



Scavengers' contribution in solid waste management sector in Gaza Strip, Palestine

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Abstract This study deals with the assessment of the role and potential contribution of—valuable and recyclable items—waste pickers (scavengers) in the overall recycling sector of solid waste management in Gaza Strip, Palestine. The analytical descriptive approach was applied in this study to achieve this goal. A special questionnaire was designed to record the views and activities of a statistically representative sample of scavengers, to determine their socio-economic conditions, their job satisfaction level, and their role in waste management. Together with that, the legal issues arising from their activity are investigated and conducted interviews with stakeholders/officials highly contributed to this. The results showed that the scavengers are mostly men, working informally for themselves, and do not belong to any official body or informal local association, yet their contribution was calculated to be 1–7.7% as far as the recyclable diversion rate is considered.

According to the processed data, 34.1% of them are collecting from community bins distributed along the streets and from random dumpsites, 15.1% are collecting from random dumps only, and 12.7% are collecting from community bins distributed along the streets in addition to the random dumps and transfer stations. The monetary outcome is less than NIS 500 (New Israeli Shekels—NIS) monthly for approximately 72% of them. Taken into consideration that 91% of them are originating from a bad economic status, the aforementioned income—however low—is considered important for their live-hood. The results also showed that 93% of them are dissatisfied with their job due to mainly the district of residence, the negative attitude receipt by community members, and the low selling price of recyclable materials. The analysis is a stepping stone for scavengers' incorporation to the official waste management sector, providing them orientation and on-the-job training, in addition to the government support through tax incentives to the private sector which is highly recommended in developing countries. Such activities will certainly lead further development of the recycling sector, a wide range of circular economy pattern application locally, and elevation of their financial/life status.

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Introduction

Recycling contributes to reducing the increasing volume of solid waste. Major recycling requirements include

basic waste management activities, separation at source, and efficient collection of waste. However, ineffective collection, limited separation at source, poor transport practices, and improper disposal of solid waste are still common features of solid waste management in developing countries (Andrianisa et al. 2016; Aparcana 2017; Aydin 2017; Fei et al. 2016; Hartmann 2018; Kollikkathara et al. 2009; Vaccari et al. 2012).

Numerous people living in cities of most developing countries depend on recycling materials for their livelihoods (Steuer et al. 2018), and it has been mentioned that up to 2% of the population in Latin American and Asian cities lives on the pits (Kashyap and Visvanathan 2014). Those are variously defined in the literature as garbage pickers, reclaimers, recyclers, scavengers' waste pickers, and waste salvagers (Chvatal 2010; Schenck and Blaauw 2010; Schenck et al. 2011). They collect valuable and recyclable items from waste in order to generate income from reselling (Sasaki and Araki 2013; Vaccari et al. 2013). The social category of scavengers poses an opportunity for local waste management sector if they are not neglected. Taking into consideration the limited financial capacity and infrastructure of developing countries', the scavengers' activities (unofficial collection, storage, and commercialization of Valuable Solid Waste (VSW)) introduce a dynamic, complex economic, and social phenomenon. Besides their contribution in local waste management sector, they play an important and key role as manufacturers' suppliers of VSW, which simultaneously contributes to mitigating the negative environmental impacts of municipal solid waste management systems (Botello-Álvarez et al. 2018). This social category constitutes of a large number of workers and is familiar with its small-scale, labor-intensive, unregistered and unregulated and low-technology industrialized, or low provision of services (Wilson et al. 2001; Botello-Álvarez et al. 2018). Regardless, scavengers are usually socially marginalized. General populations refer to them with a specific name, e.g., Dalits (untouchable caste) in India or Zabbaleen in Egypt. The informal recycling sector operates without tax-paying obligation and without any trading or operation license in contrast to formal recycling sector. So, the latter is only considered a legitimate stakeholder by government authorities (Kashyap and Visvanathan 2014) whereas the primal offers as well multiple benefits, more once organized, posing developing countries with an opportunity to overcome obstacles related to limited financial capacity and infrastructure.

Steuer (2016) showed that informal recycling sector plays a significant role in the recovery of waste from electrical and electronic equipment. It has also been reported that increased waste collection, material recovery, and litter control are possible with informal waste recycling (Ezeah et al. 2013; Gutberlet 2013; Schluep 2014). In accordance with the United Nations Environmental Program (UNEP), informal recycling prevented 30% of waste from going to the landfills in Jakarta (Indonesia) and 15% of waste in Delhi and Bangalore (India) (UNEP 2010). Moreover, informal collection and recycling had contributed to the cost of waste collection by 14, 12, and 3.4 million EUR/year in Lima (Peru), Cairo (Egypt), and Quezon (Philippines), respectively (Gunsilius et al. 2011).

