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Massoud, May; Lameh, George; Bardus, Marco; Alameddine, Ibrahim

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1 **Determinants of Waste Management Practices and Willingness to Pay for Improving**

2 **Waste Services in a Low-Middle Income Country**

3 May A. Massoud[1]*, George Lameh[1], Marco Bardus[2], and Ibrahim Alameddine[3]

4 [1] Department of Environmental Health, American University of Beirut
5 [2] Department of Health Promotion and Community Health
6 [3] Department of Civil and Environmental Engineering, American University of Beirut
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9 Corresponding author: Dr. May A. Massoud, Department of Environmental Health, Faculty of Health Sciences,

10 American University of Beirut, P.O. Box 11-0236 Riad el Solh 1107 2020 Beirut, Lebanon. Tel: +961-3-190983; Fax:

11 +961-1-744470; E-mail address: may.massoud@aub.edu.lb

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* Corresponding author: Dr. May A. Massoud, Department of Environmental Health, Faculty of Health Sciences, American University of Beirut, P.O. Box 11-0236 Riad el Solh 1107 2020 Beirut, Lebanon. Tel: +961-3-190983; Fax: +961-1-744470; E-mail address: may.massoud@aub.edu.lb

Determinants of Waste Management Practices and Willingness to Pay for Improving Waste Services in a Low-Middle Income Country

Abstract

In many low and middle-income countries, solid waste management systems remain weak and lack standardization. Moreover, these systems fail to account of citizen's insight on the proposed solid waste initiatives. This study aims to identify the main determinants of solid waste management practices in a low-middle income country, while accounting for citizens' perceived knowledge, attitudes, structural barriers, and the willingness to pay for different services. Three communities were thus selected with varying socioeconomic factors and where different solid waste management practices were adopted. A cross-sectional study based on an interviewer-administered questionnaire was conducted across the three areas. Our results showed that increased knowledge and awareness of proper solid waste management did not correlate with people's attitudes nor with their adoption of positive waste management practices, such as reusing, reducing, recycling and sorting of waste. Nevertheless, the results showed that the presence of an effective solid waste management system in a community positively influenced people's attitudes. Structural determinants, including the lack of appropriate facilities and adequate infrastructure, weak public knowledge on sorting, recycling and composting, as well as the absence of guiding policies, appeared to be core barriers hindering the adoption of sustainable waste management practices across the three communities. The results of this study highlight the importance of establishing integrated solid waste management systems in developing countries, as they appear to trigger positive behaviors by the serviced citizens.

1 Introduction

The responsibility of managing the waste sector in low and middle-income countries (LMICs) is typically devolved towards municipal authorities who lack the adequate infrastructural, technical, organizational, and financial pillars to sustain systems capable of handling the refuse generated by their own populations (Sharholy et al., 2007; Troschinetz, and Mihelcic, 2009; Guerrero et al. 2013). Problems are exacerbated by the fact that waste generation rates in LMICs have an upward trend as living standards, birth rates, and urban expansion continue to increase (Minghua et al., 2009).

54 Given, the complex web of financial, legal, political, and social determinants that govern the functionality of designed

55 systems, the waste sector has the potential to impact public health, the environment and economic sustainability. The

56 functionality of established solid waste frameworks is typically maintained through the democratization of the

57 decision-making process to leverage public involvement and community participation. Community involvement and

58 public acceptance are indispensable elements that drive the success or failure of solid waste management (SWM)

59 strategies (Marshall and Farahbakhsh 2013; Singhirunnusorn et al. 2017). While most people are generally aware of

60 the negative outcomes that improper waste management have on their communities, negative public attitudes and

61 practices towards waste management remain prevalent. Moreover, limited public knowledge concerning proper waste

62 management, the absence of proper incentives, and the inability of residents to comprehend the consequences of their

63 actions have been found to negatively impact the behavioral intentions of individuals (Davis 2006; Chung and Lo

64 2008; Licy et al. 2013).

65

66 In LMICs , proper solid waste management practices have yet to be standardized with SWM systems predominantly

67 characterized by having low rates of resource recovery, being financially unsustainable, and having large ecological

68 footprints. Generally, environmental issues tend to be pushed down the order of priority leading to the adoption of

69 inferior methods for waste disposal such as open dumping and burning. Often, citizens find little fault in their practices

70 even if they are environmentally detrimental. As such, it is imperative to assess the public's knowledge and attitudes

71 towards SWM in order to ensure a sustained engagement prior to implementing a waste management strategy.

