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Spatial distribution of waste collection points and their implications on quality of life in Mombasa County, Kenya

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ABSTRACT:

Quality of life index is a measure used to describe the living environment experienced by a segment of the population. Correspondingly, waste collection and transfer are the core of waste management chain and is influenced by the four capitals of sustainability – economic capital, physical capital, environmental capital and social capital. Mombasa generates approximately 2200 tons of waste and only 65% are collected and 13% of households' access county (local authority) waste management services due to mismanaged primary collection points. In ascertaining the link between primary collection points and quality of life, indicators used to construct the index were defined and weighting assigned based on their impact on the environment. This study employed both descriptive study approach and mixed methods involving quantitative and qualitative methods to collect and infer the data. The study showed that Mombasa County is served by nine designated collection points that are inadequate and has led to the emergence of informal collection points and exposed the residents to communicable diseases. The attitude of the residents on waste management is wanting and has exacerbated the waste management drive in the county. Correspondingly 74% of the respondents used in the study have reservations regarding the waste management conduct and practices as currently practised by the local authority. Quality of life index was arrived at with more emphasis and higher weighting on the environmental aspect. The aggregated quality of life index highlighted areas with more concentration of collection points enjoy low quality of life and converse.

1. Introduction

Urban areas in developing countries are experiencing population growth and increased waste generation volumes that can be traced to socio-economic transformation(s). The challenges experienced by these urban entities is how to reconcile economic growth, population growth and infrastructural needs with environmental protection. This scenario has raised various pertinent issues on local authorities, at the core is the ability to address (municipal) solid waste management as well as the capacity and level of mechanization complemented by relevant by-laws (legislation). These competing needs have a tremendous influence on sustainable development and quality of life (Vlek, Skolnik, & Gatersleben, 1998; Turkoglu, 2014, pp.10-14).

Waste collection rates are less than 70% in majority of low-income countries (United Nations, 2017). Baud, Grafakos, Hordijk, and Post (2001), noted that changes in urban environmental services must be assessed not only by criteria of cost efficiency and service effectiveness, but also by considering issues of equality, coverage, affordability, and environmental concerns. Challenges affecting

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urban solid waste management in developing countries can be traced to the early 1990's with the clamour by Bretton Woods Institutions for privatization and restructuring of government institutions as well as structural adjustments programmes (SAPs) and the pursuit of sustainable development agenda. Adams et al. (2012) stressed that (efficient) waste management begins in the household.

Wang, He, Kim, and Kamatta (2011) observed that a 1% increase in population in China is associated with a 1.04% increase in the solid waste generation, and 1% increase in per capita is associated with a 0.34% increase in total solid waste generation. Wealthier countries tend to generate more municipal waste per person (EEA, 2017). Consequently, majority of European countries are shifting their approach towards waste management from disposal mechanisms to prevention and recycling mechanisms. That's why a city like Barcelona according to Ajuntament de Barcelona (2017) has invested extensively in municipal waste management to ensure daily household and commercial waste collection via conveniently located street containers, door-to-door collection bags and bins for collection in shops. All these are geared towards ensuring clean and healthy public space to stimulate social and economic activities.

Waste collection is the most challenging aspect when it comes to waste management due to the massive investment(s) required in terms of personnel (capacity), and optimally located points (bins). Chalkias and Lasaridi (2009) observed that waste collection mechanisms consume 70% of the total MSW costs in Nikea, Athens, Greece. Implementation obstacles encountered in Malaysia regarding solid waste management according to Azni (2004) are low collection coverage due to inaccessibility of some areas, irregular collection services, inadequate equipment's for waste collection, crude open dumping and institutional challenges. To improve waste collection efficiency in Manadalay, Myanmar, it involved replacing the manual loading of trash into trucks with more appropriate solutions to provide greater haulage (McIntyre, 2017). Addis Ababa residents are reluctant to pay for municipal services because they fear the waste collection (system) is not working (Regassa, Sundaraa, & Seboka, 2011). In Nigeria 70–80% of the total cost of waste management is allocated to waste collection (Aremu, 2013). Less than 40% of generated waste is collected and disposed off at the designated open dumpsites in Kenya (Soezer, 2016). According to Haregu, Mberu, and Ziraba (2016) Kenya finds itself in a precarious position in addressing waste management due to urban population growth superseding general population growth rate.

Illegal waste dumping is one of the main pollution causing land degradation (Chu, Lin, & Shiu, 2013). Satisfaction with the cleanliness of environment and streets as well as the condition of garbage collection (points) can be an avenue for determining quality of life since quality of life strives to establish a link between local authorities and citizens constructive interaction (Shoeibi, Amraii, Amin, Karimi, & Vandi, 2015). There is a close link between sustainable development and (urban) quality of life. Latif, Omar, Bidin, and Awang (2011) acknowledged that if solid waste is not handled properly it has the potential to result in environmental deterioration thereby negatively impacting the quality of life. While sustainability of a city is multifaceted, urban form and its relation to the efficiency of the city is the most acknowledged issue in the world environmental agenda (Ronita, Kiyo, & Keisuke, 2011). LeBlanc (2017) stressed that, objectives of waste management are to reduce and eliminate adverse impacts of waste materials on human health and the environment to support economic development and superior quality of life. Placing (municipal) bins conveniently so that one can collect the accumulating trash and emptying (regularly) according to LeBlanc (2017) is an important phase of waste management.