Solid waste management in Palestine is one of the major problems and main contributors to the environmental degradation due to absence of modern technological options and the use of dumpsites and landfills for the final disposal. Recently, the Palestinian authority focused on the waste management sector organization through the construction of sanitary landfills at the north and south of the West Bank, Jericho, and southern Gaza Strip, closing, at the same time, several random illegal dumps. The overall waste generation rate is increasing, but solid waste composting and recycling activities are still conducted at very low rate which is below 0.5% in accordance with the German International Cooperation—GIZ (GIZ 2014). In the Gaza Strip, the average solid waste generation rate is 0.76 kg/c/d as estimated by the Palestinian Central Bureau of Statistics (PCBS) in 2012 (UNDP 2012). Meaning that daily solid waste generation in the Gaza Strip is more than 1500 t considering the population estimation of the PCBS by mid-2019.

Palestine shares the same characteristics as the other developing countries with a relatively large number of waste pickers working in the recycling sector. Their number has risen during the past 3 decades due to the severe economic conditions in Palestine as a result closure policy and movement restrictions imposed by the Israeli during the first and second *Intifadas*. Marginalized and poor people found dumpsites and garbage as a source of income through collection and selling of recyclable materials to cope with the economic crises. The waste fractions of high potential marketing are plastics, paper cardboard, and metals. The waste characteristics in the north, middle, and south of the Gaza Strip and the average characterization as performed by the UNDP (UNDP 2012) are shown in Fig. 1.

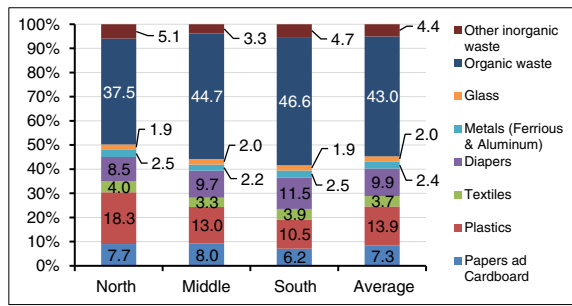


Fig. 1 Solid waste characteristics in Gaza Strip

The vast majority of the waste pickers in Palestine are working informally at random waste dumps in the Gaza strip and previously (before landfill construction) in the north and south of the West Bank. Wadi Al-Shaer Joint Service Council for Solid Waste Management (WSJSC-SWM) reported the existence of 4 waste pickers at Anabta dumpsite (WSJSC-SWM 2009). The Joint Service Council for Solid Waste Management (JSC-H&B) reported 81 waste pickers working at Yatta dumpsite, which is located at the southern part of the West Bank (JSC-H&B 2019). Eco Con Serv and Universal Group-Gaza reported 11 waste pickers at Khan Younis solid waste transfer station and 18 waste pickers at El-Fukhary landfill (Eco Con Serv and Universal Group 2013). However, the construction of the sorting plants at Zahrat Al-Finjan and Al-Minya landfills at the north and south of the West Bank respectively has contributed to the formalization of some waste pickers in the West Bank since the facilities receive/accept their collected recyclables to the solid waste separation stations together with the initially separated waste fractions.

The aim of this study is to understand the socio-economic conditions of the waste pickers, the legal issues arising from their activity, the level of their job satisfaction and factor affecting it, and finally their actual role and contribution to solid waste management sector in the Gaza Strip.

Study area

The Gaza Strip is situated on the Mediterranean coast with a total area of 365 km² (El-Hawi and Aljaja 2017). The estimated population in Gaza strip as per mid 2019 was 1,989,970 (PCBS 2019). This area is considered one of the most densely populated areas in the world (5452 people/km²). About 53% of the population was

under poverty line by the end of 2017, which is the corresponding to approximately 1.01×10^6 people, including over 400,000 children (PCBS 2017). When a person lives in Palestine on less than US \$4.6 per day, he/she is considered to be under the poverty line. This value was estimated by the Palestinian Central Bureau of Statistics as a minimum to cover basic household needs clothing, shelter, and food, as well as education, transportation, and basic health care (OCHA 2018). The economic conditions in the study area have deteriorated substantially since 1993 due to political and military obstacles imposed by the Israeli Occupation on the Gaza Strip. Complications such as closures imposed by Israeli government, and strict security control on the movement and in particular labor and goods trading between the West Bank and the Gaza Strip in one side and with other countries in other side, were and still are the main reasons of economic deterioration (OCHA 2018). The current economic crises in the study area have forced many people to work as waste pickers (Scavengers) in order to cope with the severe economic conditions.

This research study covers the whole area of the Gaza Strip, which is extended from Gaza district at the north up to Rafah in the south as shown in Fig. 2.