72 Lebanon's SWM structure suffers from conditions similar to those exhibited in other LMICs and include issues such

73 as incoherent legislation, lack of funding, weak enforcement of laws, political intrusion, indeterminate distribution of

74 responsibilities, lack of accountability, and inadequate infrastructure. Lebanon continues to grapple with the negative

75 repercussions associated with improper SWM for decades, with governmental authorities struggling to control locally

76 generated refuse in an environmentally and socially responsible manner. Short-termed disposal-oriented solutions

77 continue to be rolled out in the absence of mechanisms that facilitate the implementation of sustainable and

78 regenerative solutions. The dysfunctionality of the applied SWM systems in Lebanon manifested itself in the form of

79 a debilitating crisis in 2015 which saw wastes being openly burnt and dumped in the streets. This occurred following

80 the closure of the country's biggest landfill, after its capacity and operational lifespan had been extended far beyond

81   its initial design (Massoud et al. 2019). The absence of a contingency plan and fail-safe pre-emptive measures caused

82   governmental figures to stagnate in finding an appropriate response.

83

84   Knowledge, attitude, and practices (KAP) play a major role in the success of SWM systems worldwide. According to

85   the Theory of Planned Behavior (TPB), an individual must first have the intention to perform that behavior, which is

86   in turn is affected by the perceived norm (or "perceived social pressure"). TPB has been successfully applied to

87   understand pro-environmental behaviors, in particular solid waste related behaviors and practices (Apinhapath 2014;

88   Pakpour et al. 2014; Botetzagias et al. 2015; Arı and Yılmaz 2016; Ayob et al. 2017). Other important factors affecting

89   solid waste related behaviors and practices include the attitude of individuals towards SWM practices

90   (Singhirunnusorn et al. 2017) and socioeconomic factors, such as household size, monthly income, educational level,

91   gender, peer influence, as well as the location and size of the household (Sujauddin et al. 2008; Ekere et al. 2009;

92   Emery et al. 2003; Sujauddin et al. 2008; Ekere et al. 2009). Regarding the willingness of residents to pay, it is well

93   established that it is affected by people's knowledge, attitude and practices, the socio-economic conditions of the

94   households (Menikpura et al. 2012), the financial and educational status of residents (Tariq and Rashid 2014; Akhtar

95   et al. 2017), the availability of adequate infrastructure (Hoi-seong and Kwang-Ying 2007), gender, age, and the level

96   of satisfaction with waste management services (Akhtar et al. 2017).

97

98   Despite a number of TPB and KAP-based studies (Chengula 2015; Barloa 2016; Essuman 2017; Vassanadumrongdee

99   and Kittipongvises 2018; Ma et al. 2018) conducted around the globe on waste management, few studies (Kiran et al.

100 2015; Al Khateeb et al 2017) have been conducted in low- and middle-income countries. Against this backdrop, this

101 work attempted to study the impacts of applied waste models on the perceptions, attitudes, behaviors, and practices of

102 residents from three study areas in Lebanon. The aim of the study was to measure people's attitudes towards the solid

103 waste related behaviors, their perceived level of self-efficacy and control over these behaviors, and their perceptions

104 concerning the subjective norms associated with these concepts. This paper also evaluated the potential of

105 implementing a user charge system by measuring the public's willingness to pay and the manner through which

106 residents prefer to be charged. The data gathered from this research can assist decision and policy-makers align

107 formulated strategies with the opinions, needs, and conditions of the public.

108

2   Research Methodology

2.1 Study Design

A cross sectional KAP-based survey based on an interviewer-administered questionnaire was developed. The content was inspired by the core constructs of the Theory of Planned Behavior (TPB) – perceived behavioral control, perceived social norms, attitudes, and behavioral intention. The questionnaire was predominantly comprised of close-ended questions; but it also included several open-ended questions, allowing participants to express their opinions about the subject in certain instances. The questionnaire was pilot tested to ensure content validity and to avoid any misunderstanding or confusions over terms and questions. The survey was available in both Arabic and English and a cover letter was attached to the questionnaire to explain the purpose of the study and to solicit the consent of participants. The study was approved by the Institutional Review Board (IRB) of the local institution.

In an effort to capture the level of knowledge among respondents, questions in the survey were divided into two parts. The first part focused on capturing the general beliefs concerning waste management. It was composed of dichotomous yes/no questions that aimed to test the interviewee's knowledge and level of awareness on issues concerning waste management and the potential impacts that this sector can have on environmental health. The responses to the dichotomous questions were used to compute a knowledge score that ranged between 0 to 5, with higher scores indicating elevated levels of knowledge. Respondents were deemed to be knowledgeable if their average score exceeded 3.

