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Household Solid Waste Management in Inaccessible Neighbourhoods

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ABSTRACT

This research examines challenges in collecting household solid waste in highly populated inaccessible neighbourhoods. The main question of the study is: to what extent does the built environment affect waste management processes? To answer this question, two major aspects were analyzed: traditional planning theories, relating to environmental and sustainable planning models, and the behavioural studies and their role in waste management. Based on these two aspects, further analysis was conducted on the interrelated impacts, both of which being discussed from two points of view; the first is the impact of urban texture, and the second is the sociocultural impact. The area under study is one of the oldest and largest informal settlements in Amman, the capital of Jordan. Results revealed that both the community and the government agencies must share the service areas. In addition, the municipality has to provide access to underserved people. This study is important since it brings valuable contribution to the scarce literature on the relationship between solid waste management and informal inaccessible settlements in Jordan and within the region.

1. INTRODUCTION

Solid waste has increased significantly with rapid urbanization, population growth, and consumption-driven global development (Ai, 2011; Higano et al., 2016; Maina et al., 2016). The increasing volume of waste generated by today's consumption-driven society is one of the major challenges for sustainable city planning and design (Generowicz et al., 2011; Uzzaman and Lehmann, 2011). The main objective of solid waste management (SWM) is to decrease and eradicate the negative impacts of waste materials on human health and environment and to uphold an excellent quality of sustainable urban life (Aldayyat et al., 2019). The study and practice of waste management planning combines traditional planning methods and environmental impact assessment (Hostovsky, 2000; Fuldauer et al., 2019). This challenge is magnified when it comes to waste collection and transportation. Most parts of the informal settlements

and neighbourhoods are inaccessible, as a consequence of the unplanned narrow haphazard unpaved streets. Subsequently, these informal settlements have turned into an unhealthy crowded blight of the city's urban landscape, with harmful environment impacts.

In high population density mountainous cities such as Amman, collecting solid waste causes a major challenge for the municipality. In addition to its rough physical topography, Amman's social fabric and social inequality is tangible and very complicated. The east side of Amman, with its rough arid topography, houses the largest Palestinian camps and other informal neighbourhoods, with a high number of poor and low-income residents. Originally, Amman began to grow organically on seven hills around Wadi of Ras el Ain, the current valley bed of the city. The stream runs north-east from the plateau towards the Zarqa River basin, in the north east of Amman. The city further expanded to encompass around 19 hills.

The topography of the city and its organic growth has dictated certain physical traits. As the capital of Jordan and hub of economic activities, Amman is the most populous city in Jordan and home to almost half of the national population. It also hosts a large number of refugee population, including successive waves of historical Palestinian refugees, and the more recent arrivals from conflicts in Iraq and Syria (Al Tal and Ghanem, 2019).

Amman is characterized by strong contrasts between poor, highly populated neighbourhoods lacking in urban services, and high unemployment rates, and low level of socioeconomic development. Neighbourhoods located in the west, including the northwest and southwest, have a higher number of economically active population, and higher standards of education, buildings, and infrastructure (Al Tal, 2006; Ababsa, 2011).

This disparity reflects not only the physical sittings but also the existing social classes and economic background of residents, which led many scholars to claim that Amman is divided into West and East; the older area of East Amman includes hillside and valley settlement patterns of residential and commercial land usage, while West Amman has lower population density and generally superior infrastructure etc. This is associated with more economic investments, notably in the districts of Abdali, Shmesani, Swefiyeh, and Abdoun (Shami, 2007).

This research focuses on one of the oldest and largest informal settlements in Amman, called Jabal al Natheef (literally means 'Clean Mountain'). Unfortunately, its name does not reflect its chaotic modern urban and environmental reality. Originally, this neighbourhood has emerged as a Palestinian refugee camp in the early 1950s, which gradually transformed into an uncontrolled urban node. The settlement makes an ideal case for the current study on account of several reasons. First, it is the largest informal settlement in Amman; second, it is the settlement with the highest density and poverty level; third, it sets on a rough rocky terrain isolated by valleys; and fourth, there is a scarce literature on the relationship between the problem of solid waste management and informal inaccessible settlements on the mountains in Jordan, although there is a lot on similar contexts reflecting low-cost and informal housing on mountains, such as favelas in South America. 'Favela' originally referred to mountain flowers (Magalhães, 2016).

The current situation of the unregulated layout poses a challenge for the Greater Amman Municipality (GAM). Although it is provided with water and electricity services, this neighbourhood suffers in terms of solid waste management, not only due to its rough terrain, which is mostly accessed by stairs amounting to a hundred steps in places, but also due to the high population density, with associated physical, economic, and social problems (Fig.1).