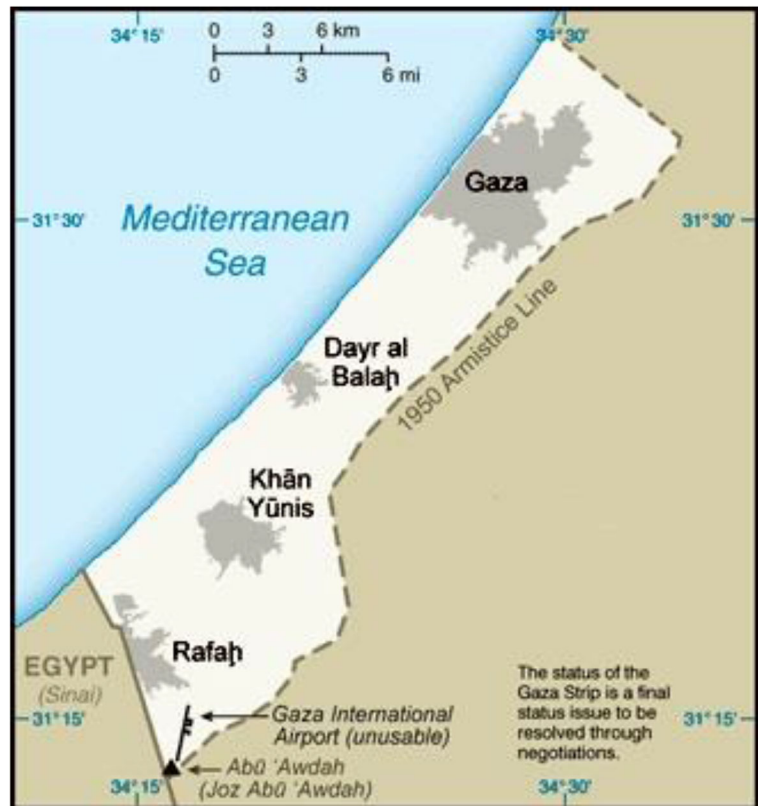
Research methodology

The research population included all scavengers in Gaza strip. The approximate number of scavengers was determined through contacting experienced officials in the Gaza Strip. In fact, the study population was assessed by consulting the relevant people in the Gaza Strip, so that it was close to the real number as much as possible. A random sample of scavengers was selected aiming to be statistically representative of the study population. The estimation of the scavengers’ sample size was conducted based on the Herbertkarn equation (Al-Rujoub et al. 2019) as shown in eq. (1):

$$n = \frac{(1-p)}{(SE \div t) + [p(1-p) \div N]} \tag{1}$$

where N = study population (1200); n , sample size; t , confidence coefficient and equal to 1.96 for 95% confidence interval; p , is the value of the main estimate, which is a relative index assumed to be 50% in order to give the largest sample size possible for this type of indicator; SE, the standard error ratio is equal to 0.05. A

Fig. 2 Map of the study area (Vidiani.com 2011)



minimum sample size of 291 was required but a sample of 301 scavengers was finally interviewed.

The sample was chosen randomly; the random starting point was in Gaza strip and then moved to their job locations (streets, transfer stations, and dumpsites) in a sequential way from the random starting point.

A special questionnaire has been designed to survey the views and experiences of the scavengers working in Gaza Strip and to record their role in solid waste recycling. The questionnaire was tested through interviews with a sub-sample of 10 scavengers, and then modified appropriately where it was required. The questionnaire included open-ended and closed questions with the following main parts: general information, social aspects, the workplace, experience, materials collected, income, constraints, and others. The questionnaire was filled out during direct interviews with the scavengers. Prior to filling out the questionnaire, the scavengers were informed on the research purposed in view of data collection facilitation and offer prior consent to it.

In addition, in-depth interviews were conducted with 3 key persons representing official organizations; the executive manager of the Joint Service Council for Gaza

and North Gaza Governorates, environmental specialist of the Municipal Development and Lending Fund (MDLF), and key expert from the Environmental Quality Authority (EQA). This contributed to the verification of the descriptive results collected from the survey method.

The Statistical Package for Social Sciences (SPSS) was used for the data analysis, in addition to the Microsoft Excel. The analysis of the quantitative data was conducted using Microsoft Excel, while qualitative data analysis was conducted using SPSS to identify the relationship between different variables. Furthermore, a logistic regression model (LRM) was developed to assess the scavengers' job satisfaction and factors affecting it as per Ali et al. (2012); Al-Khateeb et al. (2017); Al-Sari et al. (2012); Al-Sari et al. (2018); Begum et al. (2006); Begum et al. (2009); and Ittiravivongs (2012). Equation (2) shows the binary logistic model that was selected to be applied.

$$\text{Log} \frac{P_i}{1-P_i} = Z_i = \beta_i X_i + e \quad (2)$$

where P_i is the scavengers' satisfaction in his job; $P_i = 1$ if the scavenger is satisfied; and $P_i = 0$ if not; X_i = the explanatory independent variable as shown in Table 1; β_i = a coefficient of the independent variable; e = the error term and $n = 1, 2, \dots$, which is the number of the independent variables in the model.

The coefficients of the model were estimated by the application of the maximum likelihood function. The log-likelihood function, which has approximately chi-square distribution, was used to measure the goodness of fit. The proportion of the variation in the dependent variable describes by the independent variable was indicated by Cox and Snell R^2 and Nagelkerke \tilde{R}^2 . As Cox and Snell R^2 cannot attain a maximum value of 1, Nagelkerke \tilde{R}^2 , which is an adjusted type of the Cox and Snell R^2 and covers a full range from 0 to 1, was applied because it is often preferred (Bewick et al. 2005). However, a multicollinearity test was also conducted to ensure that none of two independent variables have correlation exceeding 0.7.

