

Household Solid Waste Management in Inaccessible Neighborhoods – Jordan

Raed Salem Al TAI (✉ Raedaltal@yahoo.com)

German-Jordanian University: German Jordanian University

Tala Mukheimer

German-Jordanian University: German Jordanian University

Zain Aburomman

German-Jordanian University: German Jordanian University

Ihab Al Hajjaj

German-Jordanian University: German Jordanian University

Ala'a AlSmadi

German-Jordanian University: German Jordanian University

Ala Janbek

German-Jordanian University: German Jordanian University

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Abstract

This research examines challenges and responses in collecting household solid waste in high populated inaccessible neighborhoods in Amman, the capital of Jordan. The main questions of the research are: to which extent is the physical and behavioral environment affect waste management process; how waste is collected in inaccessible areas? In order to answer these questions, two major aspects will be analyzed the traditional planning methods and the environmental impact assessment. The researchers employed a mixed used method qualitative and quantitative data approaches. The research is based on field and desk study conducted in one of the most informal and services inaccessible settlement in Jordan. The results revealed that Greater Amman Municipality (GAM) uses unconventional measures and unreliable solid waste collection strategies to overcome the accessibility challenges in the site despite a lack of cooperation of the residents. The study also revealed that the absence of adequate urban regeneration and renewal programs by (GAM) to control the root cause for inadequate solid waste management in informal settlements in the city. This study is important since it establishes a cornerstone for stakeholders to make assessments and control waste management strategies in inaccessible neighborhoods in Amman and similar areas in the country. Moreover, it forms a useful resource for future researches about waste management studies in informal settlements. There is a scarcity in the literature on the relationship between the problem of solid waste management and informal inaccessible settlements in Jordan.

1. Introduction

Municipal solid waste (MSW) has increased significantly with the rapidly growing urban population and recent consumption-driven society (Ikhlayel, Higano, Yabar, & Mizunoya,2016). The enormous volumes of waste generated because of today's consumption-driven society is one of the major challenges in waste management. Waste management forms an important concerns and a key challenge to sustainable city planning and design (Uzzaman & Lehmann,2011).

Household solid waste (HSW) is part of municipal solid waste responsibilities. This responsibility includes household solid waste and other wastes such as bulky waste, yard waste, and market cleansing waste. Municipal waste includes waste that originates from households, commerce and trade, office buildings and selected municipal services like parks. The main objective of solid waste management is decreasing and eradicating the negative impacts of waste materials on human health and the environment to uphold an excellent quality of sustainable urban life. The process of waste management has two main components: collecting and transportation then treatment and disposal. This research focuses on the collecting and transporting of waste management.

In high population density mountainous cities such as Amman, collecting household solid waste form a major challenge for the municipality. In addition to its rough physical topography, Amman social fabric and social inequality is tangible and very complicated. The east side of Amman with its rough arid topography houses the largest Palestinian camp and other informal neighborhoods with a significant

poor and low income population. This challenge is magnified when we come to waste collection and transportation. Most parts of these neighborhoods are inaccessible which resulted from the unplanned narrow haphazard unpaved streets. As a result, these informal settlements turned into an unhealthy crowded blight of the city's urban landscape with harmful environment impacts.

This research focuses on the oldest and largest informal settlements in Amman, Jabal al Natheef. Jabal al Natheef literally means the clean mountain, yet its name does not reflect its chaos urban and environmental reality. Originally this neighborhood emerged as Palestinian refugee camp in the early 1950s, and then gradually transformed into uncontrolled urban node. The settlement makes an ideal case for the current study on account of the following reasons: First, it is the largest informal settlement in Amman; second, it is the settlement with the highest density and poverty; third, it sets on a rough rocky terrain isolated by valleys; and fourth, there is a scarcity in the literature on the relationship between the problem of solid waste management and informal inaccessible settlements in Jordan. The current situation of the unregulated layout posed a challenge for Greater Amman Municipality (GAM). Although it is provided with water and electricity services, this neighborhood suffers from solid waste management not only due to its rough setting terrain which is mostly accessed by stairs that reaches hundred steps, but also due to the high population density that suffers from physical, economic and social problems Fig. 1.

Earlier studies conducted on Jabal al Natheef had addressed the socio-economic aspects and provided a spatial analysis of the area (Al Tal et al.,2017). These publications focused on the need for further research about the waste problem in the area. Minimal research attention has been paid toward waste management in slum areas with very high population density and difficult accessibility in Jordan. Analyzing the waste collection in Jabal al Natheef potentially benefit planners and officials at the GAM to solve waste management issues. Furthermore, residents of the neighborhood would become more aware of the process of waste collecting and collaborate with the municipality to solve the waste issue. The purpose of this paper is to explore the challenges in collecting household solid waste from areas which are inaccessible by vehicles in Jabal al Natheef. A mixed design method approach was used to answer the research questions: to which extent is the physical and behavioral environment affect the waste management process; how is waste being collected from areas that are inaccessible? In order to answer these questions, two major aspects will be analyzed: physical urban impact on the one hand, and the residents behavioral impact on the other. Based on these two aspects, further analysis will be conducted to investigate the interrelated impacts both of which are discussed from two points of view; first is the urban form impact, and second is the sociocultural impact .