The second part of the questionnaire focused on assessing attitudes towards SWM. A series of questions were developed to directly or indirectly capture the viewpoints held by participants. The direct questions focused on (1) determining their perceived level of the severity of the problem and the importance that SWM has and (2) eliciting their level of satisfaction with their existing SWM practices. Attitudes towards their behaviors regarding SWM revolved around ascertaining their beliefs towards the 3Rs (reduce, reuse and recycle) and establishing the presence of the NIMBY (Not in My Back Yard) syndrome. Attitude satisfaction towards existing waste services and attitude towards 3R were scored using a 5-point Likert scale, with more positive attitudes translating into higher score value. Questions related to satisfaction with the current SWM practices in the service areas were averaged as did the attitude towards the 3Rs given that the Cronbach's alpha reliability test coefficient were 0.918 and 0.769 (>0.7), respectively.

137   Additionally, a good practices score was determined based on 5 dichotomous questions (Table 1). Its score ranged

138   between 0 and 5. For each "yes" answer, a value of 1 was added to the participant's good practices score, while an

139   answer of "no" was given a value of 0. The questions used to determine the knowledge, attitude satisfaction, attitude

140   towards 3Rs and good practices scores are summarized in Table 1.

141

142   Table 1: Questions used to compute knowledge, attitude satisfaction, attitude towards 3Rs and good practices scores

Score Title	Questions
Knowledge	Do you know what kind of resources waste can be used for?
	Do you know what is considered as recyclable material?
	Do you think that improper dumping of waste can cause flooding during rainy season?
	Do you know what the common methods of waste management and disposal are?
	Do you know what happens to your waste after you dispose of it?
Attitude satisfaction	Are you satisfied with the way you store waste within your household?
	Are you satisfied with the way waste is being managed in your community?
	To what extent do you agree that waste is being disposed of properly in your community?
	To what extent do you agree that waste is being treated properly in your community?
	To what extent do you agree that your community is doing its best regarding solid waste management?
Attitude towards the 3R's	To what extent do you agree that reusing waste is a good start to solid waste management?
	To what extend do you agree that reducing waste is a good start to solid waste management?
	To what extent do you agree that recycling waste is a good start to solid waste management?
Good practices	Do you reuse material such as plastic bags, paper, glass bottles etc.?
	Do you reduce your waste at home whenever you can?
	Do you sort your waste before disposing?
	Do you recycle?
	Do you compost?

143

144   2.2 Description of the study areas

145   The study area covered three service areas located in the north (Tripoli = S1), south (Saida = S2), and center (Beit

146   Mery = S3) of Lebanon. Figure 1 displays the locations of the three service areas. The study areas were purposefully

147   selected to provide a maximum variation in SWM structures. The three service areas had operational material recovery

148   facilities (MRFs) and organic waste treatment facilities and involved the private sector in service delivery.

149   Additionally, these areas were selected because of their socioeconomic differences. The first study area (S1) has the

150   highest population, with 731,251 citizens generating an excess of 450 tons of waste per day. The quality of the service

151   provided in S1 was generally poor, no 3R related awareness campaigns had been carried out and the existing MRF

152   and compost facilities suffered from recurrent issues relating to improper monitoring and maintenance. The SWM

153   system in S2, which has a population of 220,000 residents generating 220 tons of waste per day, resembled S1. No 3R

154   campaigns had been implemented and the operations of the existing MRF and anaerobic digestion facilities were

155   suboptimal. The third study area S3, which has a population of 14,000 residents, generated 1.3 tons of waste per day

156   and had a more efficient SWM system as compared to S1 and S2. Moreover, in this area several 3R campaigns had

157   been previously implemented. Moreover, control and failsafe measures were put in place for the MRF and compost

158   facilities.

159

Figure 1. GIS map of the study areas

2.3 Sampling procedures

In each of the study regions, participants were randomly selected. People were approached on the streets, in shops,

and in local businesses and asked to participate in the study. Participants who provided verbal consent to participate

in the study were interviewed. No municipal or governmental officials were included in our sampled population to

166 ensure that no undue influence was exerted on the selected participants. The sample size needed in each study area

167 was estimated based on equation 1.

168 $$n = \frac{X}{1+\frac{X-1}{N}}$$ Eq. (1)

169 Where n = sample size; N = population size, $X=\frac{\left(\left(\frac{\alpha}{2}\right)^2\right)*p*(1-p)}{MOE^2}$; α is the selected confidence level, p is the estimated

170 prevalence of the outcome, and MOE is the margin of error. The sample size for each of the three study areas was

171 estimated to be 100, 95 and 61, respectively. Note that the estimated prevalence of the outcome (p) in S1 and S2 was

172 assumed to be 50 %, while in S3 we considered it to be 80% given the presence of a source segregation system in

173 place. The margin of error was set at 10%.

174

175 2.4 Statistical analysis

176 Statistical analyses were performed using the SPSS Statistics software version 23.0 (IBM Corp., Armonk, N.Y., USA).

177 All inferential statistics were performed at 90% confidence level (i.e. p-values <0.1). A multiple linear regression

178 model was developed to predict good practices scores of respondents from predictors representing knowledge,

179 attitudes, and socio-demographic variables. In total, four models were generated. One model combined the response

180 from the three study areas but included a locational effect as a categorical variable. Additionally, three site-specific

181 models were also fit.