Research hypothesis can be summarized as follows: scavengers are not satisfied with their job, the place of residence, monthly income, working hours, availability of recyclable materials, price of recyclable materials, and feeling negative attitude from the community are all factors affecting scavengers' satisfaction.

Results and discussion

Socio-economic conditions of scavengers

The survey sample was selected to represent the study area, so 26.9% of the surveyed waste pickers were from Gaza city, 20.6% from north Gaza, 10.6% from Deir Al-Balah, 33.6% from Khan Younis, and 8.3% from Rafah. The socio-economic conditions of study sample are shown in Table 2.

The socio-economic condition analysis showed that all of the waste pickers are males; 50.2% are aged between (19–30) year; 52.5% of them are married; 83.4% are permanently residents of cities; 62.5% members of families consisted of (5–10) members; 91.4% of the them reported their families' bad economic status (deep poverty); and 60.5% of them being at level of education of preparatory or secondary school. The average monthly income generated from scavenging activities is less than NIS 500 for 71.9% of them (1 USD = 3.5 NIS).

Similar research outcomes reveal that 47% only of the waste pickers are married in Pretoria, South Africa (Schenck and Blaauw 2011). Almeida et al. (2017) found that 56% of the waste pickers are aged between (18–34), 72% of the primary education level, and 72% of them are generating income from selling recyclables in the range of (300–500) BRL (1 BRL \approx 0.25 USD). Also, 43% of 760 surveyed waste pickers were in the age range of (26–40) years according to Women in Informal Employment: Globalizing and Organizing (WIEGO 2016). Schenck and Blaauw (2011) found that 49% of the waste pickers aged in the range of (41–50) years. The United Nations Inter-Agency Task Force on Social and Solidarity Economy reported that International Labor Organization (ILO) has estimated approximately 15–20 million informal waste workers worldwide with very low incomes, often living below the poverty level (The United Nations Inter-Agency Task Force on Social and Solidarity Economy (UNTFSE) 2019).

Legal issues

Although waste sorting is encouraged by the Palestinian policies for the purpose of resource conservation and environmental protection, informal waste sorting is considered illegal and prohibited by law. The respondents to the questionnaire mentioned that they are self-employed, working as individuals (informally) and not organized to any legal company or organization. The executive manager of Joint Service Council for Gaza and North Gaza governorates reported during the interview performed that the waste pickers are working with no municipal or any other official organization permission. He confirmed that their involvement in this sector is due to the current severe economic situation in the Gaza Strip, and thus, the authorities do not prosecute them. In addition, given that shortage in raw material is faced in local market, due to the siege on Gaza imposed by the Israeli authorities, the scavengers' job activity largely contributes to this problem alleviation.

Moreover, during the interview conducted with Mater, S. (environmental specialist at the Municipal Development and Lending Fund – MDLF), it was recorded that the waste pickers besides being working illegally at the landfills and waste transfer stations, they have been spotted to collect recyclables from the community containers at the streets. Notwithstanding, up to date, they have no official role in waste separation.

Table 1 Definition of the variables in the LRM

Variable	Description	Definition
X_1	District	1 = North Gaza; 2 = Deir Al-Balah; 3 = Khan Younis; 4 = Rafah;
X_2	Average monthly income from recyclables(NIS)*	1 = < 500; 2 = 500–1000; 3 = > 1000;
X_3	No. of working hours	1 = ≤ 4; 2 = 5–8; 3 = 9–12; 4 = >12
X_4	Availability of recyclable materials	1 = Yes always; 2 = Sometimes; 3 = NO
X_5	Feeling negative attitude by community members	1 = Yes always; 2 = Sometimes; 3 = NO
X_6	Price of recyclable materials	1 = Yes always; 2 = Sometimes; 3 = NO

*NIS New Israeli Shekels

During another interview conducted with Musleh, M. (solid waste and hazardous waste department manager at the EQA in Gaza), it was verified that the waste pickers have no official position and they are working for themselves. The main driving force for their work in waste picking is the severe economic conditions in the Gaza Strip. The data analysis showed that 83.3% of the respondents are working in this sector due to the absence of other employment and income generation options. Moreover, 96.7% of the respondents have no other job besides waste picking. Serrona et al. (2010) reported that the main reason for the growth of the informal recycling sector is the lack of jobs and the existence of poverty worldwide. Other authors also reported that obtaining reliable data on the number of scavengers is very difficult (Medina 2001; Zia et al.

2008). In the present report, the interviews conducted increased the reliability level of the collected raw data from scavengers.

Overall and in accordance with the officials' conducted interviews, the number of the waste pickers in the study area is difficult to be identified whatsoever due to the nature of their informal work, the wide area of activity, and the absence of any responsible body or organization. However, the officials reported that their number noticeably increases during school holidays in summer.