2. Theories And Methodology

The study and practice of waste management planning combines traditional planning methods and environmental impact assessment (Hostovsky,2000). The purpose of solid waste management is to decrease the harmful impacts of solid waste on the human health as well as the environment and is affected to a great extent by land-use planning and the physical form of the urban context. Participatory

planning and behavioral studies also comprise a great part of waste management planning. The first part of this section reviews theories and literature related to waste management in traditional planning theories, environmental and sustainable planning models and then moves to behavioral studies and their role on waste management. The second part of the section covers methodologies and tools that employed to test the hypothesis of the research and measure the behavioral and planning indicators.

2.1.1 Urban Theories

Two major aspects should be investigated when we come to waste management in informal urban settlements: density and accessibility. Spatial density or overcrowding as an urban term refers to the number of people who live in number of buildings in a specific definite urban setting. While accessibility is defined as the people and transportation means ability to reach and move in urban settings. On the land use and transport planning level accessibility is measured through four indicators. First, the land use indicator which is measured by the level of density and spatial distribution. Second, the transport indicator which is measured by time, cost and effort that needed to circulate in the urban setting. Third, the temporary constraints and opportunities during different times, finally, the individual indicator of the person's needs (Geures, Wee and Van, 2004). Transport and people accessibility is intersected and overlapped in many aspects. For example, residential accessibility can be examined at neighborhood level, while transportation should be scaled on neighborhood and city levels (Tsai, 2014). Accessibility may vary considerably within the same neighborhood based on the spatial distribution of retail and services relative to population density. Furthermore, neighborhood accessibility is measured by density, land use mix and street pattern design (Handy and Clifton, 2001).

Researchers found that higher land use mix and density can afford better neighborhood accessibility, but this is not the case in informal settlements where unplanned urban forms decrease transport accessibility. Accessibility in the compacted unplanned neighborhoods form challenge with more detailed investigation to evaluate the affordability of basic services and modes of transport. It required more investigation on the urban characteristics and residential environment. The following sections covers physical and behavioral urban theories and methods in waste management.

Researchers from different disciplines other than planning such as engineers, scientists, and even researchers from the fields of law and economics began to research waste management and published their work in planning and waste management journals. After 1979, scholarly work about waste management as discipline spread in environmental management journals. Lindblom (1979, 2003) proposed incremental planning as an alternative to the rational comprehensive model as it is not possible for planners to have a complete knowledge of all the factors in the problem of waste management and all the possible solutions.

The involvement of scientists and engineers in the waste management research in environmental journals in addition to urban planning journals reveals the strong relationship between waste management, traditional planning theories and environmental planning. With the rising environmental concern in the late 20th century, sustainable planning has become a pressing matter. Recently, more

concern is paid toward waste management planning and zero waste cities. Scientists in the field offer more sustainable methods of waste disposal.

Lehmann and Uzaman (2011) established model of waste disposal practices over time based on the UNEP and the Natural Edge Project. They focused on practices of the waste disposal and classified them into 6 categories from open dumping to zero waste systems. It is clear that waste management developed to a more holistic approach of the population behavior instead of tackling the process of waste collecting and disposing. It is argued that waste disposal is more related to the consumer behavior since the goal is to reduce the amount of waste generated from households.

2.1.2. Behavioral Theories

According to Lober(1995) waste management planners did not seem to take advantage of technological software in studying and planning the waste management such as Geographical Information System (GIS). By using GIS, planners could determine the best sites for landfill and waste disposing. Lober has developed a spatial predictive model that measures the level of public opposition based on the distance from undesirable facilities. GIS could be used to help in solving different problems in waste management in addition to integrating the social aspect. Waste management planners rarely addressed social concerns and public input while planning (Hostovsky ,2000). GIS is a powerful tool with much potential and can be used to effectively integrate social criteria in waste management planning, as seen with Lober's model. In addition to using technology to integrate the residents and addressing social concerns, behavioral studies and participatory planning models are integrated in waste management planning. Behavioral studies are discussed as a major part in environmental planning models since several environmental problems are the consequences of negative or destructive human behavior. Air pollution, water pollution, and odors can be the results of improper waste disposal by the residents. An environmentally aware behavior of residents plays a major role in decreasing the negative effects of waste, starting from responsible consumption which decreases the amount of waste, to proper waste disposal behaviors that minimizes the negative effects of waste on the residents' neighborhood and, consequently, the environment.

Several behavioral theories were employed to investigate waste management and sustainable behaviors of citizens. Akintude (2017) concluded that a combination of different theories will provide possible solutions to environmental problems, as none of the theories he reviewed can independently entirely explain human-environment interaction. Akintude grouped behavioral change model, environmentally responsible behavior model, and reasoned/responsible action theory under "primitive models" and reviewed several other theories. Janmaimool (2017) studied the effect of applying protection motivation theory (PMT) on sustainable waste management behavior of citizens, preferring it over other theories as it is well suited for low-cost and simple waste management. In short, PMT assumes that individuals make decisions based on a motivation to protect themselves from various threats, therefore, by making them aware of the possible threats that waste has on their environment can motivate them to adopt risk preventive behaviors. Janmaimool preferred PMT over the theory of planned behavior (TPB) and value

belief norm theory (VBN), as risks raise and individual's motivation to perform an action to protect themselves and minimize the risks.