182

183 The link between the respondents' KAP, socio-demographics, and their WTP (Yes/No) was also explored using binary

184 logistic regression. One model included the responses from all three study areas and thus included a location predictor,

185 while 3 other site-specific models were also developed. The logistic linear model is of the following form:

186 $logit(p) = \beta o + \beta 1 X1 + \beta 2 X2 + \beta 3 X3 + \dots \beta k X k$

187 Where p is the willingness of a respondent to pay for SWM. It is bounded between 0 and 1, the logit is defined as the

188 natural log of the odds of the outcome or $\ln(p / [1 - p])$. β_0 represents the baseline constant, X1 to Xk are the k

189 independent variables, and β1 to βk are the model coefficients.

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3. Results

3.1 People's knowledge, attitudes, and practices concerning SWM

3.1.1 Knowledge towards SWM

The highest level of community awareness was recorded in S3, an outcome that was expected since awareness campaigns were only held in that service area. Knowledge concerning the impacts that improper waste management can have on public health and the environment and the potential for waste to be utilized as a resource were generally high across the three service areas (Table 2), with residents of S1, S2, and S3 obtaining mean knowledge scores of 3.21, 3.46, and 3.83, respectively. Additionally, most residents believed that they had a role to play in waste management. However, these positive responses did not translate into positive practices in any of the service areas. It can be inferred that knowledge alone is insufficient to prompt responsive actions.

Table 2: Level of environmental awareness among residents of the study areas

Questions	S1 N=100		S2 N=95		S3 N=61	
	Yes	No	Yes	No	Yes	No
			Percentage (%)			
Do you know what kind of resource waste can be used into?	62	38	76.8	23.2	90.2	9.8
Do you know what is considered as a recyclable material?	80	20	86.3	13.7	80.3	19.7
Do you think that improper dumping of waste can cause flooding during rainy season?	77	23	88.4	11.6	96.7	3.3
Do you know what the common methods of waste management and disposal are?	54	46	52.6	47.4	65.6	34.4
Do you know what happens to your waste after you dispose of it?	48	52	42.1	57.9	50.8	49.2

3.1.2 Attitudes towards SWM

The attitudes of the residents towards currently applied waste management schemes were generally negative in two of the three study areas. People in S1 and S2, where no 3R related awareness campaigns had been carried out and the SWM facilities suffered from recurrent issues relating to improper monitoring and maintenance, were dissatisfied of the SWM schemes adopted by municipal authorities in their areas, with attitude scores of 1.98 and 2.48, respectively (Table 3). The majority (82%) of respondents in S1 believed that SWM is a very serious problem and 11% believed that it is a somewhat serious problem. Likewise, the majority of respondents in S2 (83.2%) considered SWM a serious

212 problem in their area, while also agreeing that residents are not doing their part. On the other hand, residents of S3,

213 where several 3R campaigns had been previously implemented and control measures were put in place for the

214 operating facilities, were highly satisfied with the SWM system that was in place and had relatively positive attitudes

215 towards the SWM-related policies and practices that are being applied in their town. They had a mean attitude score

216 of 4.02 towards current SWM practices. The 3R-related attitudes were highly positive in the three study areas with

217 respondents from S1, S2, and S3 obtaining mean attitude scores of 4.45, 4.44, and 4.37, respectively.

218

219

Table 3. The perceptions and attitudes of residents towards currently applied SWM practices and the 3R's