Recyclable materials collected

Informal waste pickers play a certain role in solid waste management, and this role differs from one country to another depending on the local conditions. Botello-

Table 2 Socio-economic conditions of the scavengers in Gaza strip

Variable	Results					
Age	0–9	10–18	19–30	31–50	≥ 50	Total
	3 (1.0%)	72 (24.0%)	151 (50.2%)	64 (21.3%)	10 (3.3%)	300 (100%)
Gender	Male	Female				Total
	301 (100.0%)	0 (0.0%)				301 (100.0%)
Marital status	Single	Married				Total
	141 (47.2%)	158 (52.5%)				299 (100.0%)
Permanent residence	City	Refugee Camp	City			Total
	236 (83.4%)	30 (10.6%)	17 (6.0%)			283 (100.0%)
Number of family members	≤ 4	5–10	11–15	16–20	> 20	Total
	63 (20.9%)	188 (62.5%)	32 (10.6%)	4 (1.3%)	2 (0.7%)	289 (100.0%)
Economic status of family	Bad	Average				Total
	272 (90.4%)	29 (9.6%)				301 (100.0%)
Average monthly income (NIS) from working in waste collection	< 500	500–1000	> 1000			Total
	215 (71.9%)	82 (27.2)	2 (0.7%)			299 (100.0%)
Education level	Illiterate	Elementary	Preparatory and secondary	College or university		Total
	15 (5.0%)	92 (30.6%)	182 (60.5%)	12 (4.0%)		301 (100.0%)

Álvarez et al. (2018) reported that informal collection represents 71.69% of valuable solid waste recovery, and potentially attenuates the climate change index by 10% for all the municipal solid waste management system. In Beijing, the informal recycling sector alleviates the municipal waste management budget by 50% (Steuer et al. 2018).

In this study, the most common recyclable materials in waste are plastics (polyethylene and polypropylene), metals (steel, copper, and aluminum), wood, paper, and cardboard. Some of these fractions such as the polyethylene and polypropylene are recycled in Palestine, while other fractions such as metals and cardboard are sold to local dealers who afterwards are selling them to Israeli factories. The availability of markets and the level of prices are the main elements that highly influence the work of scavengers.

The survey results showed that metals and plastics present the highest rate of collection. Approximately, 20.3% of the scavengers are collecting copper, aluminum, plastics, clothes, and shoes, while 61.7% of them are collecting copper, aluminum, and plastics as shown in Table 3.

The high collection rate of plastics is attributed to this material high demand in the local market where there are several local manufacturers' related to polyethylene and polypropylene recycling. However, the main driving force behind the high collection rate of copper and aluminum is the high selling prices in the market. The results showed that the highest average market price for copper is (NIS 12.48), followed by aluminum (NIS 2.48), then plastics (NIS 0.57), and finally steel (NIS 0.39), as shown in Fig. 3.

The average quantities of collected recyclables per scavenger are relatively low. The trend analysis of high rate collected materials versus the prices showed that the average daily collected quantities of recyclables is in the range of 0.67 kg for copper and 81.75 kg for steel per each scavenger. Considering the average rate of recyclables collected as per Fig. 4 for all of the scavengers in the Gaza Strip, which was estimated to be 1200, the total quantity of recyclables collected is calculated to be 7.7% of the total waste stream. However, the data collected during the interviews with official bodies, (Mater 2019: environmental specialist at the MDLF), showed that the collected quantities of the recyclable materials by scavengers do not exceed 1% of the total solid waste generated. This relatively large variation between the calculated quantities and that given by the Palestinian officials underlines the

reliability of the data provided even for the total number of scavengers and/or the given rate of separation. Considering the total recyclables diverted from the waste stream in the range between 1 and 7.7%, this may lead to a conclu-

Table 3 Type and collection rate of recyclable materials

Type of recyclable materials collected	Frequency	%
Iron	1	0.3
Copper	2	0.7
Aluminum	1	0.3
Plastic	3	1.0
Copper + aluminum + plastic + clothes and shoes	4	1.3
Iron + copper + aluminum + plastic	61	20.3
Copper + aluminum + plastic	185	61.7
Copper + aluminum + plastic + clothes and shoes + household appliances and electrical appliances	1	0.3
Copper + aluminum + plastic + wood	2	0.7
Iron + copper + aluminum + plastic + clothing	1	0.3
Copper + aluminum + plastic + clothing	3	1.0
Copper + aluminum + plastic + clothing + electric equipment	3	1.0
Copper + aluminum + plastic + shoes + clothing + electric equipment	3	1.0
Copper + aluminum + plastic + electric equipment	7	2.3
Copper + aluminum + plastic + batteries	4	1.3
Plastic + damaged foodstuffs	1	0.3
Copper+ aluminum + plastic + furniture and electrical appliances	1	0.3
Iron + copper + aluminum + plastic + shoes + clothing + electric equipment	1	0.3
Iron + plastic	1	0.3
Copper + aluminum + plastic + paper and cardboard + wood + canned food	1	0.3
Iron + copper + aluminum + plastic + batteries	1	0.3
Iron + copper + aluminum + plastic + electric equipment	1	0.3
Copper + aluminum + plastic + wood + electric equipment	1	0.3
Copper + aluminum + plastic + wood + shoes	1	0.3
Copper + aluminum + plastic + shoes	1	0.3
Copper + aluminum + plastic + wood + clothing and electrical appliances	1	0.3
Copper + aluminum + plastic + glass + wood	1	0.3
Aluminum + plastic	4	1.3
Copper + aluminum	1	0.3
Iron + copper	1	0.3
Copper + plastic	1	0.3
Total	300	100.0