Majority of planners are turning to quality of life (especially the indicators that constitute it) towards creatively planning as well as assessing (needs of) their urban areas environment. Quality of life is conceived as a broad concept that covers three meanings: (1) quality of living environment, (2) quality of performance and (3) subjective enjoyment of life (Veenhoven, 2001, pp. 67–95). According to Veenhoven (2001, pp. 67–95), ecologists view quality of life as measures towards coping and adapting to environmental degradation. Urban planners are thrust into addressing this view of ecologists and coming up with a comprehensive master plan for waste management to result in varied sustainable economic and environmental opportunities. Repercussions of illegal dumping of solid waste are not restricted to the environment rather also to the social life of communities (neighbourhoods) therefore onus is on the local authorities to address this issue exhaustively (Zainun, Rahman, & Rothman, 2016).

Mombasa generates approximately 2200 tons of waste daily, 65% being collected and 35% uncollected posing a health risk to the residents (Athman, 2017). Lee, Kung, and Ratti (2015) observed that in more affluent neighbourhoods of Mombasa, such as Old Town, municipal service(s) covered only 13% of the households through collection from dumpsites. The importance of an efficient and reliable primary collection system cannot be disputed, especially for any town that strives to be referred to as a sustainable or smart city. The study also highlights the disparity with regard to the conduct and access of municipal services as well as the distribution and location of primary waste collection (municipal) points or bins between neighbourhoods. In addition, this study strives to query the emergence and explosion of different diseases (fever) in Mombasa attributed to waste collection points (garbage collection) like *Chikungunya* fever. This study appraises public health (and environmental) issues courtesy of the primary collection points and their implications on the quality of life in Mombasa City. Furthermore, the study offers an insight as to how to define and identify relevant domains and indicators to measure urban quality of life that is more biased towards the environmental domain.

2. Materials and methods

2.1. Conceptual Framework

The concept of sustainable (urban) development refers to undeniable fact that considerations of ecology can and should be used in economic activities (Larijani, 2016). Likewise, Goran and Jelisavka (2016, pp. 5–24) underscored that the concept of sustainable development implies prosperous adaptation of humans to environmental changes while preserving a consistently high level of quality of life.

Malilomo (2019) observed that waste depicts the way a society produces and consumes. Among all key challenges, waste management is one of the most important challenges for sustainable city design (Zaman & Lehman, 2011). Admittedly, urban areas

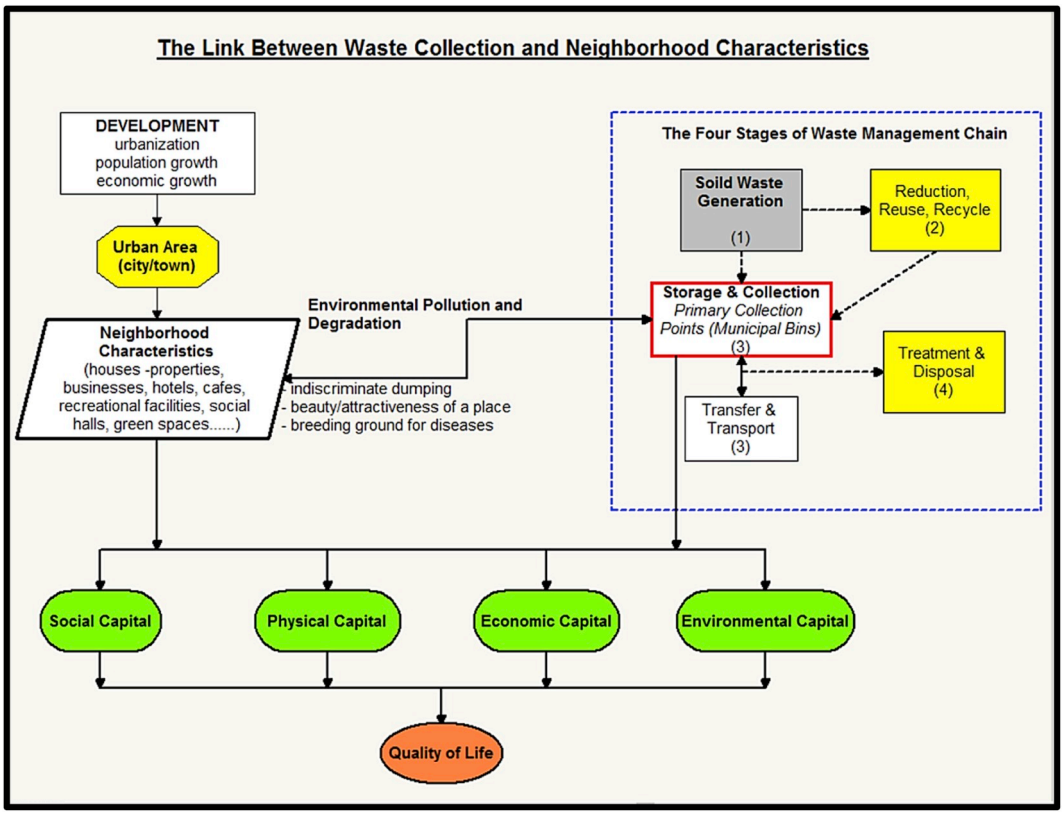

Fig. 1. Conceptual framework.

are refuge of social interactions and economic activities which have a profound bearing on the state of physical infrastructure and the environment.

Quality of life of a place (region or neighbourhood) is usually computed and an index arrived at, that is used for ranking. The index for this study was achieved via arithmetic computation, $\{\sum_{a=1}^{4} k_a\, i_n\}$; $QoL\ Index = (0.23\,k_1 + 0.23k_2 + 0.31k_3 + 0.23k_4)i_n$, where k_1, k_2, k_3 *and* k_4 are physical capital, social capital, environmental capital and economic capital attributes respectively and the respective indicators of the stated attributes are denoted by i_n (see Fig. 1).