Questions		Strongly agree 1	Agree 2	Neither nor 3	Disagree 4	Strongly Disagree 5	Mean
		Percentage (%)					
Perceptions and attitudes of residents towards currently applied SWM practices							
Are you satisfied with the way you store waste in your household?	S1	12	33	27	17	11	2.82
	S2	7.4	23.2	29.5	27.4	12.6	3.15
	S3	1.6	8.2	9.8	47.5	32.8	4.02
Are you satisfied with the way waste is being managed in your community?	S1	51	35	6	3	5	1.76
	S2	36.8	27.4	20.0	8.4	7.4	2.22
	S3	1.6	11.5	8.2	32.8	45.9	4.1
To what extent do you agree that waste is being disposed of properly in your community?	S1	46	34	10	6	4	1.88
	S2	1.6	30.5	17.9	9.5	10.5	2.17
	S3	3.3	8.2	14.8	31.1	42.6	4.02
To what extent do you agree that waste is being treated properly in your community?	S1	52	37	3	7	1	1.68
	S2	31.6	32.6	18.9	5.3	11.6	2.33
	S3	4.9	6.6	11.5	37.7	39.3	4
To what extent do you agree that your community is doing its best regarding solid waste management?	S1	42	44	9	3	2	1.79
	S2	30.5	29.5	22.1	9.5	8.4	2.36
	S3	3.3	8.2	13.1	34.4	41.0	4.02
To what extent do you agree that open dumping is a good SWM practice?	S1	16	14	6	18	46	3.64
	S2	1.1	11.6	8.4	29.5	49.5	4.15
	S3	4.9	6.6	1.6	21.3	65.6	4.36
To what extent do you agree that open burning is a good SWM practice?	S1	1	4	12	31	52	4.29
	S2	4.2	5.3	7.4	40	43.2	4.13
	S3	1.6	11.5	3.3	19.7	63.9	4.33
To what extent do you agree that sanitary landfilling is a proper SWM practice?	S1	13	22	23	20	22	3.16
	S2	14.7	45.3	15.8	16.8	7.4	2.57
	S3	9.8	11.5	19.7	27.9	31.1	3.59
To what extent do you agree that composting is a good and fast SWM practice?	S1	38	37	17	5	3	1.98
	S2	38.9	41.1	12.6	2.1	5.3	1.94
	S3	55.7	24.6	6.6	8.2	4.9	1.82
Residents' attitudes towards the 3R's							
To what extent do you agree that reusing waste is a good start to solid waste management?	S1	0	4	2	37	57	4.47
	S2	1.1	0	6.3	42.1	50.5	4.41
	S3	1.6	6.6	8.2	18.0	65.6	4.39
To what extend do you agree that reducing waste is a good start to solid waste management?	S1	5	3	5	38	49	4.23
	S2	0	1.1	9.5	41.1	48.4	4.37
	S3	4.9	3.3	8.2	21.3	62.3	4.33
To what extent do you agree that recycling waste is a good start to solid waste management?	S1	0	0	2	29	69	4.67
	S2		1.1	6.6	35.8	61.1	4.57
	S3	3.3	4.9	6.6	18.0	67.2	4.41

222   Respondents in the three study areas were found to have negative attitudes towards open burning and open dumping,

223   whereas they agreed that composting was a good SWM practice. Those who undertook such practices claimed that

224   the lack of accountability, the absence of waste storage areas, and the convenience brought by such practices drove

225   them into adopting these habits. Moreover, respondents in the three areas were uncomfortable living next to

226   incinerators, sanitary landfills, or a composting facility. The strength of the NIMBY syndrome in the three areas was

227   possibly related to the high level of mistrust that the public had towards governmental organizations. The poorly

228   managed SWM systems in S1 and S2 aggravated the level of mistrust that exists between local officials and residents.

229   Remarkably, the relatively more efficient SWM system in S3 did not serve to alleviate some of the concerns that

230   residents had concerning waste management facilities, as NIMBY associated attitudes were as high as the other two

231   areas. In fact, NIMBY attitudes were, at times, most prominently expressed in S3 (Table 4).

232

233   Table 4: Attitudes towards the NIMBY Syndrome

Questions		Very comfortable 1	Somewhat comfortable 2	Neither nor 3	Uncomfort able 4	Definitely uncomfortable 5	Mean
		Percentage (%)					
How comfortable are you with having waste dumped around your household premises?	S1	2	3	4	28	63	4.47
	S2	6.6	1.6	-	26.2	65.6	4.43
	S3	6.3	7.4	9.5	24.2	52.6	4.09
How comfortable would you feel if your house was located near a waste incinerator?	S1	2	3	2	17	76	4.62
	S2	-	9.8	-	11.5	78.7	4.59
	S3	3.2	-	4.2	26.3	66.3	4.53
How comfortable would you feel if your house was located near a sanitary landfill?	S1	3	5	12	27	53	4.22
	S2	3.3	8.2	1.6	26.2	60.7	4.33
	S3	4.2	15.8	15.8	27.4	36.8	3.77
How comfortable would you feel if your house was located near a composting facility?	S1	7	14	30	28	21	3.42
	S2	13.1	16.4	11.5	27.9	31.1	3.48
	S3	4.2	14.7	18.9	34.7	27.4	3.66

234

235   *3.1.3 Solid Waste Related Practices*

236   Good practices explored in this study consisted of reusing, reducing, recycling, sorting and composting waste.

237   Willingness to initiate recycling was found to be highest among the respondents in S3, which may be due to the fact

238   that the area has a relatively more effective recycling program and awareness campaigns are continuously

239   implemented by the municipality. Conducting awareness campaigns is highly important given that the behavioral

13

240   alterations invoked by such strategies have long lasting impacts on the practices of residents. It was significantly lower

241   among residents of S1 and S2, where no recycling currently occurs and no awareness campaigns had been initiated.

