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ADOPTION OF CRITICAL SUCCESS FACTORS FOR EFFECTIVE SUSTAINABLE SOLID WASTE MANAGEMENT IN KARACHI

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ABSTRACT

Thesis reviews urban situation of Karachi and the environmental and social impacts of waste on urban growth. Today the population has grown with such rapidity that an uncontrollable amount of garbage is being generated. This is a great concern for metropolitan city like Karachi as is generates 10,000 tons of solid waste on daily basis out of which only 4000 t0ns is lifted and dumping at land fill site daily basis by SSWMB.The consequent impact of improper solid waste disposal and their haphazard treatment not only destroy the aesthetics of Karachi city but also create severe impacts on health by chronic diseases and environmental pollutions.Dumping of solid wastes in Karachi cites is a stinging and wide spread problem. it should be resolved technically feasible, compatible, socially acceptable, financially sustainable and solid waste management issue is the one of the major challenge of the authorities of mega city. The conventional landfill sites is also important role in current situation. Thus the goal of this thesis is to understand the SSWM Karachi and come up with an sustainability. This study will look at the most practical means of resolving Karachi's solid waste problems without affecting those who are already working in this field, and in a responsible manner.

Keywords: SOLID WASTE MANAGEMENT, Sindh Solid Waste Management Board (SSWMB), City District Government Karachi (CDGK)

1. INTRODUCTION

Waste has become a major concern in modern times, not just in the developing world but even among civilized countries. Waste management has gotten more difficult and sophisticated as the human population has grown and become more sedentary, relocating to metropolitan area with the rise of cities and towns (Puopiel, 2010). waste disposal became more problematic as large numbers of people began to congregate in relatively limited regions in search of livelihoods (Ahmed & Ali, 2004).While the population of urbanized cities grew and per capita garbage output rose, the amount of land accessible for waste disposal shrank (Okai, 2020).Poor waste management puts the country's economy at risk.Waste management involves the classification, creation, prevention, and monitoring of wastes, as well as their processing, treatment, recycling, and disposal Effective solid waste management is critical used for human health and well-being. (Sushi ,1990).

2. LITERATURE

According to Farvacque-Vitkovic et al. (2008), present quick and dynamic urban expansion priorities the ability to create roads and services, resulting in town sprawl and useless land use.The sixth Sustainable Development Goal focuses on improving the availability and long-term management of waste and sanitation for everyone. The management of solid waste is essential to the sustainable development rationale (Mwanz & Mbohwa 2017).They argue that achieving Sustainable Development Goal 6 will need a large reduction in waste generation and a significant increase in resource efficiency (Domfeh et.al, 2012).Rapid population expansion and high consumption of products are influenced by development, resulting in the generation of huge volume of trash within our cities and town (Zaman & Lehmann, 2011). The main goal of this study is to better understand the solid waste management system in Karachi, as well as to identify failure causes and implement essential success criteria for successful trash management.

Table No.1: Types of Solid Waste Generators

SOURCES	TYPICAL WASTE GENERATOR	TYPE OF SOLID WASTE FOUND
Metropolitan Solid Waste		
HOUSING	Single family and multi-family homes	Household hazardous wastes include, among other things, food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, and special wastes (such as bulky products, consumer electronics, whitewoods, batteries, oil, and tyres).
MARKETABLE	Offices, hotels, marketplaces, restaurants, and other commercial structures.	Paper, cardboard, and plastics Examples of hazardous wastes include food wastes, wood, glass, metals, special wastes, and hazardous wastes.
OFFICIAL	healthcare, jails, education, and government buildings	Card board, paper, and plastics Food wastes, wood, glass, metals, special wastes, and hazardous wastes are a few examples of waste products.
DEMOLITION AND CONSTRUCTION	locations for new development, road repairs, renovations, and building destruction	soil, concrete, steel, wood, etc.
COMMUNITY SERVICES	landscaping, parks, beaches, other outdoor recreation places, water treatment facilities, and street cleaning	The general garbage from parks, beaches, and other recreational areas, sludge, and street sweepings.
UNUSUAL WASTE		
PROCESS	Refineries, chemical plants, power plants, mineral extraction, and processing are all examples of heavy and light manufacturing.	Waste from industrial processes, scrap materials, off-spec goods, slag, and tailings
AGRICULTURE	Crops, orchards, vineyards, dairies, feedlots, farms	Food wastes that have gone bad, agricultural wastes, and hazardous wastes (e.g. I pesticides)
INDUSTRIAL	Fabrication, building sites, electricity and chemical facilities are all examples of light and heavy manufacturing.	Household wastes, packaging, food wastes, building and demolition materials, hazardous wastes, ashes, and special wastes are all examples of household trash.