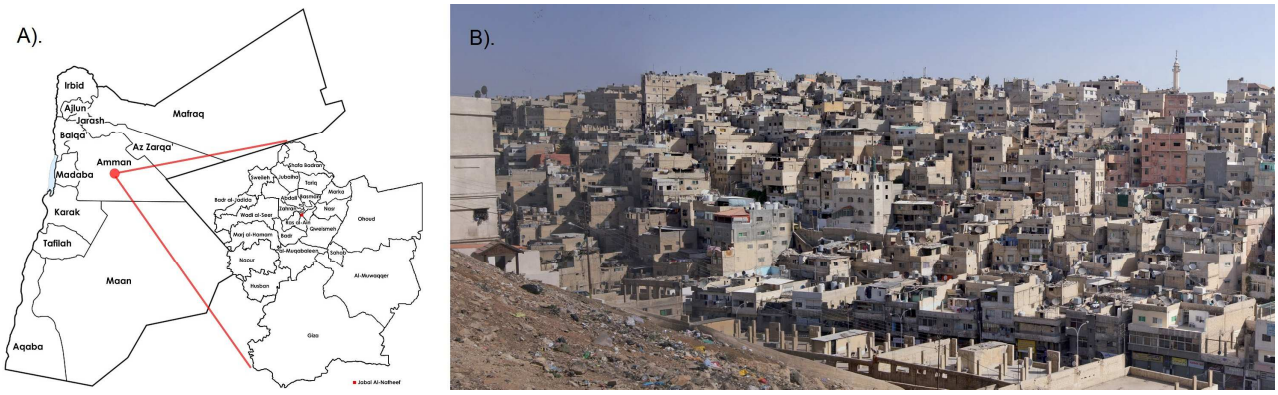

Fig. 1. A). Location of Jabal al Natheef; B). Neighbourhood of Jabal al Natheef *(source: Google Maps, 2021).*

Earlier studies conducted on Jabal al Natheef addressed the socioeconomic aspects and provided a spatial analysis of the area (Al Tal et al., 2018). These publications highlighted 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 waste collection in Jabal al Natheef can help planners and decision-makers to solve waste management issues in

Greater Amman Municipality. Furthermore, residents of the neighbourhood would become more aware of the process of waste collection and collaborate with the municipality to solve the waste issue.

A mixed design method approach was used to answer the research questions: to what extent does built environment affect waste management processes; and how it is waste collected from inaccessible areas? To answer these questions, two major aspects were analysed: urban planning impact, and residents' behavioural impact. Based on these two aspects, further analysis was conducted to investigate the interrelated impacts, both of which are discussed from two points of view; the first is the impact of urban fabric, and the second is the sociocultural impact.

2. MATERIALS AND METHODS

The process of waste management has two main components: collection and transportation, followed by treatment and disposal. This research focuses on the collection and transportation of waste, as part of the specific management process. The first part of this section reviews theories and literature related to waste management in traditional planning theories, related to environmental and sustainable planning models. The second part explores behavioural studies and their role in waste management. The third part covers methodologies and tools employed to answer the research question and measure the behavioural and planning indicators.

In relation to waste management, two major aspects should be investigated about informal urban settlements: density and accessibility. In urban terms, spatial density or overcrowding refers to the number of people who live in a number of buildings within a specific and definite urban setting. Accessibility is defined as the ability of people and means of transportation to reach and move within urban settings (Handy and Clifton, 2001; Tsai, 2014). On the land use and transport planning level, accessibility is measured through four indicators: the land use indicator, which is measured by density and spatial distribution; the transport indicator, measured by time, cost, and effort needed to circulate in the urban setting; the temporary constraints and opportunities during different times; the individual indicators of people's needs (Geures and van Wee, 2004).

The accessibility of transport and people intersects and overlaps in many aspects. For example, residential accessibility can be examined at the neighbourhood level, while transportation should be scaled on the neighbourhood and city levels (Tsai, 2014). Accessibility may vary considerably within the same neighbourhood based on the spatial distribution of retail and services, relative to population density. Furthermore, neighbourhood 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 provide better neighbourhood accessibility, but this is not the case of informal settlements, where unplanned urban physical texture decrease transport accessibility. Accessibility in compact, unplanned neighbourhoods determines challenges requiring more detailed investigation, particularly to evaluate the affordability of basic services and modes of transport. Such contexts warrant more investigation of urban characteristics and residential environments. The following sections cover physical and behavioural urban theories and methods in waste management. Lober (1995) developed a spatial predictive model that measures the level of public opposition based on the distance from undesirable facilities.