242   Moreover, households with higher levels of income tend to exhibit higher rates of recycling; with the residents of S3

243   generally more affluent than inhabitants of S1 and S2. The socio-economic status of residents may also impact the

244   likelihood of individuals to reuse materials such as textiles which would justify why reuse rates were relatively low in

245   S3, especially when compared to S1.

246

247   The computed mean average scores for "good practices" were generally low across the three areas, with values of

248   2.22, 1.43, and 2.26 in S1, S2, and S3, respectively. Respondents that did not reduce, reuse or sort their wastes stated

249   that they lacked the know-how and technical skills to perform such tasks, did not have enough time, or were not

250   accustomed to undertaking such practices. Respondents also reported that the absence of sorting bins in their

251   households prevented them from adopting eco-friendly practices. Additionally, several participants indicated that they

252   did not practice the 3Rs because they believed that the segregated wastes were going to end up in landfills. Public

253   mistrust in governmental authorities and the lack of normative and social pressures are further diminishing the efficacy

254   of applied solid waste management systems primary in the context of countries where such practices have yet to be

255   normalized.

256

257   3.2 Willingness to Pay

258   Most residents in the three service areas declared their willing to pay for SWM services. The residents of S3 were the

259   most prepared to accept the addition of service fees; 83.6% of the interviewed residents accepted such a toll. In S1

260   and S2 that percentage was only 75% and 61.1%, respectively. Some of the residents in S1 and S2 who were against

261   the notion of paying for waste services stated that their economic status hindered their ability to sustain any additional

262   fees. It should be noted that we did not find any significant correlation between the financial status of the individual

263   and her/his WTP. Interestingly, the preferred method of payment differed between the three service areas, with

264   respondents in S3 and S2 preferring a flat fee, while participants in S1 favoring a weight-based charging method.

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269   3.3 People's Solid Waste Practices and their Associations with other Factors

270   When people's solid waste practices were pooled across the three study area, we found 5 variables that had significant

271   impact on predicting the participant's environmental practices (Table 5). Overall, respondents that did not take

272   initiatives to keep their communities clean were found to have a lower good practices score as compared to those who

273   do. Not believing that the quantity of waste that they were producing was problematic highlights the inability of

274   respondents to comprehend the negative outcomes associated with their consumption behaviors and patterns. Female

275   respondents were found to have a higher practice score when compared to their male counterparts since household

276   chores, including those related to waste management, tend to be carried out by women. Moreover, respondents that

277   felt uncomfortable when a composting facility was located next to their house were found to have a lower score as

278   well. Respondents that tended to disagree with the statement that the quantity of waste in their household is a problem

279   were found to have a score that was lower by 0.173 as compared to those that agreed. Respondents that reported that

280   they disposed their waste in a community container were found to have a score that was on average 0.530 units higher

281   as compared to those who don't. The model also found that locational differences played a significant role. Assuming

282   all other things constant, the good practice score in S3 was highest. It was almost 1 unit higher than S2. The average

283   score in S1 was 0.746 units higher than S2. Overall, the developed model was only able to explain 19% of the total

284   variability observed in the good practices score.

285

286   Table 5: Regression model for predicting the good practices score across the three study regions

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Constant	2.216	0.394	5.628	0.000	1.440	2.991
[SWP12=no]	-0.726	0.173	-4.203	0.000	-1.066	-0.386
[Location=S1]	0.746	0.174	4.288	0.000	0.403	1.088
[Location=S3]	1.077	0.208	5.172	0.000	0.667	1.488
SWA20	-0.188	0.062	-3.056	0.002	-0.309	-0.067
SWA02	-0.173	0.069	-2.518	0.012	-0.308	-0.038
[SWP04=yes]	0.530	0.260	2.041	0.042	0.019	1.042

296

297 3.4 Predictors Associated with the Willingness to Pay

298 The developed logit model that pooled the data from the 3 study areas was able to explain approximately 19% of the

299 variation in the willingness to pay. Participants who displayed higher level of knowledge, had positive and pro-active

300 attitudes, and were more satisfied with current SWM practices were more willing to pay for waste services.

301 Respondents who were not willing to participate in SWM seminars were found to be 53% less willing to pay for

302 SWM. The respondents who tended to disagree with the notion that waste management is an overarching and a social

303 responsibility were on average 36% less willing to pay for SWM. Moreover, respondents who disagreed with the

304 statement that sanitary landfilling is a proper waste management practice were 28% more willing to pay for SWM.

305 Compared to S1, respondents in S2 were 57% less willing to pay for SWM. Respondents with a higher knowledge

306 score and who had positive attitudes towards the 3Rs and indicated satisfaction with current SWM practices were

307 respectively 27% and 36% more willing to pay for SWM services.