There is a perceived significant difference in waste disposal behavior between people living in planned neighborhoods and residents of unplanned and unregulated areas (Mamady, 2016). Mamady's study shows that in Guinea, residents live more than 100 meters from permitted municipal dumps tend to dispose of their waste by themselves, burning it or dumping it on open lands. Hence, it is essential to take into consideration the characteristics of the built environment and incorporate a suitable mix of behavioral theories when planning for waste management in a specific area.

2.2 Methodology

An embedded mixed method is employed in this paper to study the waste management in Jabal al Natheef. Data was collected using different approaches. First, a preliminary media analysis was conducted, and various audio-visual materials were examined. The researchers conducted daily site visits in different times. The field observations show that there is household solid waste thrown on stairs with a stinky smells spilling out of the plastic bags causing awful smells and unpleasant views. However, there were several street sweepers working on the streets and on the stairs as well. The effective factors that impact on road network in study area were identified and the necessary maps were generated and classified.

While the population of Jabal al Natheef is 150.000, a calculation of 10% as a sample size seems impossible because of the time and budget limitations a, therefore, the point of view of the residents and GAM, was required to conduct a one-to-one interviews. Interviews with the GAM were conducted with the head of the environmental department in GAM, the supervisor in Ras al Ain, and street sweepers who work in the neighborhood. Due to the social difficulties, key people in Jabal al Natheef were interviewed. GAM provided several documents and statistics about the waste generation and waste management in the area, although some were outdated and needed to be updated to accommodate some major changes on the municipality level in the past 10 years. Site visit was made with the Head of the Environment Department, who explained in details the waste collection procedures applied by GAM in Jabal al Natheef, the number of street sweepers, and what procedures are implemented to overcome the accessibility challenges.

Yes or no styled questions (dichotomous scale) in the questionnaire survey were used, dichotomous scale is a two-point scale that helps the participant to choose the answer without confusion, so all the participants can understand the questions and the answers clearly, and all the questions were followed by a blank space for the notes, if any of the participants wanted to explain their answers. The analysis of data then categorized into two themes. The first theme focused on measuring the satisfaction of the beneficiaries of the services administration's policies and processes to enhance environmental quality in the study area. It measured the degree of the respondents in relation to waste management. The second theme measured the impact of the physical density in the study area on solid waste disposal service. The results of the survey questionnaire were ordered as follow (Table 1).

3. Discussion And Analysis

Amman is the home of nearly half of Jordan's population that becomes the highest population city. Despite it is the third-largest area, not merely, because it is the capital of Jordan and the center of economic activities, but also because most of the refugees settle in. Amman is characterized by strong contrasts between poor, highly populated neighborhoods with a lack of urban services, and high unemployment rates, which are mainly located in the East of Amman, and neighborhoods that are located in the West but also in the Northwest and Southwest, where the active population is greater, the level of education is better, buildings and infrastructure are more developed (Ababsa, 2010). This disparity reflects not only the physical settings but also the existing social classes and economic background of its residents which led many scholars to claim that Amman is divided into West and East parts. According to Seteny Shami (2007), "East Amman is the older part where residential dwellings are on the hillside and commercial areas are distributed in a traditional liner layout along the valleys. West Amman, on the other hand, is less densely populated and more fashionable. Most economic investments are centered in different districts there such as Abdali, Shmesani, Swefiyeh and Abdoun. However, a large physical and social contrast exists between East and West Amman" (Shami, 2007, p.208).

The growing population, the consumption driven urban lifestyle, and the various economic and social activities that take place in Amman all contribute to the large amount of household solid waste generated in the city, reaching an average of 4872700 kg per day. On average, the per capita waste generation in Amman is 0.9 Kg a day, but the amount of household solid waste in Amman is affected by several factors that increases or decreases the amount of generated waste. Each of the 27 districts of Amman generates waste at a different rate. The districts vary in surface area and population density, in addition to other differences in social and economic aspects. Statistics from Greater Amman Municipality (GAM) show that downtown Amman, also called the Madinah or al-Balad (city center), has the highest rate of waste generation reaching up to 1.8 Kg per capita a day. This is due to the large number of stores and economical and social activities there. On the other hand, Badr al-Jadidah is at the lower end of the spectrum with 0.52 Kg of waste per capita a day, which is expected since it is mostly a residential area with low population density.

Official documents of GAM show there is a significant increase in the amount of waste generated in Amman during the summer season in comparison with winter. According to the GAM, waste generation in Amman increases significantly in summer and during the holy month of Ramadan due to the return of expatriates to spend the holidays and the summer vacation with their families and the increase of various social occasions, like weddings and graduation parties. In conclusion, the amount of waste in Amman varies between different areas, depending on the activity type, surface area, and population density. Moreover, household solid waste is generated at different rates in different times of the year due to various social activities.