Behavioural studies are discussed as a major consideration in environmental planning models, since several environmental problems are the consequence of negative or destructive human behaviour. Air pollution, water pollution, and odours can be the results of improper waste disposal by the residents. An environmentally aware behaviour of residents plays a major role in decreasing the negative effects of waste, starting from responsible consumption decreases the amount of waste at source), and extending to proper waste disposal behaviours to minimize the negative localized impacts of waste on residents' neighbourhoods, and consequently the environment in general (ECODIT, 2010). Akintunde (2017) concluded that a combination of different theoretical paradigms can provide possible solutions to environmental problems, as none of the theories he reviewed could independently and entirely explain human-environment interactions. Janmaimool (2017) studied the effect of applying protection motivation theory to conceptualize citizens' sustainable waste management behaviour, preferring it over other theories as it is well-suited for low-cost and simple waste management. The theory 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, this can motivate them to adopt risk-preventive behaviours. There is a perceived significant difference in waste disposal behaviour between people living in planned neighbourhoods and residents of unplanned and unregulated areas. Mamady (2016) found that residents who lived more than 100 meters from permitted municipal dumps in Guinea tended to dispose of their waste by themselves, burning it or dumping it on open land. Hence, it is essential to consider the characteristics of the built environment and incorporate a suitable mix of behavioural theories when planning for waste management in a specific area.

2.1. Methodology

The research methodology is based on a mixed-method approach, which includes both qualitative and quantitative strands. Descriptive statistics and content analysis were used to analyse the collected data. The quantitative data is based on previous studies and comprises datasets derived from satellite images and maps. Satellite images and maps were used to extract data and get a more precise mapping and classification of the existing urban fabric, road network and topography of the neighbourhood. Data was collected using different approaches. First, a preliminary media analysis was conducted, and various audio-visual materials were examined. Daily site visits were conducted at different times. Field observations revealed that House Solid Waste (HSW) is commonly thrown on stairs, with overpowering stench from plastic bags, causing revolting smells and unpleasant views. However, there were several street sweepers working on the streets and on the stairs, as well. The effective factors that affect road network in the study area were identified, and the necessary maps were generated and categorised. Interviewers posed questions that clarified the topic, instead of moving forward with questions on the survey. This meant that interviewees from the same category did not always receive the same questions or cover the same topics. Instead, the sampling procedure was to continue conducting interviews until clear trends emerged. For example, in the case of GAM, interviews were conducted with all levels of environmental management, as well as street level actors who work in the neighbourhood. Due to social difficulties, key people in Jabal al Natheef were interviewed to fill in the questionnaire. The goal of interviewing the people of Jabal al Natheef was to examine the social and cultural impacts on the community and its role in issues related to solid waste management services.

Finally, results from the interviews carried out with residents and GAM officials overlapped significantly; hence, they are mostly presented together, separated only by category. GAM provided several documents and statistics about 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 ten years. Site visits were made with the Head of the Environment Department, who explained, in detail, 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.

The sample of the questionnaire survey from the neighbourhood was based on household units rather than individual respondents, considering each family as a single unit. Yes or no dichotomous scale questions were included in the questionnaire survey. Two-point scales enable participants to choose answers without confusion, so all of them can understand the questions and answers clearly, and all the questions were followed by a blank space for the notes, in case any of the participants wanted to elaborate on their answers. Data analysis was then oriented in two directions: one of them focused on measuring the satisfaction of the beneficiaries of GAM services and processes to enhance environmental quality in the study area; the other one focused on measuring the impact of the physical density on solid waste disposal service in the study area.

According to the latest official statistics (DoS, 2018), the population of Jabal al Natheef is approximately 150,000 inhabitants, who live in a 1.24 km2 area (Almansy, 2018). The number of households in Jabal al Natheef is about 30,000, of which 61.4% have an average household size of 6.5 members. This study focused on the old neighbourhood of Jabal al Natheef that first emerged as an extension of the "Mohammad Amin" Palestinian refugee camp founded in 1948 (Fig. 1). There are 54,000 people inhabitants in the neighbourhood, residing on 0.078 km2, which results in an urban density of 69,269 people/km2, which is extremely high in comparison with the urban density of Amman (528.8 people/km2) (Al Tal et al., 2018). There are 8,307 households in this neighbourhood; the built-up area covers 82% of the neighbourhood, while 17% is used for streets and 3% is left for open spaces, trade and services (Al Tal et al., 2018).