308

309 **4. Discussion**

310 The ongoing waste crisis in Lebanon helped spread awareness about waste mismanagement risks, which may explain

311 the generally high level of awareness and knowledge concerning the impacts that improper waste management can

312 have on public health and the environment recorded in the three study areas. However, the type of knowledge that

313 residents possess on proper solid waste management was found to be insufficient and did not trigger positive waste

314 management practices. Similar outcomes were reported by Ma et al. (2018) and Essuman (2017), where participants

315 also failed to act upon their acquired knowledge, despite several studies (Ehrampoush and Baghiani 2005; Tatlonghari

316 and Jamias 2010; Chengula et al. 2015; McAllister 2015) indicating that awareness and education play a crucial role

317 in positively influencing environmental behavior. This finding could also signal the prevalence of a low level of

318 perceived behavioral control, whereby residents are aware of what ought to be done, though believe that they are

319 unable to perform it. According to Bortoleto et al. (2012), factors such as past experiences impact a person's perceived

320 behavioral control.

321   The negative attitudes of residents in S1 and S2 towards currently applied waste management schemes may be

322   attributed to the implications associated with the 2015-crisis and the existence of hundreds of open dumpsites across

323   the country. Moreover, the lack of accountability and the fact that municipalities have thus far failed to act on concerns

324   expressed by residents as improper waste management practices such as the open dumping and burning of wastes go

325   unpunished may have affected residents' attitudes. The majority complained about the odors during windy periods,

326   the unappealing sight of the dumps and the health risks due to improper waste management. The relatively positive

327   attitudes towards SWM in S3 may be attributed to a more effective waste management structure, in contrast to those

328   applied in S1 and S2 which are by far inferior. These findings coincided with those reported by Al-Khateeb et al.

329   (2017) who found that the presence or absence of an effective SWM can impact people's attitudes. Alternatively, the

330   highly positive 3R-related attitudes were expected as a result of the high level of knowledge and awareness that

331   residents appeared to have (McAllister 2015).

332

333   Existing negative SWM practices reported by the residents' may be attributed to the lack of accountability, the absence

334   of waste storage areas, and the convenience brought by such practices. Convenience has been previously reported as

335   a predictor of certain practices and behaviors (Davies et al. 2002; Bortoleto et al. 2012; Babaei et al. 2015).

336   Respondents who abstained from participating in community beneficial initiatives typically stated that they either felt

337   apathetic towards such gestures or simply did not care or they did not have enough time. This is in agreement with the

338   findings of Barr (2007), who states that those who feel that their actions are worthwhile and that they gain some

339   satisfaction from reusing material were more likely to do so. Meanwhile those who refrained from issuing complaints

340   believed that no action will be taken against perpetrators or they simply did not know who to report to, which once

341   again brings forth the issue concerning the lack of perceived behavioral control.

342

343   Respondents that did not reduce, reuse or sort their wastes stated that they lacked the know-how and technical skills

344   to perform such tasks, did not have enough time, or were not accustomed to undertaking such practices. Other studies

345   (Refsgaard and Magnussen 2009; Keramitsoglou and Tsagarakis 2013; Babaei et al. 2015) have also reported that the

346   absence of adequate knowledge and technical skills among the general population act as barriers for mainstreaming

347   practices such as the reuse and recycle of wastes. Respondents in our study also reported that the absence of sorting

348   bins in their households prevented them from adopting eco-friendly practices. This is in agreement with

349   Vassanadumrongdee and Kittipongvises (2018), who reported that the absence of proper infrastructure was a

350   significant barrier for the adoption of sustainable practices. Additionally, several participants justified their choice of

351   not practicing 3R related behaviors, such as source segregation, by stating that such efforts would not lead to any

352   positive outcomes since they felt all of the segregated wastes would eventually end up in landfills or dumps. This may

353   be attributed to the lack of trust in the local governmental authorities and the lack of normative and social pressures.

354   The socio-economic status of residents may also impact the likelihood of individuals to reuse materials (Cruz-

355   Cárdenas et al. 2019), which would justify why reuse rates were relatively low in the S3 that has a higher socio-

356   economic level as compared to S1.

357

358   Even though the lack of knowledge and adequate infrastructure are more reflected as barriers for good practices in

359   this study, a significant number of respondents who did not recycle, reuse, reduce, sort or compost waste said they

360   didn't have the time for it or that they simply didn't care. This reflects the value they hold on waste and the low priority

361   given to its management. Barr (2007) reported that people who were willing to reduce and reuse more waste, in essence

362   performing good practices in SWM, tend to have stronger environmental and citizenship values. Moreover,

363   Vassanadumrongdee and Kittipongvises (2017) and Nguyen et al. (2015) showed that respondent's subjective and

364   personal norms affect their practices.