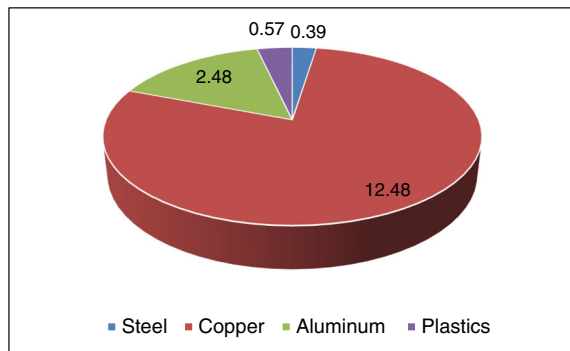


Fig. 3 Average prices (NIS) of the highest rate collected recyclable materials

sion that the current role of scavengers in waste reduction is relatively low, yet their contribution is considered a starting point from the environmental perspective view, and may contribute to locals' enhanced participation to recycling schemes and ultimately environmental sustainability. They set an example of materials' upcycling since they subconsciously apply the circular economy pattern. According to El-Hawi and Aljaja (2017), recycling and scavenging of SW items should be adopted as an environmentally sound disposal strategy parallel to landfilling since it saves collection and control of waste-related diseases and extend lifespan of landfill and 73% of questioned population (in Gaza Strip) appreciate scavengers' contribution.

On the other hand in Egypt, it has been reported that scavengers (Zabbaleen) played an important role in the collection and sorting of household waste produced in various parts of Cairo, Egypt, where it was estimated that they collected about half of the household waste produced since the 1930s (Ezeah et al. 2013; Wilson et al. 2006). The trend analysis also showed that the higher the material market price, the lower is the collected quantity, as shown in Fig. 4.

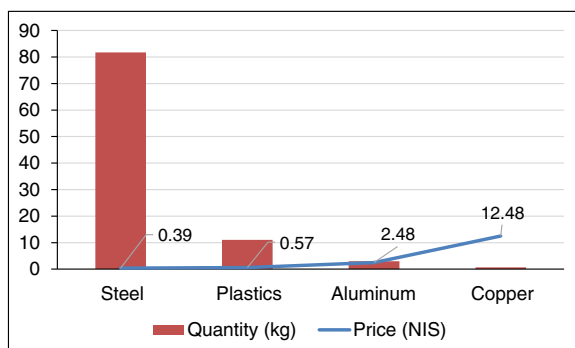


Fig. 4 Recyclable materials quantities VS prices

The VSW market prices and their availability in the waste stream highly influence the collected quantities. Approximately, 31.9% of the scavengers reported that the recyclables are not found in sufficient quantities and quality, while 64.4% of them reported that the materials are only sometimes available and only 3.7% said that the materials are available in sufficient quantities and qualities. In addition, the average income generated from scavenging is less than NIS 500 monthly for 71.9% of scavengers who reported limited availability of recyclable materials (that was 64.4% of total population). However, in India, waste pickers were estimated to earn up to 22 USD per month while the wholesalers could earn up to 154.2 USD per month (Ezeah et al. 2013; Zia et al. 2008). In Latin America, waste pickers have been organized in cooperatives or associations (Bonner 2008). An initiative named "Coopamare cooperative in Brazil" grouped several local scavengers, who manage to sell approximately 100 t of recyclable materials per month (Ezeah et al. 2013; Medina 2000), and each member of the group earns USD 300 per month (Ezeah et al. 2013; Medina 2008). The later example makes a good point and sets a good practice on the importance of the informal sector formalization that leads to their living/financial status enhancement.

Place of collection and transfer

An informal waste-picker, scavenger, or recycler is described as a person whose living depends on collecting valuable materials from markets and households, in the streets, at landfills, transfer stations, or dumpsites (Gutberlet et al. 2009; Moreno-Sánchez and Maldonado 2006; Rouse and Ali 2001; Uddin and Gutberlet 2018). Researchers' observations lead to the conclusion that the scavengers in the Gaza Strip are mostly spotted in three environments; city (collecting recyclables from waste bins), waste transfer stations, and landfills (illegally, without stakeholders/operators official consent).