The suitable sample size of households for the questionnaire employed in the field survey was calculated by using (Raosoft Sample Size Calculator), where the Confidence Level was considered 95% (Z Score = 1.96), margin of error 5% (0.05), and the sample proportion was 50% (= 0.5).

$$S_s = \frac{N \times ((Z_{\frac{a}{2}})^2 \times p \times (1-p)/MOE^2)}{((Z_{\frac{a}{2}})^2 \times p \times (1-p)/MOE^2) + N - 1}$$

where,

S_s – sample size;

Zα/2 is the critical value of the Normal distribution at α/2 (e.g., for a confidence level of 95%, α is 0.05 and the critical value is 1.96);

MOE is the margin of error, p is the sample proportion, and N is the population size.

Then, the sample size for the needed questionnaire survey is:

$$S_s = \frac{8.307 \times ((1.96)^2 \times 0.5 \times (1-0.5)/0.05^2)}{((1.96)^2 \times 0.5 \times (1-0.5)/0.05^2) + 803 - 1)} = 368$$

The minimum sample size needed was of 368 households, when N=8307 households. Some 500 questionnaires were distributed to randomly selected households during field visits. Questionnaires were

translated from Arabic into English, and then transcribed and coded. Questionnaires were designed as to be used as an indicator of impact and influence and not necessarily provide quantitative data. Of the 450 responses received, only 410 were considered suitable for analysis. Some 40 responses were eliminated due to the following reasons: 1. Respondents did not answer all questions; 2. Respondents left the questionnaire blank. The results of the survey are presented in Table 1.

Table 1. Questionnaire results.

Survey questions	Percentage	
	Yes	No
Physical: density and accessibility		
Is the number of the street sweepers sufficient for the cleaning and waste collection?	46.3	43.7
Are the vehicles and equipment used by the Greater Amman Municipality for the collection and transport suitable, and is there a convenient waste policy?	58.5	41.5
Is your house located in an underserved area, which lacks service quality?	65.8	34.2
Is there poor cooperation between public and government agencies like GAM?	78	22
Is solid waste periodically collected?	68.2	21.8
Behavioural (psychological, social)		
Are there any awareness campaigns about solid waste collection and management by GAM?	25	75
Do you usually keep garbage unprotected on the stairways and unreachable pathways?	25	75
Have you ever been asked to suggest ideas and solutions to improve your neighbourhood environment?	27	73
Do you think that it is safe for women and young girls to go outside and throw the garbage bags in the proper bins?	24.6	75.4

3. RESULTS AND DISCUSSION

The growing population, consumption-driven urban lifestyle, and various economic and social activities that take place in Amman, they all contribute to the large amount of HSW generated in the city, reaching an average of 1,873 t/day, collected from 20,000 bins, by 231 trucks (Aldayyat et al., 2019). While average per capita waste generation is of 0.7 kg/day, but the amount of HSW in Amman is influenced by numerous, diverse and fluctuating factors. Each of Amman's 27 districts generates waste at different rates. I

n addition to socio-economic characteristics, districts vary in surface area and population density. GAM shows that downtown Amman, also called the 'Madinah' or 'al-Balad' (city centre), has the highest rate of waste generation, reaching up to 1.8 kg per capita/day. This is due to the large number of stores and economic and social activities located here. On the other hand, Badr al-Jadidah is at the lower end of the spectrum, with 0.52 kg of waste per capita/day, which is attributable to this being a mainly residential area, with low population density.

There is a significant increase in the amount of waste generated in Amman during the summer season compared to winter. According to GAM, waste generation in Amman increases significantly in summer and during the holy month of Ramadan, due to the return of expatriates to spend holidays and summer vacation with their families, and the increased prevalence of various social occasions, namely weddings and graduation parties. In conclusion, the amount of waste in Amman varies among different areas, depending on the activity type, surface area, and population density. Moreover, HSW is generated at different rates, in different times of the year, due to various social activities.

GAM divides Amman into six main waste collection districts, each of them comprising five areas. The highest amount of waste comes from district 1, reaching approximately 500 t/day. This district is characterized by high population and houses density and large economic, social, and governmental amenities. Conversely, district 6 in West Amman has low population density, producing the lowest waste volume, of around 300 t/day.