2.2. Study area

The study looked at the spatial distribution of waste collection points in Mombasa City. Neighbourhoods (households) as well as properties adjacent to the waste collection points were of interest for the study (Fig. 2).

2.3. Population, sample size and sampling procedures

This study used 203 households in Mombasa City (distributed as shown in Table 1). This population was arrived at based on the 2009 data from the Kenya National Bureau of Statistics (KNBS).

Slovin's formula a random sampling technique formula was used to calculate the sample size since one can influence the degree of confidence and is suitable if one has no prior information about the population of interest (WordPress, 2019).

Slovin's formula is expressed as;

$$n = \frac{N}{(1 + Ne^2)}.$$

Where: n = no. of samples, N = total population, e = error of margin or margin of error.

For this study, using a confidence level of 93%, whose margin of error translates to 0.07, therefore, our N = 31, 507 Households, e = 0.07, translating to 7%.

$$\boldsymbol{n} = \frac{31507}{1 + (31507 \times 0.07^2)} = 203$$

The population size for the study was 203, which was distributed as shown in Table 1 in the respective sub-locations.

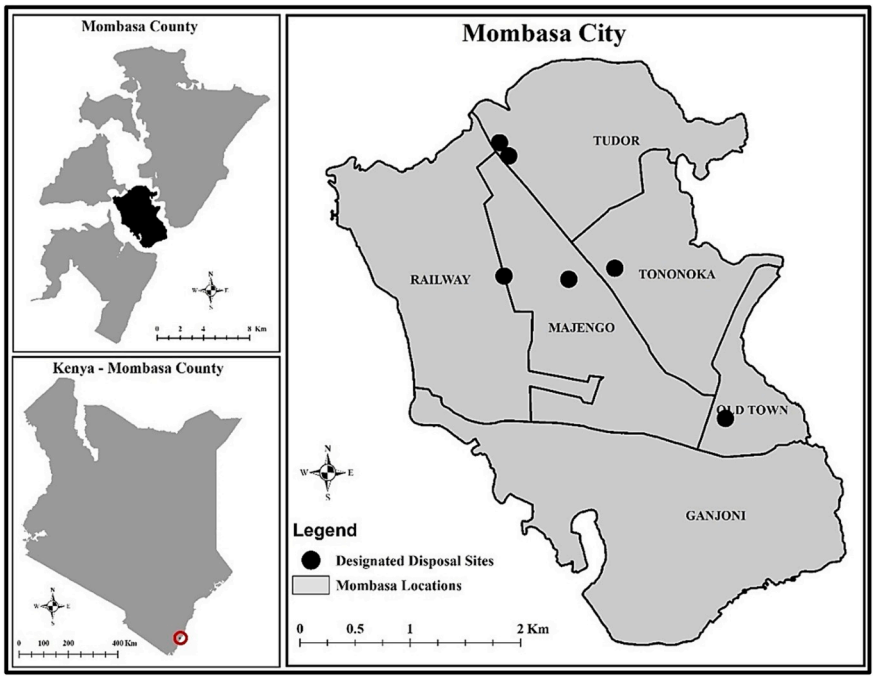

Fig. 2. Study area map.

Table 1
Household distribution in Mombasa city - sample size.
(Source; Data for House Hold size from KNBS, 2017).

Location	Sub - Location	Area in Km^2	Household	Ratio (HH)	Actual sample size/sub location
Ganjoni	Ganjoni	2.17	2583	0.082	17
Ganjoni	Kizingo	2.18	1543	0.049	9
Majengo	Majengo	1.45	6933	0.220	45
Old Town	Mji wa Kale	0.39	1760	0.056	11
Mwembe Tayari	Mwembe Tayari	0.62	1806	0.057	12
Railway	Railway	3.42	2110	0.067	14
Tononoka	Bondeni	0.49	1696	0.054	11
Tononoka	Tononoka	1.02	3849	0.122	25
Tudor	Tudor 4	1.72	3436	0.109	22
Tudor	Tudor Estate	0.84	5791	0.184	37
Total		**14.3**	**31,507**	**1.0**	**203**

2.3.1. Sampling techniques and instruments for data collection

This study used descriptive study method backed by systematic sampling and purposive sampling employed to households in close proximity to the waste collection points. Observation checklist, questionnaires and interview schedules were used to gather and extract data from varied sources. Whereas spatial data was achieved using global positioning system (GPS) cell phone application *(GPS Coordinates)* from Google Play Store.

2.3.2. Data analysis and construction of quality of life index

To analyse both the descriptive and inferential statistics Statistical Package for Social Studies version 25 was utilised. Quality of (urban) life index was arrived at through aggregation of respective attributes scores. *Quality of Life Index = Economic Capital + Environmental Capital + Social Capital + Physical capital.* This was then aggregated and the score for each attribute arrived at and then aggregated using the stated weights to get the quality of life index for Mombasa City.

Feneri, Vagiona, and Karanikolas (2013) postulated that QoL is an essential part of sustainable development, and the only way to safeguard sustainable development especially in an urban environment is by integrating economic, social and technological advancement with environmental protection.

3. Results and discussion

3.1. Introduction – primary collection points

- Ideal Waste Collection Points

Hauled and stationary container systems are the most common types of waste collection systems used. The following needs to be taken into consideration when installing a residential waste container (storage container) (Avinash, 2019);

- Efficiency – container should be able to maximise overall collection efficiency.
- Convenience – container(s) need to be easily accessible and manageable to both residents and the collection crew.
- Compatible and ownership – containers need be harmonious with the collection equipment.
- Public health and safety – containers should be securely covered and stored.