All officials interviewed confirmed this grouping. They indicated that scavengers working at the transfer stations and landfills are mostly well-known to the facilities' personnel as they are regularly working there during the regular working hours, while those working in the streets are not known due to parameters such as the wide working area and unregulated time-shifts, informal position, and absence of official responsible association/body. Nevertheless, the survey results showed

that some scavengers are working in more than one of the aforementioned environments. The analysis showed that 34.1% of them are collecting from community bins distributed along the streets, and from random dumpsites, 15.1% are collecting from random dumps only and 12.7% are collecting from community bins distributed along the streets in addition to the random dumps and transfer stations. Only 7.7% and 5.0% of the scavengers are only working in landfills and transfer stations respectively as shown in Table 4.

Wilson et al. (2006) reported that in most cities with an acting informal solid waste collection system, at least six categories of waste pickers exist. Among others aforementioned, some street pickers are spotted, gathering valuable materials from mixed waste in transfer stations, streets, markets, and garbage bins (Wilson et al. 2006; Zia et al. 2008).

Table 4 Recyclable collection place

Place of recyclables collection	No.	%
Containers distributed in the streets	11	3.7
Random waste dumps	45	15.1
Landfills	23	7.7
Waste transfer stations	15	5.0
Random waste dumps + sanitary landfills	2	0.7
Containers distributed in the streets + sanitary landfills + waste transfer stations	1	0.3
Containers distributed in the streets + the random waste dumps + the landfills	26	8.7
Containers distributed in the streets + random waste dumps + waste transfer stations	38	12.7
Containers distributed in the streets + waste transfer stations	6	2.0
Containers distributed in the streets + the sanitary landfills	4	1.3
Random waste dumps + waste transfer stations	1	.3
Landfills + waste transfer stations	4	1.3
Containers distributed in the streets + random waste dumps + sanitary landfills + waste transfer stations	16	5.4
Containers distributed in the streets + the random waste dumps	102	34.1
Random waste dumps + sanitary landfills + waste transfer stations	1	0.3
Containers distributed in the streets + random waste dumps + transfer stations + in front of the house	1	0.3
In front of the houses	2	0.7
A plastic factory	1	0.3
Total	299	100.0

The results also showed that scavengers apply various transportation methods to transfer the collected recyclables, as shown in Fig. 5. Overall, 33.1% of them use their own cars; 23.1% use owned horse carts; 14.7% hire a horse cart to transfer their materials; 6.4% use carts pulled by bicycles; 6.0% are using a small three wheel vehicle (Toktok); and the rest of the scavengers (17.3%) use other ways for material transportation, including hand carts, on body back, selling the recyclables onsite, or apply a combination of the abovementioned ways of transport. Around 44.1% of the scavengers are using non-fuel burning vehicles, and around only one-third of them own a private vehicle.

Scavengers’ job satisfaction level and factors affecting it

Scavengers evaluated their job satisfaction level. The results showed that the vast majority (93.0%) of the scavengers are not satisfied with their job in waste picking and only 7.0% are satisfied. Ramos et al. (2013) found that 65% of waste pickers interviewed said that they were better off as waste pickers, which showed they were more satisfied as waste pickers than with their previous work. He also found that 39% of the waste pickers interviewed liked the profession which indicates a type of satisfaction.

The research was partly extended to find out the factors that influence the job satisfaction level of scavengers. Six factors were considered to have a major impact as shown in Table 1 and were selected to enter the LRM. The results showed that three out of six factors are significantly affecting scavengers’ satisfaction ($P \leq 0.05$). District of scavengers’ residence, negative attitude receipt from community members, and the level of recyclables selling price are the identified significant determinants of scavengers’ job satisfaction level. The

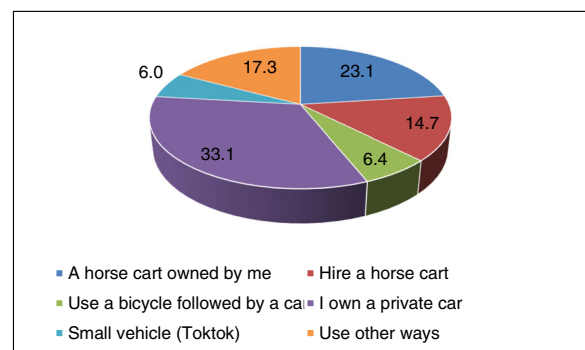


Fig. 5 Ways of recyclable material transfer

Table 5 LRM output of the scavengers' satisfaction

Variable	Variable definition	Estimated coefficient (β)	Standard error (S.E)	Wald statistics	df	Significance (P value)
X1	District	-0.740	0.247	8.999	1	0.003*
X2	Average monthly income from recyclables(NIS)	0.816	0.592	1.902	1	0.168
X3	No. of working hours	-0.519	0.401	1.679	1	0.195
X4	Availability of recyclable materials	0.457	0.402	1.292	1	0.256
X5	Feeling negative attitude by community members	0.703	0.298	5.585	1	0.018*
X6	Price of recyclable materials	-1.226	0.335	13.395	1	0.000*

*Significant at $P \leq 0.05$

specific factor affecting the scavengers' attitude was estimated using eq. (3) as follows:

Logit (Scavengers' Satisfaction)

$$= -0.740 X_1 + 0.816 X_2 - 0.519 X_3 + 0.457 X_4 + 0.703 X_5 - 1.226 X_6 \quad (3)$$