The study area of this research is part of district 3, which is close to (and may even be considered an extension of) the city downtown. Accordingly, the estimated rate of waste generated from this part reaches up to approximately 1.3 kg capita/day. In terms of plastic garbage bag production, the collected data during field visits showed that the following percentages of varying bag types were produced by households: 52.6% produced two medium-sized bags; 36.8% produced large-sized bags; and 22.8% produced more than two medium and large-sized bags. Thus, the

daily HSW production reaches an average of 70.2 (54000 x 1.3) t/day for residents, and 10 t/day for commercial activities and retail shops, amounting to 80.2 t/day.

Solid waste collection and transport in Amman starts at generation points, such as homes and grocery stores, who are supposed to deposit their garbage at arranged pick-up points for picking up by the collecting crews that are driving around neighbourhoods in trucks, and further transport the collected waste to transfer stations or disposal points. The collection phase is difficult and complicated in most areas of Amman, where solid waste collection methods vary between residential and commercial areas. In residential areas, the most common collection methods are street and alley services, where residents and tenants deposit single-use plastic bags in garbage containers.

In commercial areas, property owners are responsible for transporting their waste in garbage bins. Street cleaning, waste collection and waste transportation out of the neighbourhood and the city is associated with the GAM sweepers' responsibilities. In all cases, neither residents nor sweepers separate solid waste. GAM does not provide door-to-door waste collection; instead, residents must bring their waste and put it inside the closest container. The capacity of each container is of 80-100kg. These containers have wheels, so they can be easily moved around by workers, to be lifted and emptied in the garbage truck. Recently, GAM distributed containers without wheels, to reduce maintenance costs and prevent residents from moving them around.

In addition to collecting waste from community containers, GAM employs approximately 4000 street sweepers, who collect waste from streets and public spaces. GAM operates different types of small and medium compaction garbage trucks, ranging in capacity from 1 to 8 tons, which collect waste from the 21,000 garbage containers distributed throughout the city. Each compaction truck is operated by a crew of two or three workers, including the driver. In areas with high waste generation, containers can be emptied up to three times per day; however, in remote areas and areas with low waste generation, the waste is collected every other day. There are 150 containers available garbage containers in the study area, distributed on roads accessible to garbage trucks. The maximum capacity of these containers is of 750-800 kg. According to the field research and survey questionnaire, the containers are distributed between zero and more than 100 meters from houses (33.3% reported less than 50 meters; 36.1% are allocated at 50-100 meters; and 3.6% were more than 100 meters away) (Fig. 2).

The neighbourhoods 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 neighbourhoods are connected by major roads and stairways. Stairways connect houses with each other, and with roads in the surrounding valleys. The centre of Amman and the older areas in the East are famous for their large number of such stairways, whereas newer suburban areas in the West have almost none of these features (in the newly expanded neighbourhoods).

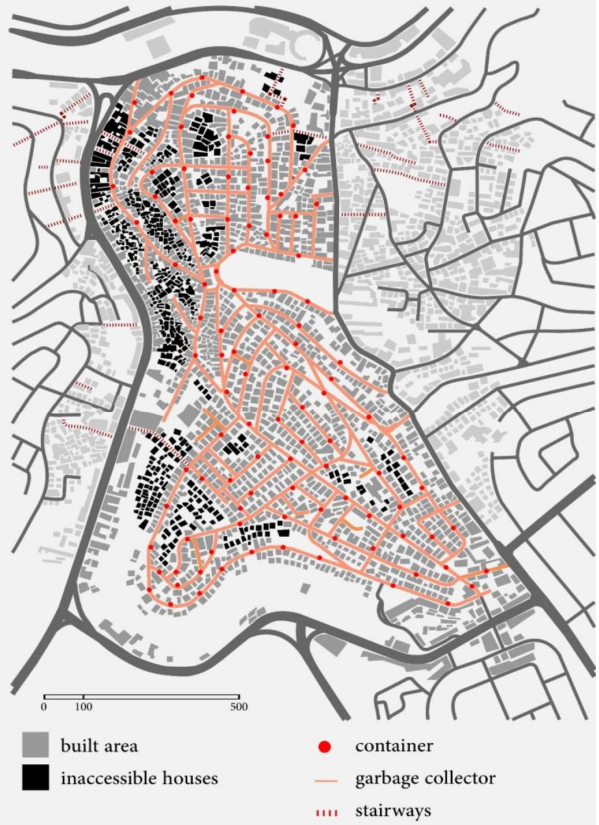

Fig. 2. Challenging spots for waste collection in Jabal al Natheef *(source: Google maps, redrawn by researchers, 2021).*

Al Tal et al. (2018) have recently examined the social and spatial effects of overcrowding in one of the East Amman's informal refugee camps, Jabal al Natheef, an irregular slum complex, finding that inhabitant density has exacerbated and caused huge pressure on basic services, including, but not limited to, road network and infrastructure, in addition to public and open spaces (Fig. 3).