GAM divides Amman into six main districts for collecting waste. Each districts is divided into five areas. The highest amount of waste comes from the first district reaching approximately 500 ton/day. This

district is characterized by its high population density and houses large economic, social, and governmental amenities. In return district six which located in the west part of Amman with low population density, produces the lowest waste that reaches around 300 ton/day. The study area of this research is part of district three which is so close or even an extension of the city downtown Figure 2. Accordingly, the estimated rate of waste generated from this part approximately reaches up to 1.3 kg per capita a day. According to the latest official statistics the population of Jabal al Natheef is approximately 150.000 inhabitants live on 1.24 km square. The number of the households in Jabal al Natheer is about 30000 with %61.4 of them is a household average size of 6.5. The collected data of the field survey shows that %52.6 of the households produced two medium size and %36.8 large size garbage plastic bags. %22.8 of the households produced more than two medium and large bags. Thus, the daily waste solid reach an average of 135 ton/day by residents and approximately 10 ton/day produced by commercial activities and retail shops which reach in total 145 ton/day.

Solid waste collection and transport starts at the generation points such as homes, groceries and so forth and pick-up points, pick up by the crew, trucks driving around the neighborhood, and truck transport to a transfer station or disposal point. The collection phase is the most difficult and complicated in most areas of Amman. In Amman, solid waste collection method varies from residential to commercial areas. In residential areas, the most common collection methods are street and alley services, the residents and tenants carry the single-use plastic bags garbage containers. In commercial areas, property owners are responsible for transport waste in the garbage pins. Cleaning the streets and the waste collection and transport of waste out from the neighborhood and the city is associated with the GAM sweepers responsibilities. In all cases, neither the residents nor the sweepers separated solid wastes.

GAM does not provide door-to-door waste collection, instead residents must bring their waste and put it inside the closest container in most cases . The capacity of each container is 80-100 Kg. Those containers have wheels so they can be easily moved around by clean workers to be lifted and emptied in the garbage truck. Recently GAM distributed containers that do not have wheels because to reduce their maintenance and to prevent the residents from moving them around. In addition to collecting waste from community containers, GAM employs approximately four thousand street sweepers who collect waste from streets and public spaces.

GAM operates different types of small and medium compaction garbage trucks ranging in capacity 1-8 tons that collect waste from the 21,000 garbage containers distributed throughout the city. Each compaction truck is operating with a crew of two or three, including the driver. In areas with high waste generation, the containers can be emptied up to 3 times per day, on the other hand, in remote areas and areas with low waste generation, the waste is collected every other day. The available garbage containers in the study area are 150 containers distributed on the garbage trucks accessible roads. The maximum capacity of these containers is 750-800kg. According to the field research and survey questionnaire the containers are distributed between zero and more than 100 meters from houses (% 33.3 less than 50 meters, %36.1 are allocated in 50-100 meters, and %3.6 more than 100 meters) Figure 3.

Amman began to grow organically on seven hills around Wadi of Ras el Ain, which is a stream that runs north-east from the plateau towards the Zarqa River basin. Since then, Amman expanded to encompass around nineteen hills. The topography of the city and its organic growth has dictated certain physical traits. The neighborhoods of Amman are built on separate hills served by streets and defined by natural terrain of interconnected valleys mainly in the urban central core.

Most parts of these neighborhoods are connected by the major roads and stairways. Stairways connected houses with each other and roads in the surrounding valleys as well. The center of Amman is famous by the large number of these stairs, whereas almost no stairs in the newly expanded neighborhoods of the city. A recent research by Al Tal and et al. (2018) examined the social and spatial effects of overcrowding on one of East Amman informal camp Jabal al Natheef, the informal development has affected the inhabitants' density which in turn caused huge pressure on basic services, including but not limited to the road network, infrastructure in addition to public and open spaces Figure 4.

Jabal al Natheef is located in the downtown of Amman and overlook the historical center . Despite this proximity, only two roads connect the city center with Jabal al Natheef making it separate and disconnected from downtown. The neighborhood itself has grown in unplanned haphazard way where houses are built adjacent to each other and connected by steep stairways and narrow alleyways. Originally, the neighborhood emerged from the Palestinians refugee of Mohammad Ameen which named after the owner of the land in the early 1950s. The settlement starts in the form of tents and then these tents were replaced by permanent concrete and masonry brick houses (Al Tal et. al, 2018). The neighborhood is famous for its high urban density, social problems, lack of security, widespread substance abuse, and poor infrastructure in services such as solid waste, drainage and sewage (Al Tal et.al, 2018, Arini, 2013). According to the Department of Statistics (DoS) (2018) the population of Amman counts 4,327,800 people live over 1,662 km². The average urban density of Amman is 2,604 person / km², in return the urban density of Jabal al Natheef reaches 120,968 person/ km², which is very high in comparison with the urban density of Amman (Table 2).

