How far are you satisfied with the current Waste management fee ?	6%	44%	26%	19%	5%
13	How far are you satisfied with the current Waste management system maintenance ?	5%	5%	16%	51%	23%

14	How far are you satisfied with the current Waste management system upgradation plan ?	0%	20%	69%	11%	0%
15	How far are you satisfied with End user participation & evaluation in waste management system of the building ?	19%	41%	26%	10%	4%
16	How far are you satisfied with the current system ?	10%	15%	26%	48%	1%
17	What are the major Waste management issues & gaps do you face, mention critical ones:	Choking of garbage chutes, waste over spill, smell on some floors, high fee, poor optimization, night shift poor performance.				
18	How far are you satisfied with the Overall performance of the system ?	9%	8%	20%	55%	9%

As shown above in the table 03, occupants mixed response has been highlighted with the highest value being highlighted in grey. With respect to environmental perception as part of system was responded 69% satisfied, environmental activities were considered satisfied by 56%, 81% were unaware about any specific environmental law or rue followed by or in the system and 48% were satisfied with waste system integration in the overall design of the building. With respect to environmental waste segregation 51% were satisfied as they were the persons who have been given the responsibility to segregate the waste at the door step prior to dumping in the garbage chutes. 40% were satisfied with the waste collection system, 53% were Unsatisfied with waste transportation as waste overspill was reported by many, 45% were highly unsatisfied with waste recycling as they believed it could have been integrated in the system but it was completely missed in the design and concept stage. 48% were satisfied with the end users and the administration knowledge about the system integrity and operations. However 44% were unsatisfied with the system equity with respect to sharing the cost as higher as compared to maintenance and operations cost bared by the services side. With respect to the overall system performance and its operational aspects were evaluated in end. 69% were satisfied with the current optimized system functionality under current conditions where complete building still have many apartments vacant. 44% were unsatisfied with waste management system fee as too high. 51% were satisfied with the maintenance done by the administration team. 69% were unaware and unsure about any form of system upgradation that might help the end users. 41% were unsatisfied with lack of end users point of view integration in the overall system, they wanted to be taking part in system evolution and be concerned about the betterment of the system they have invested a lot of money and time in these buildings as part of their investment. However 48% of the users were satisfied with the building system associated with waste management and 55% were satisfied with the overall performance of the waste management system in the current exploration.

It was observed that overall waste management has been kept as an integral part of the design intent yet it was not prioritized with respect to the scale of the project. It was observed that waste management system evolved across the garbage chutes in the system provided but their scale was not in match with the scale and need of the project. Two major chutes were proposed and only one was later deployed. Hence half of the system was now dependent on the single chute. Here the current aspect of poor occupancy rate enable better or equivalent level of performance since waste generated was less as compared to be expected, so the system was able to bare the load. However its is evident under the current scenario of urbanization and increasing population, soon the existing system will choke and will need major interventions.

From the administration point of view, the current system was optimized under the time as all major components were regularly maintained and kept operational all the time. However they did also agree that with full occupancy of the building, the system will have more issues and hence may lead to choking or failure. Hence they have been engaged with

enhance of the system in future but incase of higher waste influx, they will opt for three times removal of waste from the steel containers of waste collection and hence can break the overall load over the time.

With respect to the end users and occupants point of view, they faced some of the issues which included but were not limited to choking of garbage chutes in public holidays and events, waste over spill, smell on some floors, high fee, poor optimization, night shift poor performance and few others. It was noted that people themselves lack a prioritization for waste management. They lacked proper segregation of waste and have been seen involved in just filling the chutes with all the waste at the same time without even segregation or breaking them into small chunks to make it manageable. Public awareness and sensitization was a key factor missing in the practices done by most of the people.

Conclusions

Based on the defined research methodology and carried out research brought out the following major issues:

Design Issues

a. Small design of chute for the targeted population.

b. Chute cannot be expanded.

Operations & Maintenance Issues:

a. Only twice in the day, garbage is removed.

b. Cost segregated for the waste management and garbage system is costly.

c. Staff is less.

d. Night shift poor performance issue.

Social & Public domain related Issues:

a. Lack of sensitization.

b. Non-cooperative behavior.

c. Lack of following the standard protocols.

d. Lack of communication and coordination with administration & management.

With respect to the highlighted issues and aspects, the figures in observational study clearly shows the existing system failure and its repercussions acting as challenges discussed above. In a nut shell, the existing performance of the system was acceptable and was done to the best by the administration of the building which was not only seem satisfactory from the researcher point of view but also by the respondents too. However this level of satisfaction is only temporary, since with rise in influx of the people in the building it will have poor performance and will not be able to be accepted by the end users.

It was concluded that Urbanization and vertical growth has been highly correlated and have to address the shortage of housing and shelter in the modern day cities of Pakistan. The explored building i.e. Lignum Tower is a residential high rise building in the context of DHA, Islamabad city. It has 20 floors and is mainly occupied since it was built in mid 2013. With focus on waste management system in high rise buildings, garbage chute system was

deployed in the building and is still in active usage. Its administration claimed that the system is optimized while the end users were not highly satisfied with it. Amongst the end users, major issues included waste transportation system, waste recycling potential, overall operations fee and equity, waste management feedback, etc. It was observed that some of these issues were prevalent on site but mainly due to lack of waste management sensitization which was reported by the administration was also there and people / occupants were mismanaging the system usage which has resulted in the choking of the system under stress. With respect to the existing scale of the building, the existing waste management system integrating garbage chute was found to be highly under stress and may lead to failure if all the building is completely occupied. Hence there was a need to have alternate choice of a back up plan for worse case scenarios. There was also a strong need felt for occupants training, sensitization and system standardization so that waste could be better managed and enabling better waste management performance and outcome. Hence a line of action has been proposed with reference to the current exploration.

Recommendations

It is need of the hour to enhance the existing system through addition of one more garbage chute. Since addition to central core cannot be done, hence close to internal staircase a chute could also be added as an additional system integration and at the bottom of the building can have multiple waste collection points. Shift from two to three times removal of waste from the metal bin collectors. Removal from site to be managed in a more formal and controlled manner. On each garbage chute opening point, add a list of instructions to be followed and add cameras next to each core central area so that people do follow the instructions. Helps managing the operational side as well as maintaining hygiene. Ensure all instructions are also provided in Urdu and add signage/graphics to them. It will help in easy understanding even if someone is unable to read English. Provide the occupants with standardized waste collection bags or allow them to gather their own ones and then make it clear that only a specific amount of waste should be put in each one. Standardization could be the only help that can avoid choking of the system under higher pressure and influx of waste. It will help manage the size of the garbage collected in each bag for a specific size. For more waste, more bags would be added but chute will not choke with one large bag. Enable better integration of the people and occupants through continuous feedback mechanism and keep them informed and update them through modern day tools if chute is under repair, maintenance or any other work is happening. It will help develop a monitoring, integration, communication and feedback system for better coping and cooperation. Provide proper uniform to the staff in the waste management and operational units. Enable them being recognized by the people. Will also help in keeping track of safety and security on each floor with respect to anyone without uniform and reaching garbage chute for any misuse. Revisit the costing of the services and also keep the end users intact for such decision making. Develop a proper schedule of waste collection, segregation and removal and let the occupants be aware of these activities. Waste segregation must be priority of the occupants and they must get properly trained for it. Kindly enable better engagement and opt for showing them how this is done. Integrate modern technology related to waste management and hygiene specially in the post pandemic conditions and enable people to better understand and follow it.

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