Jabal al Natheef is located in downtown Amman, next to the historical city centre. Only two roads connect the historical city centre with Jabal al Natheef, making it a separate and disconnected cul-de-sac from the downtown. The neighbourhood itself has developed in an unplanned and haphazard way, with houses built adjacent to each other and connected by steep stairways and narrow alleyways. Originally, the neighbourhood emerged around the nucleus of land belonging to a Palestinian refugee, Mohammad Ameen, in the early 1950s. The settlement began as a group of tents, which were subsequently replaced by permanent

concrete and masonry brick houses (Al Tal et al., 2018). The neighbourhood is famous for its high urban density, social problems, lack of security, widespread substance abuse, and poor infrastructure related to services such as solid waste management, drainage, and wastewater treatment (Alshahid, 2018; Arini Foundation, 2013; Al Tal et al., 2018). The population of Amman comprises 4,327,800 people living in a 1,662 km² area (DoS, 2018). The average urban density of Amman is of 2,604 people/km², while the urban density of Jabal al Natheef reaches 120,968 people/km² (46 times higher than the average urban density of Amman) as shown in Table 2.

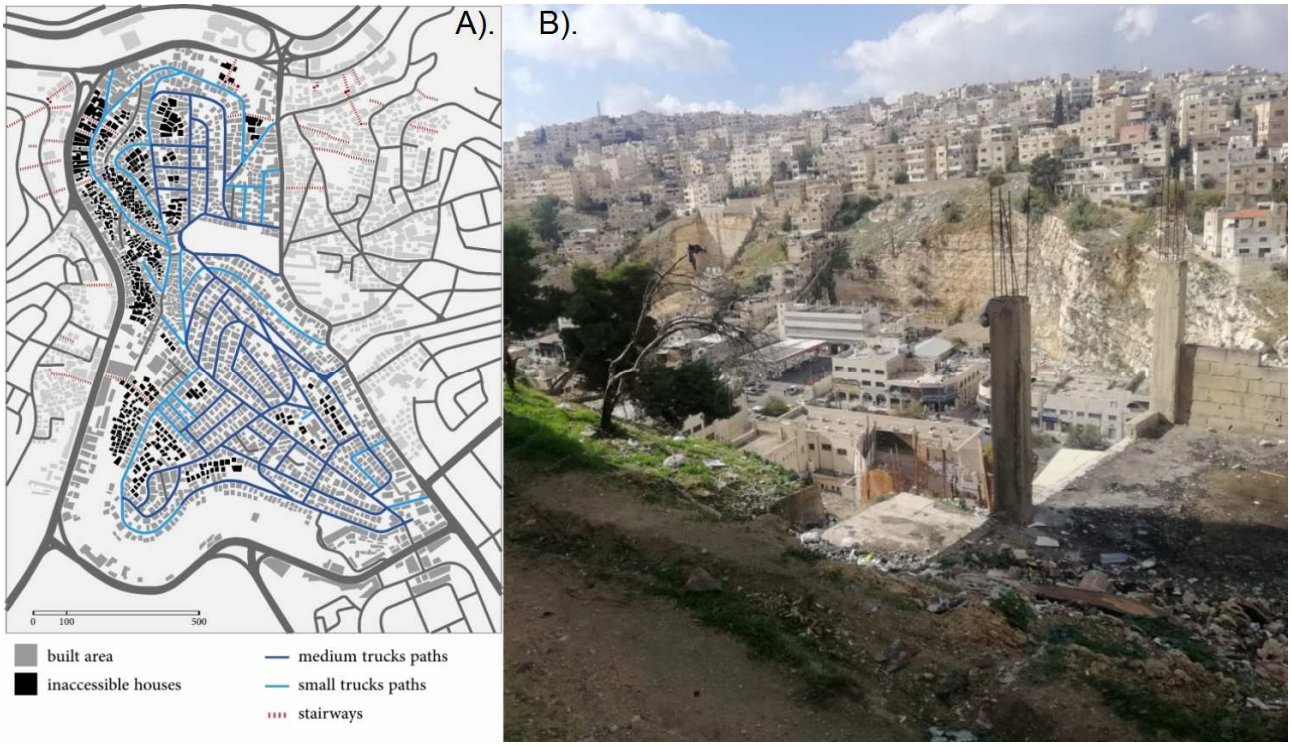

Fig. 3. A). Paths of garbage vehicles and street sweepers; B). Jabal al Natheef.