Mobility and accessibility form a major problem of services and facilities for the population living in residential parcels located on the rough topographical areas in Jabal al Natheef. Figure 4 shows the road network connected and serve the area. The irregularity reveals the topography, landform and existence land features like valleys surrounding the mountain as dominant factor that controls lack of alignment network such roads often climb impossible passages through steep mountains. Driving can be traitorous due to narrow roads, blind curves, and unprotected embankments sometimes on the edge of cliffs “expect the unexpected”. In general, driving in inaccessible mountains Amman is challenging with low level of road safety , drivers do not obey any lanes or rules and traffic directions. They were built to meet the driving needs. They are in reproachful states of repair and poor condition, unreliable signage, and inadequate for density of traffic. These roads consist of one lane per direction, without and division islands or painted line in the middle to separate cars moving in opposite directions. Shoppers, residents, and commercial providers lay there vehicles on street sides it normal to be stuck in major congestion in

the mixed use streets. Parking on the streets can be impossible to find for service and inappropriate type and size of garbage collection vehicles. In this research, we rank links of a network according to their width, connectivity, and garbage compactors accessibility. Data collected from GAM shows that only medium and small size garbage compactors served the area in addition to the medium size trucks. The researchers overlapped obtained data with streets width and connectivity observed in the study area. Acerbically, the road networks classified into medium trucks path, small trucks path, stairways, and inaccessible residential parcels such a ranking can be particularly helpful when we consider susceptibility to be connected to the SW collecting and transport Figure 5. Out of 66 streets 41 streets 68.2% could be accessed by medium and small compactors and 15 streets 22.7% only accessed by small garbage compactors and small trucks. The impeccable about 40 stairways and less than 2 meter passageways are served by door to door collection by the street sweepers. Figure 4 shows that the inaccessible neighborhoods concentrated on the edge of cliffs of the mountain. The responsibility and authority to minimize the risk that waste collection vehicle drivers might pose to public safety in these areas.

GAM was impelled to deploy some unconventional methods to overcome the major challenges in collecting household solid waste from Jabal al Natheef. The narrow and intertwined streets forced GAM to use small trucks to collect garbage instead of the garbage compactors. In general , these small trucks are used in Jordan for transporting various objects and commodities such as vegetables, livestock, furniture and so forth. Street sweepers collect household waste on stairs and alleyways which thrown by the residents. Table 3 shows the number and type of garbage trucks according to the collecting shift and capacity. GAM assigned 26 garbage sweepers monitored by two foremen, four sweepers are assigned serve the 40 stairs of Jabal al Natheef.

Areas with poverty, poor accessibility, and unregulated settlements witness the largest percentage of random waste disposal (Mamady, 2016). The residents of Jabal al Natheef spilled waste on stairs, alleyways, abandoned and half demolished buildings, and on the empty plots on the side of the hill which is a common sight and environmental hazards associated with such improper behavior increasing Figure 6. Women open their kitchen windows and hurl a plastic bag full of kitchen waste out onto these spaces. 75.4 % believed that it is unsafe for women and young girls to go outside and throw the garbage bags in the proper pins. Collecting this waste from those steep sloped empty lands poses an enormous challenge that demanded a special treatment. This open dumping of waste causes foul smell, breeds diseases and spoils the public image of the GAM, especially in the mountain side seen from the GAM administration complex and the main throughways in valley bed .

In some cases, GAM installs hiking ropes for street sweepers to climb and collect the piled-up waste by manual tools such as shovels and brooms, which are used for collection. Some residents have memorized the schedules of garbage trucks and street sweepers and intentionally throw their waste on the street or stairs after the shift is over. Although residents always complain about the negative effects the random disposal is doing to their neighborhood, they do not seem to know they are the main cause of the problem. Mamady (2016) concluded in his study that citizens who live more than 50 meters away from waste collection pins in Guinea tend to dispose of their waste on their own by throwing or burning it.

In Jabal al Natheef, some residents must go down around 400 steps to the nearest garbage bin then up again to their house. However, this is not an excuse to litter your neighborhood, as GAM once provided small bins on the stairs which unfortunately stolen.

The residents of Jabal al Natheef should be aware of their negative behavior on the environmental aspects. The application of the protection motivation theory through planning and awareness campaigns could hold a solution since it raises people's motivation to act to protect themselves. In addition to that, GAM should consider deploying participatory planning methods to make residents feel they are an active part of the plan. The ignorant behavior of the residents is a principal challenge in Jabal al Natheef. 90.7% of the study sample assisted that there is no awareness campaigns about solid waste collecting and management by GAM. Also, 88.0% answered that there is inadequate cooperation from citizens with the public and government agencies like GAM in addition to the inadequate containers capacity at the communal collection points. In conclusion, in places, such as areas with large and diverse underserved populations and significant unmet need, it may be appropriate and beneficial to both the community and the government agencies involved to share all or part of the same service area. In return GAM has to provide access to underserved people as possible, and, in some instances, supporting multiple sites within the same service area may compromise this principle.