Hauled container system is preferred in open air markets (and industrial areas) where there are large volumes of garbage. This mode of waste collection system is flexible due to the ability of the local authority responsible to increase or decrease the capacity of the container as dictated by the volume of solid waste. Stationary container system is recommended for residential and commercial areas where the container remains in the vicinity of the neighbourhoods. It is suitable for all types of waste and the container when full can be loaded to a large container on a truck. This is then transported to a disposal or landfill site.

3.2. Status and spatial distribution of the primary collection points in Mombasa City

Mombasa City is served by nine designated (9) collection points, these collection points tend to be in densely populated areas and closer to the major roads (Fig. 3). Currently Mombasa County is being served by twelve (12) trucks which act as waste collection points (as well as transfer stations) replacing strategically located communal bins.

The current designated waste collection points were arrived at in a discretionary manner and are inadequate taking into consideration the urban sprawl witnessed and the growth of both formal and informal settlements. Transfer of solid waste becomes essential when distances for hauling to the designated processing centres, disposal or landfill sites increases and where direct hauling becomes uneconomical or these sites are remotely located. Therefore, it has led to the emergence of private waste handlers who lack resources as well as capacity (Fig. 4).

3.2.1. Respondents perception of the collection points

More than 70% of the respondents view the current waste management practices in Mombasa County as a more of a privatization drive than motivation towards solving the garbage menace. Majority of the respondents are not happy with the limited number of the designated collection points as well as their distribution.

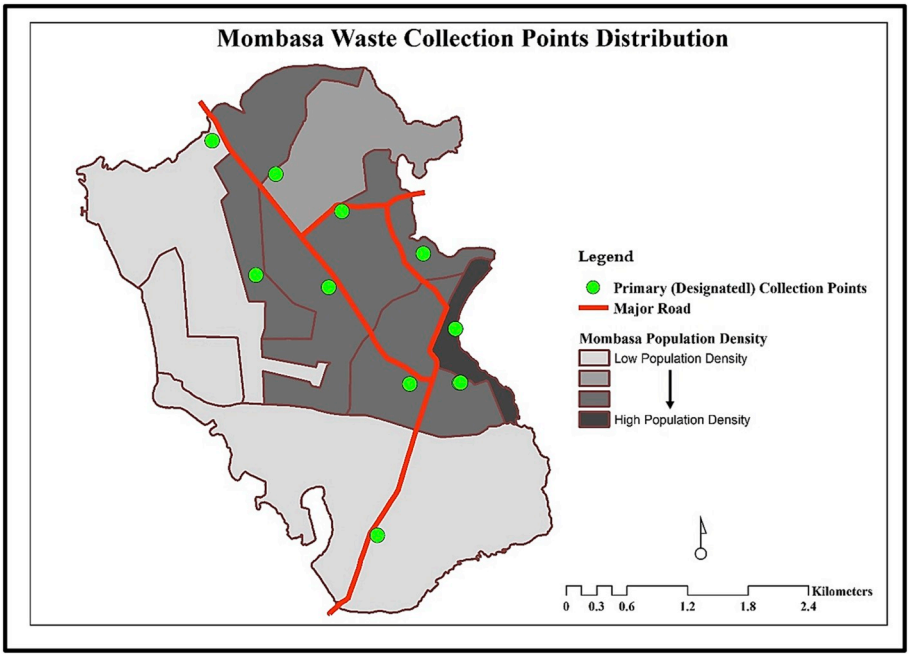

Fig. 3. Primary (designated) waste collection points for mombasa.

Fig. 4. Handcart transferring solid waste.

With the proximity, economic and operational challenges encountered, majority of the households are compelled to keep the solid waste in their vicinity for a couple of days or even weeks before they are collected by the private waste handlers (see Fig. 5). Di Felice (2014) noted that managing solid waste well and affordably is the key towards having a responsible city government.

3.2.2. The performance of the collection points

150 households corresponding to approximately 74% view the primary collection points as wanting whereas 53 households (26%) are satisfied. Inefficient waste collection and transfer services from the households, proximity and the appearance of the collection points as well as the odour emanating from the collection points due to the decomposition process (emission of hydrogen sulphide and ammonia gasses) are the major deficiencies highlighted by the dissatisfied households regarding the performance of the collection points.

Majority of the households view the amount charged by the private waste handlers for transfer of their waste as exorbitant, hence prefer either to dispose of their waste in undesignated points or mobilise amongst themselves and collect as well as transfer the waste. Moreover, majority of the private waste contractors use plastic sacks and handcarts to collect the solid waste from storage facilities within the neighbourhoods and transfer to the designated primary collection points exposing residents to communicable diseases by littering the waste all over.

3.3. Quality of life attributes and waste collection points

The way waste is handled in Mombasa County can be a good source of how to identify and group neighbourhoods. More affluent neighbourhoods scored highly in economic capital index, environmental capital index and physical capital index. Whereas in low – income areas the social capital index score was high, illustrating the need of this segment of the population in consolidating their resources towards addressing waste management challenges they encounter.