Table 2. Urban density of Jabal al Natheef.

City	Area (km²)	No. of population	Urban density person/km²	Average daily solid waste (t/day)	No. of garbage containers	No. of sweepers and collectors	No. of large compressors
Jabal al Natheef	0.078	54000	69,269	80.2	150	26	0
Amman	1662	4,327,800	2,604	1,873	22000	6000	231

Spatial mobility and accessibility represent a major problem for providing services and facilities to the population living in residential parcels located on the rough topographical areas in Jabal al Natheef. Figures 2 and 3 show the connected road network that serves the area. The irregularity reveals the topography, landform, and existence of land features like valleys surrounding the mountain, as dominant factors that result in a lack of straight road network. For instance, roads often climb impossible passages through steep mountain ravines. Driving can be treacherous due to narrow roads, blind curves, and unprotected embankments, sometimes along cliff edge.

In general, driving in inaccessible mountains Amman is challenging, with low levels of road safety. Drivers commonly do not comply with any lanes or rules, or even traffic directions. Ad hoc road systems evolved to meet the driving needs of local residents, and this irregular status results in rare maintenance and rehabilitation. Consequently, such roads are in reproachful states of repair and poor condition, with unreliable signage, and they are wholly inadequate for the increasing density of traffic. These roads are typically of two-lane width, without division islands or road markings in the middle to separate cars moving in opposite directions. Shoppers, residents, and commercial providers clutter the sides of roads with their vehicles, making major congestion a regular feature of mixed-use streets. Parking on the streets can be impossible to find for proper garbage service vehicles, thus inappropriate types and sizes of garbage collection vehicles are deployed.

In this research, we ranked links of a network according to their width, connectivity, and garbage

compactor accessibility. Data collected from GAM shows that only medium-sized and small-sized garbage compactors serve the studied area, in addition to the medium-sized trucks. We overlapped the obtained data with street width and connectivity observed in the study area. Road networks were classified into medium trucks paths, small trucks paths, stairways, and inaccessible residential parcels. Such ranking can be particularly helpful when we consider susceptibility to be connected to solid waste collection and transport as shown in Fig. 3. We learned that 41 of 66 streets (68.2%) could be accessed by medium and small compactors; and 15 streets (22.7%) could only be accessed by small garbage compactors and small trucks. The 40 impenetrable stairways and less than 2 meter-width alleys were served by door-to-door collection by street sweepers. Figure 3 shows the inaccessible neighbourhoods concentrated on the edges of mountain cliffs. Clearly, waste collection vehicle drivers and the general public are at risk due to the unacceptable hazards posed to safety by garbage collection in such circumstances. About 58.5% of the respondents believe that number of garbage vehicles is insufficient.

GAM was impelled to employ some unconventional methods to overcome the major challenges in collecting HSW from Jabal al Natheef. The narrow and intertwined streets forced GAM to use small trucks to collect garbage instead of ordinary garbage compactors. In general, these small trucks are used in Jordan for transporting various objects and commodities such as vegetables, livestock, furniture and others. Street sweepers collect the household waste thrown out by the residents on stairs and alleyways. 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, with four sweepers assigned to serve the 40 staircases of Jabal al Natheef.

Table 3. Waste collecting vehicle size and collecting shifts in Jabal al Natheef.

Vehicles	**Morning shift**		**Noon shift**		**Evening shift**
Vehicle size	Middle	Small	Middle	Small	Small
No. of vehicles	3	2	1	2	1
Average collected (tons)	17-20		7-9		1-2
	28 t/day				
Average generated (tons)	80.2 t/day				

Areas with poverty, poor accessibility, and unregulated settlements witness the largest percentage of random waste disposal (Mamady, 2016). The residents of Jabal al Natheef spill waste on stairs, alleyways, near and in 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 behaviour are increasing (Fig. 4). Women open their kitchen windows and hurl plastic bags full of kitchen waste out onto these spaces. Some 75.4% believe that it is unsafe for women and young girls to go outside and throw the garbage bags in the proper bins due to personal safety issues and the fear of harassment.

Fig. 4. Waste accumulation examples on the streets and stairs in Jabal al Natheef (2021).