4. Conclusion

This research started with a hypothesis that there is a deficiency in waste collection in Jabal al Natheef. However, the results of the research revealed that the behavior of the residents play great role. The residents disposed of their waste in random ways, throwing it on stairs, narrow alleyways, empty plots on the foothill, and in abandoned and half demolished buildings. They sabotaged any efforts done by GAM, like stealing away the little bins on the stairs, and memorized the schedule of the garbage trucks and deliberately threw their waste after the trucks had finished their round. The difficult conditions that presented in the site such as the lack of roads that reach the houses, the steep staircases and the empty plots and half demolished buildings that became a hotspot for accumulating waste required more effort. They deployed unconventional and extreme measures that were site specific to collect waste from the neighborhood. Examples of these methods include garbage collectors climbing the side of the hill tied to climbing ropes and assigning specific garbage collectors to work exclusively on the stairs. Such problems can be avoided by integrating and addressing the society role when planning the waste collection methods in the area by adopting participatory planning methods. Moreover, Greater Amman Municipality should cooperate with the community institutions on increasing the public awareness and integrate the protection motivation theory in their programs. Adopting a model that address residents like participatory model and protection motivation theory could lead to a sense of ownership of the waste management plan by the residents and therefore reduce the negative behavior.

Declarations

Availability of data and material: This research was entirely based on available data either obtained by Greater Amman Municipality or available websites and accessed by the public.

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Tables

Table 1 Questionnaire results

Survey Questions	Percentage	
	Yes	No
Physical : density and accessibility		
Are the number of the street sweepers enough for the cleaning and waste collection ?	42.1	57.9
Are the vehicles and equipment used by the GAM in collection and transport are suitable and have convenient waste policy ?	50.9	49.1
Does your house locate in underserved area that lacks service quality ?	57.9	42.1
Poor cooperation between public and government agencies like GAM	88.0	22.0
Is there periodic collecting for the solid waste ?	59.6	40.4
Behavioral (psychological, social)		
Are there any awareness campaigns about solid waste collecting and management by GAM ?	9.3	90.7
Do you usually keep garbage unprotected on the stairways and unreachable pathways ?	29.8	70.2
Have you been discussed about your needs to improve the environment?	20.3	79.7

Source: Authors, 2021

Table 2 Urban density of Jabal al Natheef

	Area km ²	No. population	Urban density	Average daily solid waste tons/day	No. of Garbage containers	No. of sweepers and collectors
Jabal al Natheef	1.24 km ²	150.000	120. 968 / km ²	145	150	26
Amman	1662 km ²	4,327,800	2,604/ km ²	750	22000	6000
Jabal al Natheef/ Amman	0. 075%	3.46%		19%	0.68%	0.43%

Source : Authors, 2021

Table 3 Waste collecting vehicle size and collecting shifts

	Morning shift		Noon shift		Evening shift
Vehicles size	Middle	Small	Middle	Small	Small
No. of Vehicles	3	2	1	2	1
Average collected (tons)	17-20		7-9		1-2
	28 tons /day				
Average generated (tons)	145 tons /day				

Source: Authors ,2021

Figures



Figure 1

location and urban fabric of Jabal al Natheef Source: Google (2021)