3.3.1. Relationship between household size and waste collection points

This study showed that household size has a negative correlation with proximity to the collection points, waste management expenditure, waste management behaviour (attitude) and exposure to (communicable) diseases (Table 2). Thus, these relationship(s)

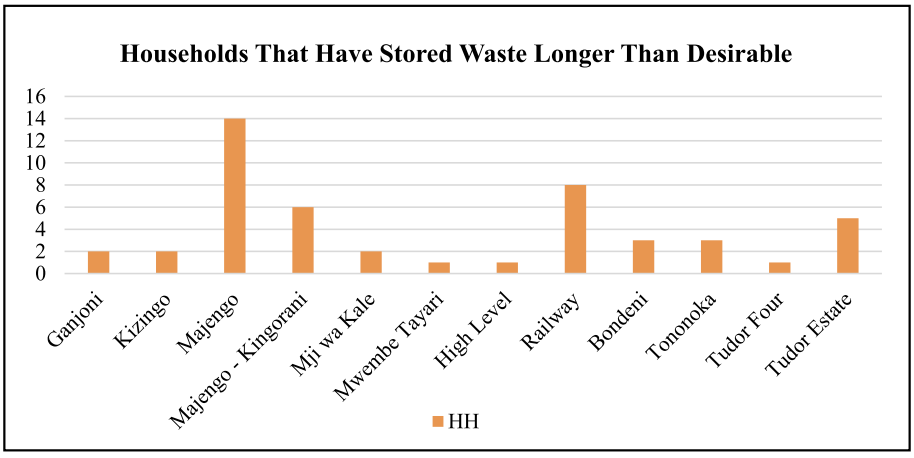

Fig. 5. Households that have stored solid waste owing to cost, proximity to collection points and infrequent collection of waste schedule.

Table 2
Correlation between household size and proximity to collection points, air quality, waste management expenditure, waste management behaviour and prone to communicable diseases.

Correlations							
		Household size	Proximity to Collection Points	Air Quality	Waste Mgt Expenditure	Waste Mgt Behaviour	Exposure to Diseases
Household size	Pearson Correlation	1	-.191**	.217**	-.200**	-.337**	-.219**
Proximity to Collection Points	Pearson Correlation	-.191**	1	-.268**	.268**	.238**	.385**
Air Quality	Pearson Correlation	.217**	-.268**	1	.028	-.261**	-.206**
Waste Mgt Expenditure	Pearson Correlation	-.200**	.268**	.028	1	.167*	.378**
Waste Mgt Behaviour	Pearson Correlation	-.337**	.238**	-.261**	.167*	1	.364**
Exposure to Diseases	Pearson Correlation	-.219**	.385**	-.206**	.378**	.364**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

depict that the larger the household size, the nearer the household is to the primary collection points, spend more on waste management, has a tendency to haphazardly dispose off their waste and is exposed to communicable diseases. The relationship between household size and air quality is a direct and positive one. Implying that household(s) with a shrinking population tend to reside in areas that they perceive to have good air quality.

3.3.2. Relationship between economic capital indicators and waste collection points

The results in Table 3 revealed that there is a significant positive correlation between the income level and the property value, waste management expenditure, proximity to waste collection points and waste management behaviour (attitude). On the other hand, the relationship between the income level and waste collection and transfer mechanisms is significant but inverse (negative).

With regard to correlations of economic capital indicators and waste collection points, the following were deduced; Income level of households influences the type and quality of dwellings. Households with high income tend to rent or own homes that are of good if not very good quality and away from the (primary) collection points. Secondly, income level influence also extends to the investment one apportions towards managing the municipal solid waste. Persons with high income prefer their municipal solid waste to be handled by reputable private waste handlers. And lastly, households with high income are sensitized and informed regarding good environmental behaviour.

3.3.3. Relationship between environmental capital indicators and waste collection points

This study revealed the following regarding the correlation coefficient between the environmental capital indicators and waste collection points (Table 4). Foul odour emission (emission of hydrogen sulphide and ammonia gasses) is directly associated with the proximity to the waste collection points, vulnerability to communicable diseases and waste management behaviour (attitude). In addition, the relationship between frequency of emptying the collection points and waste management behaviour (attitude) is direct.

The relationship between the various indicators of environmental capital and the waste collection points reaffirmed the immense influence the waste collection points have on the whole aspect of the urban environment. For instance, the frequency of emptying the collection points is influenced by the waste management behaviour (attitude) practiced in the neighbourhoods. More affluent neighbourhoods tend to ensure the waste does not accumulate in their midst.

Foul odour (emission of hydrogen sulphide and ammonia gasses) can be attributed to the proximity to the collection points. Correspondingly, neighbourhoods reporting likelihood of contracting diseases identified proximity to the collection points and foul odour as the major factors of their vulnerability. Waste management behaviour (attitude) of a neighbourhood tend to influence the emission of foul odour. Therefore, there's no foul odour in areas observing good waste management behaviour.

Table 3
Correlation Between Income level, Property Value and Waste Transfer and Collection Mechanisms, Waste Expenditure, Proximity to Collection Points, Frequency of Waste Collection Emptying, and Waste Management Behaviour.

Correlations								
		Income Level	Property Value	Waste Transfer & Collection	Proximity to Collection Points	Frequency Waste Emptied	Waste Expenditure	Waste Management Behaviour
Income Level	Pearson Correlation	1	.597**	-.324**	.264**	-.093	.261**	.188**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 4
Correlations between odour, proximity to waste collection points, frequency of waste collection emptying, prone to communicable diseases and waste management behaviour.

Correlations

		Odour	Proximity to Collection Points	Frequency Waste Emptied	Exposure to Diseases	Waste Management Behaviour
Odour	Pearson Correlation	1	.313**	-.029	.270**	.246**
Proximity to Collection Points	Pearson Correlation	.313**	1	-.122	.385**	.238**
Frequency Waste Emptied	Pearson Correlation	-.029	-.122	1	-.180*	.205**
Exposure to Diseases	Pearson Correlation	.270**	.385**	-.180*	1	.364**
Waste Management Behaviour	Pearson Correlation	.246**	.238**	.205**	.364**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 5
Correlations between air quality, odour, proximity to waste collection points, waste transfer and collection mechanisms, frequency, frequency of waste collection emptying, prone to communicable diseases and waste management behaviour.