The model output showed that the scavengers of Rafah district are the most job satisfied among others. The degree of satisfaction is reduced as moving toward north Gaza district. Scavengers' satisfaction level increases with the increase of the average monthly income generated from recyclable selling. Ramos et al. (2013) found that 56% of waste pickers who were satisfied as waste pickers than with their previous work attributed their satisfaction to the higher income they generated from being working as waste pickers. Satisfaction level decreases with the increase of the number of working hours. Data analysis showed that 55.3% of the respondents are working in the range of 5–8 h daily, and 39.7% of them are working in the range of 9–12 h daily. The JSC-H&B (2015) reported that the waste pickers were working 8 h daily at Yatta dumpsite before the "facility" closure. Asim et al. (2012) noted that the waste pickers are usually working an average of 10 h daily. The availability of

recyclable materials in quantity and quality also plays an important role on job satisfaction. The higher the quality/quantity of available materials, the higher the scavengers' job satisfaction level because the availability of recyclable materials in large quantities and good qualities indicates a higher level of income. Asim et al. (2012) reported that earning of a scavenger depends on the availability of waste and how rich is the waste for recyclable item. Scavengers who receive negative attitude from community members are the most dissatisfied ones. Ramos et al. (2013) reported the existence of frequent reports of prejudice and humiliation from society that ignores the social role of the waste pickers' work. In accordance with Uddin and Gutberlet (2018), the majority of the waste pickers in Mongolia are socially and economically excluded and live in extreme poverty. Finally, yet importantly, the model output showed that the higher the recyclable market prices, the higher is the scavenger's job satisfaction level because the prices of the recyclable materials indicate the level of income. Table 5 presents the output of the LRM of the factors affecting the scavengers' job satisfaction. The tests' results applied to quantify how the model fits the data are summarized in Table 6, where the proportion of the variation in the dependent variable made by the independent variable of the model is determined.

Table 6 Model summary and goodness of fit tests

Test	Results		
Model summary	-2 Log likelihood	Cox and Snell R^2	Nagelkerke R^2
	121.804	0.622	0.829
Omnibus tests of model coefficients	Chi-square	df	Sig.
	285.766	6	0.000

Conclusion and recommendation

Around 1500 t of municipal solid waste is generated at the Gaza Strip on a daily basis. The economic crisis at the Gaza Strip has forced several poor and marginalized people to seek for sources of income generation in informal sector, collecting and selling recyclable waste fractions, and this phenomenon has spread across the area from northern Gaza up to Rafah in the south. The persons known as scavengers or waste pickers may be found in working areas such as the city streets, dumpsites, waste transfer stations, and landfills.

This research aimed to identify the socio-economic conditions of the scavengers, the current legal framework, their job satisfaction level, and their overall role and current contribution in solid waste management. Palestinian officials in the Gaza Strip including the Joint Service Council for Solid Waste Management for Gaza and North Gaza district, Municipal Development and Lending Fund, and Environmental Quality Authority actively participated and offered raw data to the research. The results showed that the number of the waste pickers could not be accurately determined due to the informality of their work, the absence of responsible body, and the wide area of their activity. However, the overall field research results show that scavengers are not satisfied with their job, the place of residence, monthly income, working hours, availability of recyclable materials, price of recyclable materials, and feeling negative attitude from the community are all factors affecting scavengers' satisfaction.

In particular, the results showed that the waste pickers in Palestine are men, and their generated income is less than NIS 500 monthly from waste picking activities, around 72% of them are in bad economic status, and are working informally for themselves not belonging to any official body or association. Despite their profoundly important activity in the raw materials shortage and market alleviation, the blockade on the Gaza Strip limits their contribution to the waste management sector as small waste quantities are diverted from the waste stream, not exceeding 1–7.7% of the total waste generated. Their environmental contribution locally may be limited but the inspiration they may bring is high. Considering that materials are upcycled, scavengers implement a circular economy pattern that encourage locals to participate in recycling schemes and decision makers to efficiently plan future recycling schemes or even involve scavengers actively in existing ones to

achieve further environmental sustainability followed by high economic activity in circular economy sector.

Currently, due to the limited financial capacity and infrastructure, waste management in Palestine highly depends on landfilling as a main way of final disposal, and it is highly recommended to activate the waste sorting and recycling in order to reduce the waste stream that is landfilled. Waste pickers have the knowledge and experience on this particular field (recyclable waste fraction diversion), constituting an asset for local waste management sector. That asset can be exploited if they are incorporated in the formal waste management system (following the good example set by Brazil). In addition, it is recommended for the local government to encourage the development of waste sorting and recycling activities by through reducing taxes on recyclable materials and goods produced from recyclables, supporting the local economy since such businesses already exist. Similarly, support and encourage the private sector to invest in waste management sector in order to increase the collected quantities and types of recyclables, contributing to the minimization of the landfilled waste, and improve the living and financial status of the waste pickers at the same time.

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