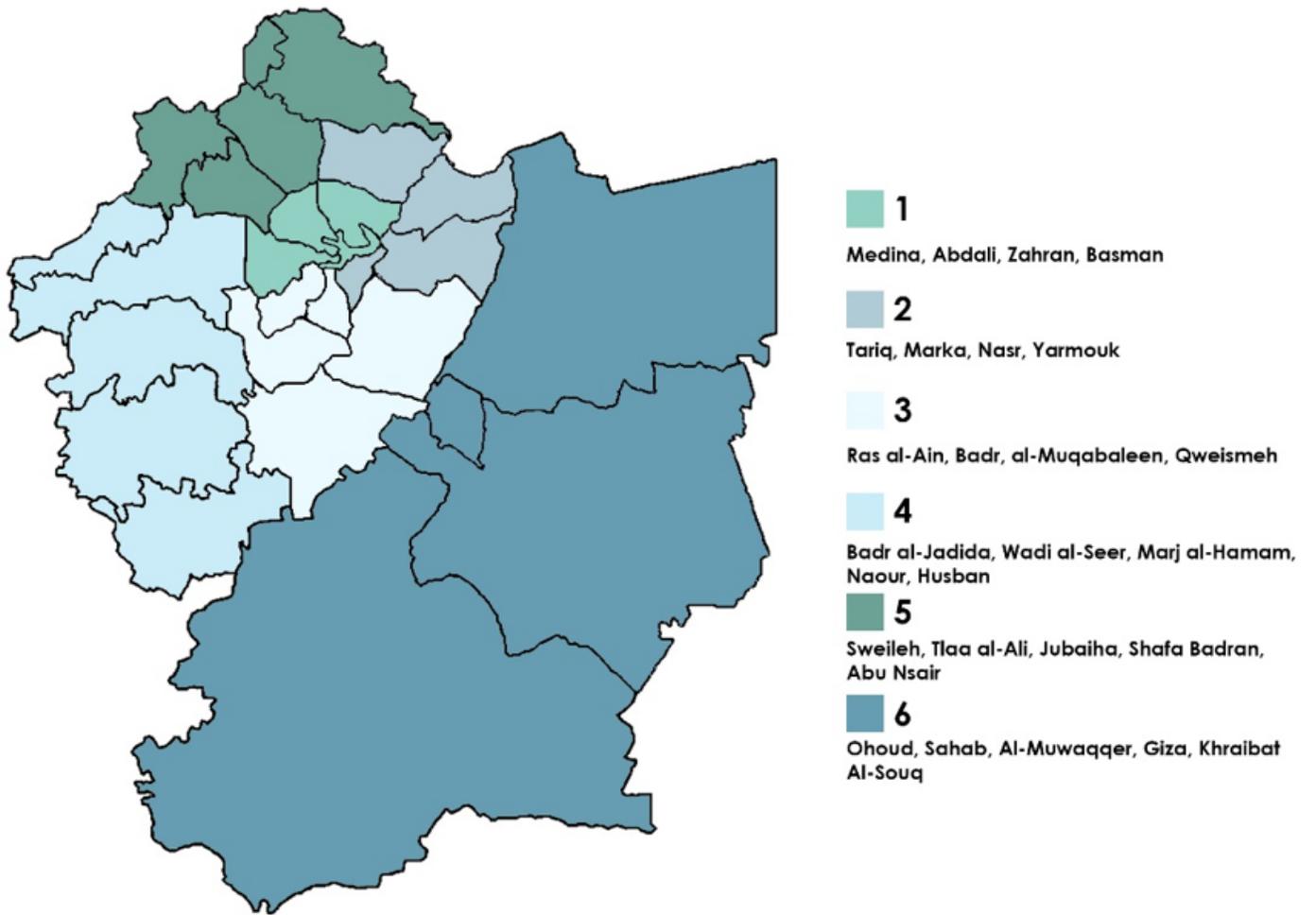


Figure 2

Waste collection districts in Amman Source: GAM illustrated by researchers (2021)