Correlations

		Income Level	Property Value	Odour	Waste Transfer & Collection	Proximity to Collection Points	Frequency Waste Emptied	Waste Expenditure	Waste Behaviour
Property Value	Pearson Correlation	.597**	1	-.211**	.246**	.201**	.264**	.257**	.163*

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 6
Correlation between social amenity and proximity to collection points.

Correlations

		Waste Transfer & Collection	Social Amenity (Eateries)	Proximity to Collection Points
Waste Transfer_Mov't	Pearson Correlation	1	.292**	-.167*
Social Amenity (Eateries)	Pearson Correlation	.292**	1	-.239**
Proximity to Collection Points	Pearson Correlation	-.167*	-.239**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.3.4. Relationship between physical capital indicators and waste collection points

In ascertaining the influence of the collection points on the property value, it was established that there exists a direct relationship between property value and the income level, waste management expenditure, frequency of emptying municipal solid waste and waste transfer and collection mechanisms (Table 5). Whereas the relationship between property value and emission of foul odour (emission of hydrogen sulphide and ammonia gasses) is indirect.

Households with high – income tend to reside in high – valued properties (Table 3). Low – valued properties are in densely populated areas, close to the waste collection point(s). Most properties near waste collection points are vacant if not the rent for such properties are usually below the market rates. High valued properties have an elaborate mechanisms and schedules for collection and transfer of the solid waste. Additionally, high valued properties spend quite a substantial of their financial resources to have reputable private waste handlers manage their municipal solid waste.

3.3.5. Relationship between social capital indicators and waste collection points

This study revealed that social amenity that is most frequented are eateries (cafes, hotels) and have a direct association with the waste transfer mechanism and an indirect (negative) association with proximity to the collection points (Table 6).

Majority of these eateries are located in low-income areas and are closer to waste collection points. Most of the residents in these areas and closer to the eateries tend to mobilise amongst themselves to undertake waste collection and transfer activities. Old Town,

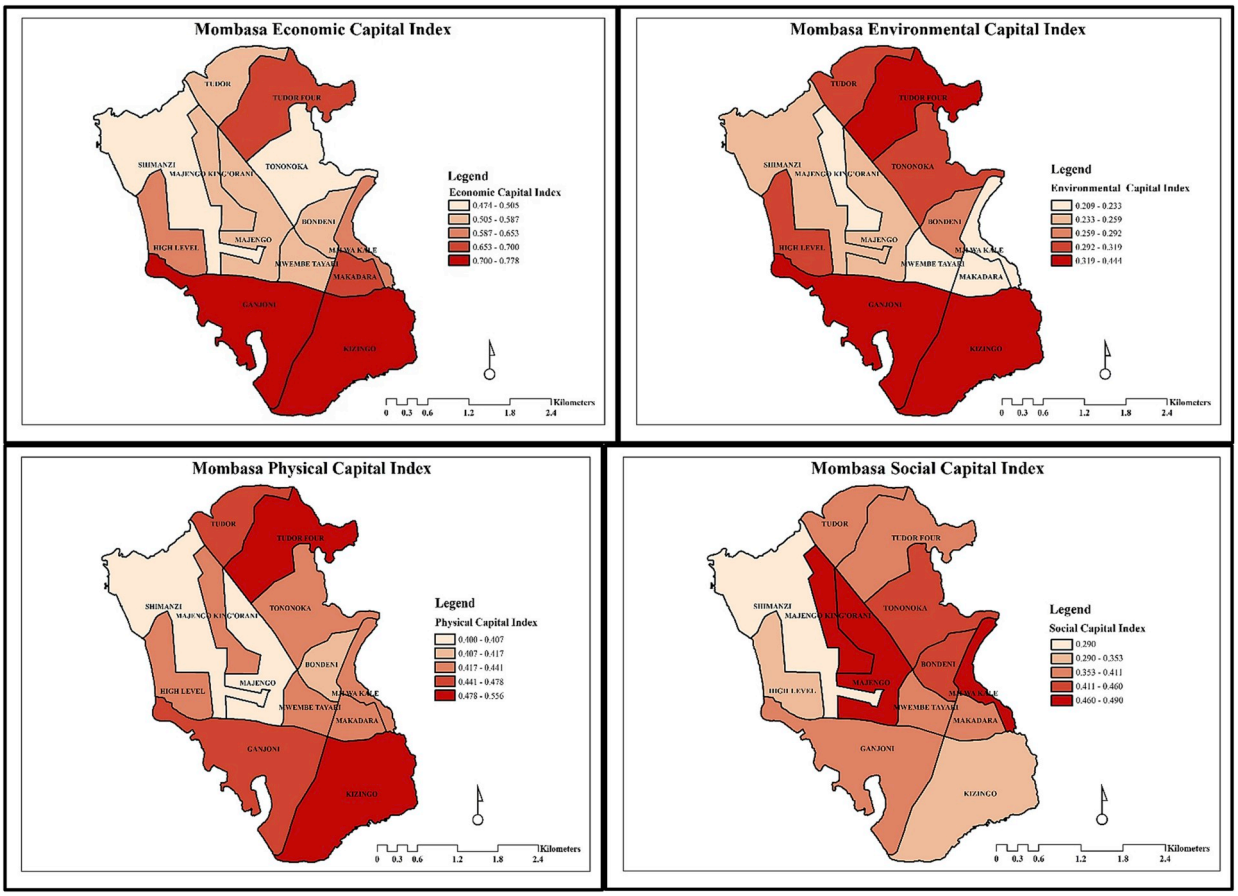

Fig. 6. Economic, environmental, physical and social capital index (clockwise) for mombasa city.