Collecting waste from those steeply sloped empty lands carries an enormous challenge that demands special treatment. This open dumping of waste is a health hazard to population and causes foul smells, encouraging rats and other vermin and insects to thrive, and undermining the public image of the GAM, especially on the mountain side seen from the GAM administration complex and the main throughways in the valley bed (see Fig. 3). In some cases, GAM installed grappling ropes for street

sweepers to climb and collect the piled-up waste using manual tools such as shovels and brooms, which are used for collection. However, 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, presumably as a statement of their contempt for the GAM and the nation in general. Although residents always complain about the negative effects of random disposal in their neighbourhoods, they do not seem to acknowledge that they are the literal producers of the problem, as if the garbage piled in their streets arrived from elsewhere. In their study, Mamady (2016) concluded 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 discarding it in the street or burning it. In Jabal al Natheef, some residents have to descend around 400 steps to the nearest garbage bin then climb up again the stairs to their house; however, this is only because bins provided on the stairs by GAM were stolen.

Waste pickers play a major role in municipal solid waste management and make a significant contribution to the economic as well as environmental wellness in the poor underdeveloped countries such as the urban South Africa (Simatele et al., 2017). Matthews (2019) recommended involving the public-private cooperation in the waste management process by involving informal pickers. Thus, when stakeholders are engaged in the waste management process, the communities would have recycling companies to provide formal jobs for the pickers. In addition, the poor informal pickers could sell the sorted waste to the recycling companies.

There is a definite need to educate residents of the neighbourhood about their antisocial and irresponsible behaviour with regard to environment and hygiene. The application of the protection motivation theory through planning and awareness campaigns could offer solutions, raising people's motivation to act to protect themselves. Foreign institutions and the United Nations Development Program (UNDP) established initiatives and show promising progress in terms of developing plans and roadmap to have better social empowerment programs in Jabal al Natheef, in collaboration with GAM. The main aim of the programs is to develop the way youth think and behave related to societal and environmental issues so they can achieve self-efficacy and positively impact their neighbourhood and society. The challenges these programs face are mostly cultural, related to gender issues of participation as residents oppose girls' participation, and the lack of commitment (UN, 2021). In addition, GAM should consider deploying participatory waste management strategies to make residents feel they are an active part of the plan. The role of training and specialized courses offered by the Greater Amman Municipality will offer a broader perspective in implementing waste management strategies and explain the logic behind the policies for waste management.

The ignorant behaviour of the residents is the most fundamental challenge need to be tackled in the neighbourhood. Some 78% of the study sample reported that there had been no awareness campaigns about littering and solid waste collecting by GAM, targeting public concern. Although, residential interviews consistently voiced willingness to take action on health and environmental safety, some 75% stated that the GAM is not ready to make a positive impact on the built environment and highlighted the inadequate cooperation between citizens and the local authority, in addition to the inadequate container capacity at communal collection points.

In conclusion, in areas with large and diverse underserved populations and significant unmet needs, it may be appropriate and beneficial, to both the community and the government agencies involved, to share all or part of the same service areas. In return, the municipality has to provide access to underserved people as much as possible, and, in some instances, support multiple sites with the same service.

4. CONCLUSIONS

This study demonstrates that there is a deficiency in waste collection in Jabal al Natheef. This deficiency results from the lack of cooperation between Greater Amman Municipality and the neighbourhood community and the difficult physical conditions presented at the site, such as the lack of roads that reach the houses, steep staircases, empty plots and dilapidated buildings, which became a hotspot for accumulating waste. The results of the survey revealed that the behaviour of residents toward waste disposal plays a great role. The residents dispose their waste in random ways, such as throwing it on stairs, in narrow alleyways, on empty plots on the foothill, and inside and near abandoned and dilapidated buildings. Furthermore, they actively sabotage efforts undertaken by Greater Amman Municipality by stealing small bins placed on stairs. In return, about 58.5% of the respondents believe that number of garbage vehicles is insufficient. Some 75% stated that authorities deployed unconventional and extreme site-specific measures to collect waste from the neighbourhood. These problems could be avoided by integrating and addressing the societal role in planning waste collection in the area by adopting participatory planning strategy. About 78% of the study sample reported that there had been no awareness campaigns about littering and solid waste collecting targeting public concern. The major challenge and limitation of the research was the safety circumstances in the neighbourhood, which made

taking pictures, recording videos, and conducting interviews difficult. The neighbourhood is famous for its high urban density, social problems, lack of security, widespread substance abuse. This study is important because waste and urban management have received little attention in the national agencies development agendas in Jordan. At the academic level, this research brings valuable contribution to the scarce literature on the relationship between solid waste management and informal inaccessible settlements planning in Jordan and the region.

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