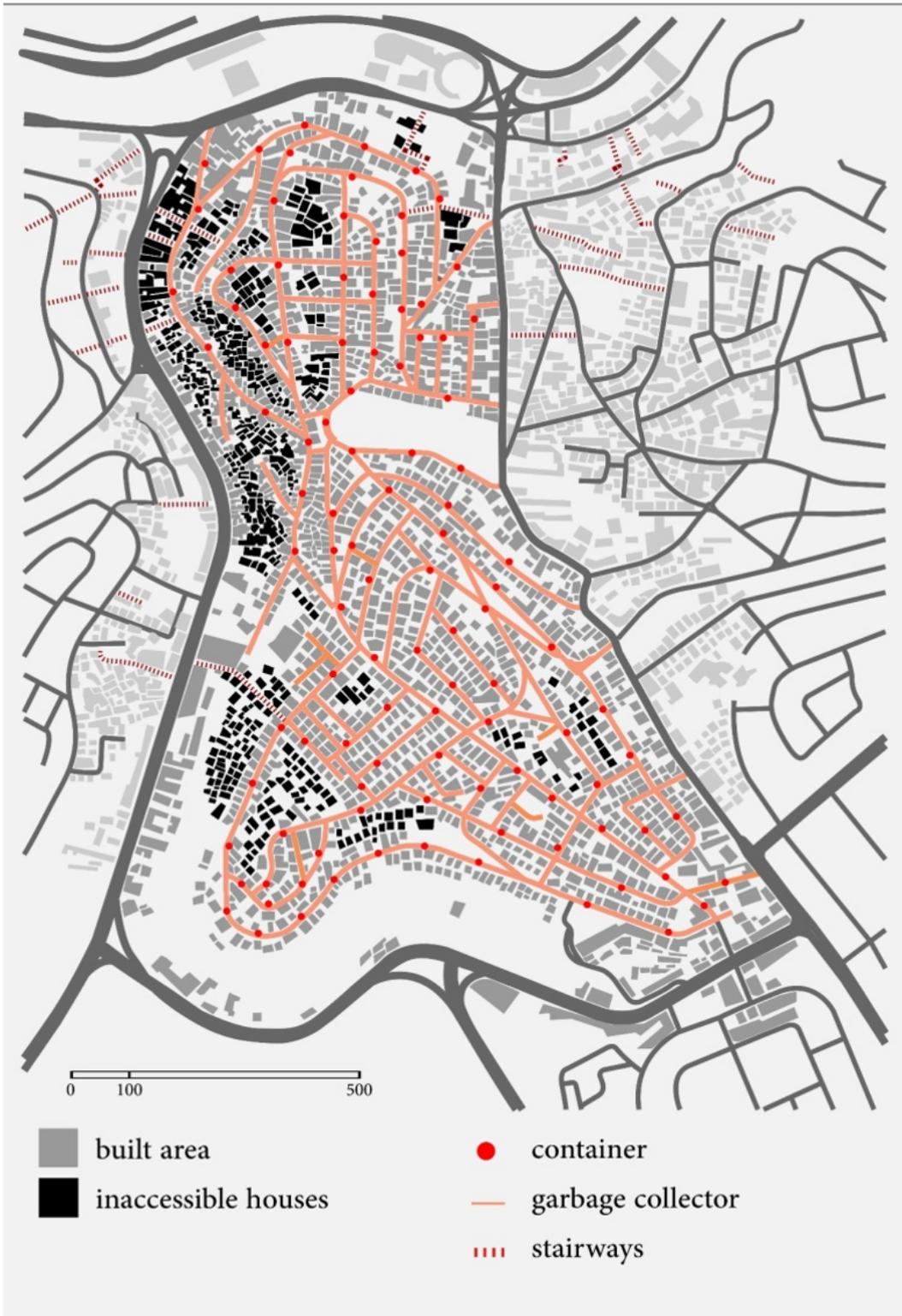


Figure 3

Challenging spots in waste collection in Jabal al Natheef source: Google maps and illustrated by researchers (2021)



Figure 4

Jabal al Natheef urban density Source: Google (2021)

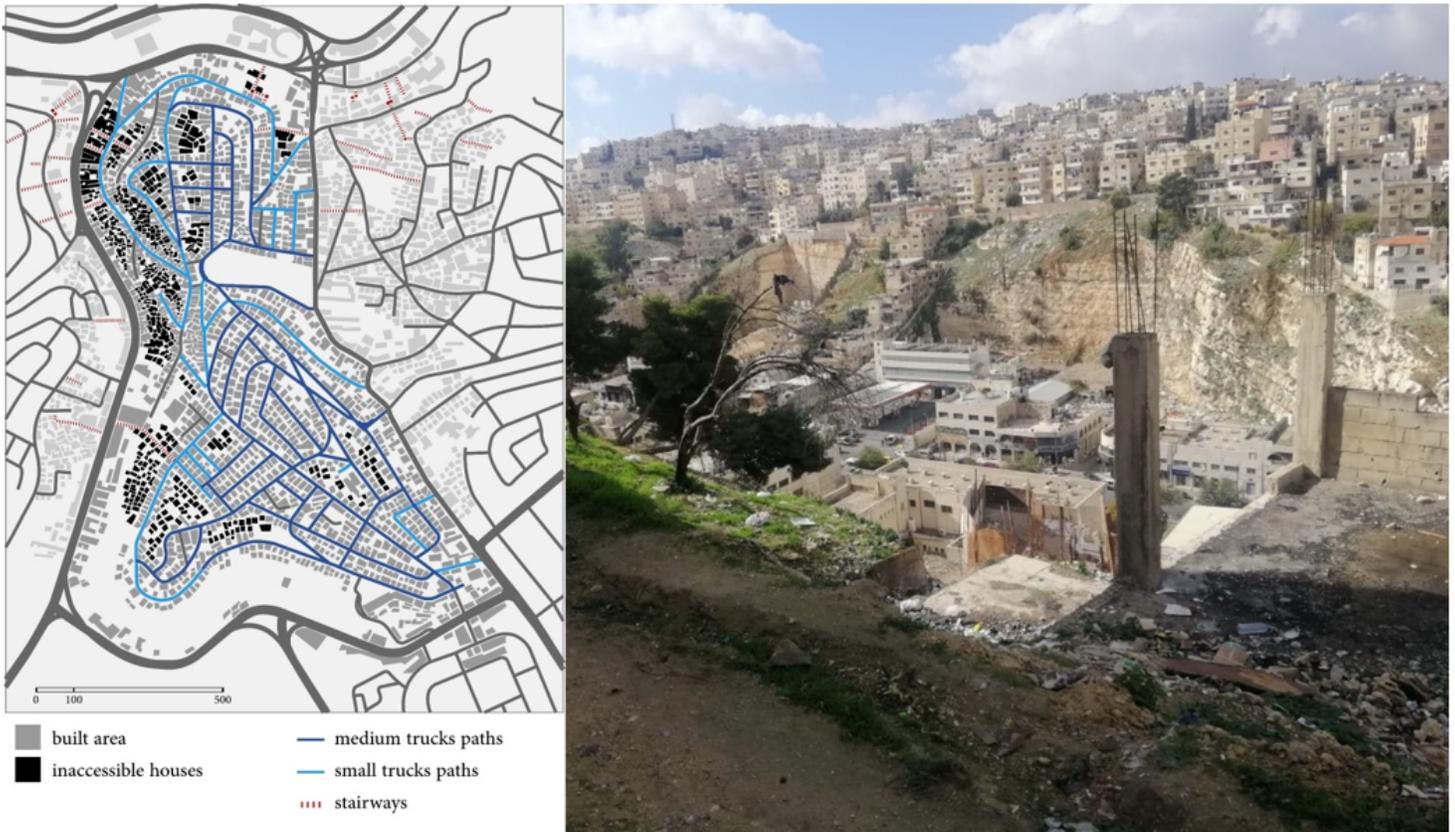


Figure 5

Paths of garbage vehicles and street sweepers. Source: Authors (2021)



Figure 6

waste accumulation in Jabal al Natheef , Source: Authors