Majengo – King'orani and Mwembe Tayari tend to score highly with regard to social capital due to the ability of the residents to come together to address waste management challenges encountered.

3.4. Quality of life for Mombasa City

The quality of life index arrived at through the aggregation of the respective four (4) capitals shows, that Kizingo, Tudor Four and Ganjoni (more affluent neighbourhoods) experience high quality of life (Fig. 6). Closer inspection of the pattern of densities of both informal and formal collection points shows that areas with high density of collection points are the same areas experiencing low quality of life (Fig. 7).

Furthermore, neighbourhoods experiencing low quality of life are the same areas grappling with meeting their own basic needs. Gray and Milne (2002) emphasised that sustainability is the efficient and equitable distribution of resources intra-generationally and inter-generationally over time with the operation of economic activity within the confines of a finite ecosystem.

4. Conclusion

This study identified and illustrated that waste collection points play a critical role in the waste management chain and they influence the urban quality of life. This study demonstrated the importance of the environmental aspect in an urban setting. From diseases to properties value, the environment holds the key to any urban area success and liveability. Nature of urban sprawl is also an important factor in urban waste management and urban quality of life. The environmental impacts in an urban area have influence beyond the urban area itself if not well addressed. Using the four capitals of sustainability to come up with urban quality of life index, areas with high concentration of collection points are the same areas experiencing low quality of life. Therefore, the waste management currently practiced in the county has exposed the deprived areas to more misery and can be used as a source of segregating a high – income and low – income neighbourhoods. Very few studies have strived towards establishing the relationship between the waste collection points and urban quality of life.

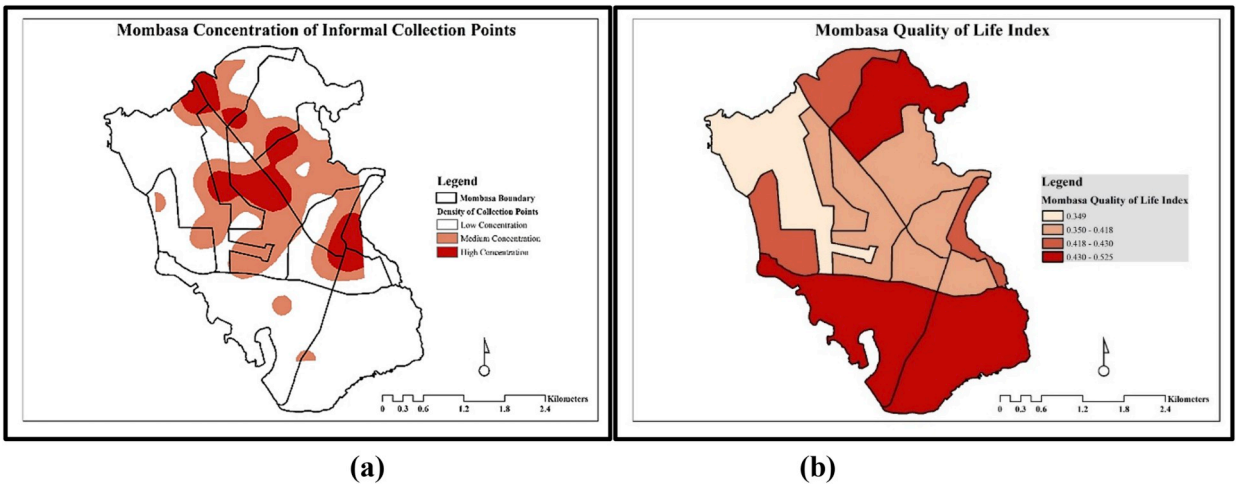

Fig. 7. Concentration of collection points (a) and quality of life index for mombasa city (b).

Even though urbanization is an inevitable and irreversible process there's need to ensure whatever is undertaken is sustainable. Waste management is an important element in urban planning and there's need to have systems that do not segregate the residents rather enable them to access and derive maximum benefit. Any urban related intervention to be successful there is need to have a robust public participation to ensure whatever is implemented has the desired outcome.

References

Adams, P., Holmes, S., Kneeland, K., Lee, K., Wells, L., Hatch, N., ... Roberts, C. (2012). *Environmental policy update 2012: Development strategies and environmental policy in East Africa.* Waterville, Maine: Colby College Environmental Studies.

Ajuntament de Barcelona (2017, December 6). *Ecology, urban planning and mobility.* Retrieved from Ecology, Urban Planning and Mobility: ajuntament http://barcelona.cat/ecologiaurbana/en/services/the-city-works/maintenance-of-public-areas/waste-management-and-cleaning-services/household-waste-collection.

Aremu, A. S. (2013). In-town tour optimization of conventional mode for municipal solid waste collection. *Nigerian Journal of Technology, 32*(3), 443–449.

Athman, S. (2017, December 8). Baraka Fm. Retrieved from Baraka Fm: http://barakafm.org/2016/11/20/mombasa-county-seeks-innovative-ways-to-deal-with-waste-management/.

Avinash, A. (2019, Mach 23). Cribd. Retrieved from Scribd: https://www.scribd.com/document/301450589/Lecture-3.

Azni, I. (2004). Overview of waste disposal and landfill/dumps in Asian countries. *Journal of Material Cycle Waste Management, 3*, 48–59.

Baud, I., Grafakos, S., Hordijk, M., & Post, J. (2001). Quality of life and alliances in solid waste management - contributions to urban sustainable development. Cities *Cities - Elsevier Science, 18*(1), 3–12 2001.