365

366   Most residents in the three service areas declared a willing to pay for SWM services. The overall readiness of the

367   citizens to pay for waste services is likely correlated with the high levels of knowledge and environmental awareness

368   that they possessed (Basili et al. 2006). Vassanadumrongdee and Kittipongvises (2017) found that knowledge of solid

369   waste issues positively correlated with respondents' willingness to pay. It is important to note that there was no

370   correlation between the financial status of the respondent and his/her WTP. This finding is at odds with what has been

371   reported by several studies (Al Khateeb et al. 2017; Akhtar et al. 2017). Moreover, residents who were satisfied with

372   the existing SWM practices, thus having positive attitudes, were found to be more willing to pay for SWM services.

373   Similar results were reported by Afroz et al. (2009). The minority who were not willing to pay believed that this

374   service should be provided by their government for free as they were already paying taxes.

375

376 Residents, who performed better practices in SWM such as recycling, reducing or reusing waste, were found to be

377 less willing to pay for SWM. This was also reported by Vassanadumrongdee and Kittipongvises (2017) who attributed

378 this to the fact that people who had enough knowledge on waste segregation could perform that activity themselves

379 thus they were less willing to pay for that service. Multiple factors were found to affect people's preferred charging

380 methods, with the majority of respondents favoring a flat rate fee method. According to Welivita et al. (2015), most

381 developing countries resort to using flat-based models. Flat rate method is progressively being implemented due to its

382 stable profitability, low logistic requirements and its ability to generate constant revenue to the corresponding

383 authorities (Töpfer 2005). Yet, it does not present any incentive for people to minimize their waste generation rates

384 (Bennagen and Altez 2004; Gellynck and Verhelst 2007). Generally, quantity based methods are desired as they

385 provide incentives for people to decrease the amount of waste they generate (Chang et al. 2008; Ayalon et al. 2013).

386

387 **5. Conclusions and Recommendations**

388 The continuous increase in waste generation and the absence of a comprehensive solid waste management strategy

389 with clearly defined targets and objectives will cause the sector to continuously deteriorate. The 2015 waste crisis

390 highlighted the long standing challenges that the Lebanese authorities have been facing when tackling the solid waste

391 sector and further emphasized the need to transition towards an integrated and circular approach to waste management,

392 away from the currently applied linear disposal-orient scheme. The study revealed that respondents from the three

393 study areas were generally highly aware of the impacts of improper SWM on the environment, human health and the

394 economy which may be attributed to the fact that the waste crisis of 2015 exposed them to the adverse environmental

395 impacts associated with poor management. Yet, this knowledge did not prove to be greatly associated with good or

396 improved SWM practices. Hence, to enhance practices through knowledge, the responsible authorities ought to begin

397 by changing the perceived limitations of residents and improving on the convenience of certain actions to incentivize

398 their adoption. The awareness and communication campaigns that are to be conducted need to focus on tipping the

399 cost-benefit analysis that residents are performing in favor of more environmentally sound behavior, focusing on

400 reducing the perceived costs associated with activities such as waste segregation. Citizens also must fully comprehend

401 the consequences of their actions and efforts ought to be placed on campaigns that thoroughly explain the steps

402 involved in performing certain activities such as waste reduction. These initiatives will have a knockoff effect,

403 whereby normative pressures will build as a result of 3R-related behaviors becoming normalized.

404 The existing lack of transparency and accountability in the country may also explain why respondents had such

405 negative attitudes towards their municipalities. Attitudes are worsened in the two service areas where complaints go

406 unanswered and respondents are frustrated with the fact that there is nothing they can do to ameliorate their situation.

407 Authorities must also work on improving their public image by taking steps that increase the level of transparency of

408 all operations and hold those responsible for any mismanagements accountable. Attitudes towards the 3Rs were highly

409 positive in the three study areas. These attitudes should be cultivated and transformed into better practices.

410 Accordingly, it is essential to have the appropriate infrastructure for segregation of waste at source. Updating and

411 implementing environmental policies and regulations, such as financial incentives and disincentives would curb waste

412 disposal rates and incentivize increasing waste treatment. It is also recommended to coercively pressure citizens into

413 complying with legislation by establishing proactive monitoring and evaluation systems that actively respond to

414 residential complaints and concerns and penalize any wrong doings. Authorities must also work on improving their

415 public image by taking steps that increase the level of transparency of all operations and hold those responsible for

416 any mismanagements accountable. Furthermore, given the weak infrastructure and the lack of knowledge towards

417 applying service charge models, a flat fee appears to be the most feasible at this stage. The establishment of municipal

418 cooperation models allow local administrations to share the responsibilities associated with operating solid waste

419 frameworks that reduces the vulnerability of local administrations and diminishes regional economic disparities.

420

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