Chalkias, C., & Lasaridi, K. (2009). A GIS based model for the optimisation of municipal solid waste collection: The case study of Nikea, Athens, Greece. *WSEAS Transactions on Environment and Development, 10*(5), 1–11.

Chu, T.-H., Lin, M.-L., & Shiu, Y.-S. (2013). Risk Assessment Mapping of Waste DumpingThrough a GIS-Based Certainty Factor Model Combining Remotely Sensed Spectral UnmixingModel with Spatial Analysis. *Paper presented at the 7th International Conference onRenewable Energy Sources and the 1st International Conference on Environmental Informatics, Kuala Lumpur, Malaysia, April 2–4*.

Di Felice, P. (2014). Integration of spatial and descriptive information to solve the urban waste accumulation problem. *Procedia - Social and Behavioral Sciences, 147*, 182–188 2014.

Eea (2017, December 3). European environment agency (EEA). Retrieved from European Environment Agency (EEA): https://www.eea.europa.eu/themes/waste/municipal-waste/municipal-waste-management-across-european-countries.

Feneri, A. M., Vagiona, D., & Karanikolas, N. (2013). Measuring quality of life (QoL) in urban environment: An integrated approach. *13th international conference on environmental science and technology* (pp. 1–8). Athens, Greece: CEST.

Goran, R., & Jelisavka, B. (2016). *Theoretical approach to the study of quality of life in rural and urban settlements.* Seria Geografie: Analele Universităţii din Oradea.

Gray, R., & Milne, M. J. (2002). Sustainability reporting: who's kidding whom? *Chartered Accountants of New Zealand, 81*(6), 66–70.

Haregu, T. N., Mberu, M., & Ziraba, A. K. (2016). *Evolution of solid waste management policy landscape in Kenya: Analysis of evolvement of policy priorities and strategies.* Nairobi, Kenya: Nairobi: African Population and Health Research Center.

Knbs (2017, December 24). *Kenya data portal.* Retrieved from Kenya National Bureau of Statistics: kenya http://opendataforafrica.org/sys/login/.

Larijani, A. H. (2016). Sustainable urban development, concepts, features, and indicators. *International Academic Journal of Science and Engineering, 3*(6), 9–14 2016.

Latif, S. A., Omar, S. M., Bidin, Y. H., & Awang, Z. (2011). Environmental problems and quality of life: Situational factor as a predictor of recycling behaviour. *Pocedia - Social and Behavioral Sciences, 35*, 682–688 2012.

LeBlanc, R. (2017, December 23). *Sustainable management: An introduction to solid waste management.* Retrieved from thebalance: https://www.thebalance.com/an-introduction-to-solid-waste-management-2878102.

Lee, D., Kung, K., & Ratti, C. (2015). *Mapping the waste dynamics in Mombasa using mobile phone GPS.* CUPUM 2015.

Malilomo, F. N. (2019, February 20). Solid waste management and sustainable development. Retrieved from Solid waste management and sustainable development. https://mg.co.za/article/2018-04-20-00-solid-waste-management-and-sustainable-development.

McIntyre, A. (2017, June 23). *Asian development blog.)*. Retrieved from Waste management in Asia: 1 goal, 5 cities, 5 lessons: https://blogs.adb.org/blog/waste-management-asia-1-goal-5-cities-5-lessons.

Regassa, N., Sundaraa, R. D., & Seboka, B. B. (2011). Challenges and opportunities in municipal solid waste management: The case of Addis Ababa city, Central Ethiopia. *Journal of Human Ecology,* 1–13.

Ronita, B., Kiyo, H. K., & Keisuke, H. (2011). Linking urban form & quality of life in Kolkata, India. *47th ISOCARP congress* (pp. 1–12). Wuhan, China: ISORCAP & UN-Habitat.

Shoeibi, M., Amraii, I., Amin, M., Karimi, A., & Vandi, A. A. (2015). Analysis of subjective indicators of quality of life in urban areas of Iran (case study: Sonqor city). *Journal of Research in Humanities and Social Science, 3*(3), 39–46 2015.

Soezer, A. (2016). *Nationally appropriate mitigation action on A circular economy solid waste management approach for urban areas in Kenya.* Kenya: New York: United Nations Development Programme & Ministry of Environment and Natural Resources.
Turkoglu, H. (2014). *Sustainable development and quality of life.* ScienceDirect.
United Nations (2017). *The sustainable development goals report*New York: UN - Department of Economic and Social Affairs (DESA).
Veenhoven, R. (2001). *Quality of life and happiness: Not quite the same.* Centro Scientifico Editore.
Vlek, C., Skolnik, M., & Gatersleben, B. (1998). Sustainable development and quality of life: Expected effects of prospective changes in economic and environmental conditions. *Zeitschrift für Experimentelle Psychologie, 45*(4), 319–333.
Wang, H., He, J., Kim, Y., & Kamatta, T. (2011). *Municipal solid waste management in small towns: An economic analysis conducted in yunnan, China. Yunnan, China: Policy research working paper*.
WordPress (2019, February 20). Statistics how to. Retrieved from Statistics How To: https://www.statisticshowto.datasciencecentral.com/how-to-use-slovins-formula/.
Zainun, N. Y., Rahman, I. A., & Rothman, R. A. (2016). Mapping of construction waste illegal dumping using geographical information system (GIS). *International engineering research and innovation symposium (IRIS)* (pp. 1–8). .
Zaman, A. U., & Lehman, S. (2011). Challenges and opportunities in transforming a city into a “zero waste city”. *Challenges, 2*, 73–93.