2.1 Study Area

The image of visual destruction in Karachi's urban districts serves to illustrate the physical issues that are

associated with the country's inner-city growth (Onyebueke, 2014). Karachi is a wealthy city (city of lights). It is Pakistan's biggest metropolis and the world's 12th largest city, housing, providing, and feeding water, power, public transportation, and health and education services (albeit insufficient).The population of Karachi in 2016 is presently projected to be 16,093,784. Karachi have a people of 1,055,380 citizens in 1950. Since 2015, Karachi's residents has increased by 1,804,626 citizens a 2.41% yearly increase (Mahmood & Khan 2019). The current version of the united nation (WUP) World Urbanization Prospects provide these population figures and predictions. These figures indicate Karachi's urban collection, which generally comprises the city's population as well as nearby suburban regions (Niazi & Azad 2018).

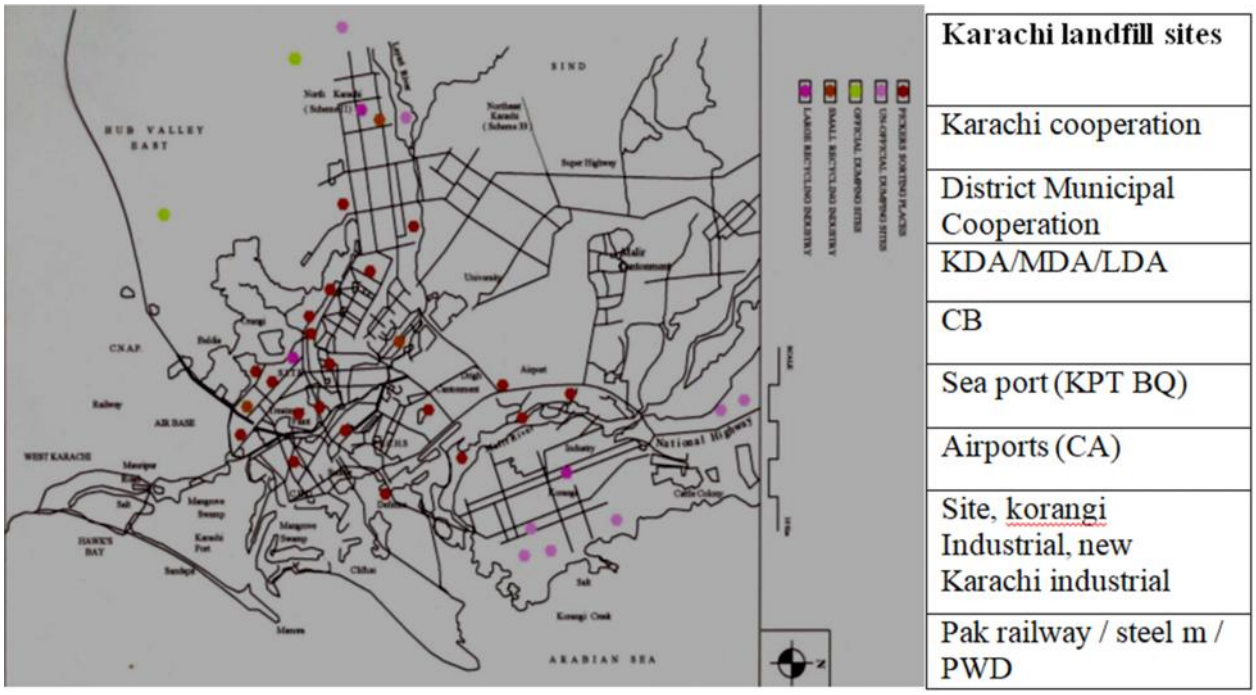

Fig.01:Location of Official And Unofficial Dumping Sties, Sorting Areas And Recycling Industry

KMC officials provided the names of the agencies responsible for garbage collection and transportation in Karachi. The KMC has conducted Karachi Strategic Development Plan 2020 to investigate the precise statistics for trash created or removed (Mukherji, 2018).

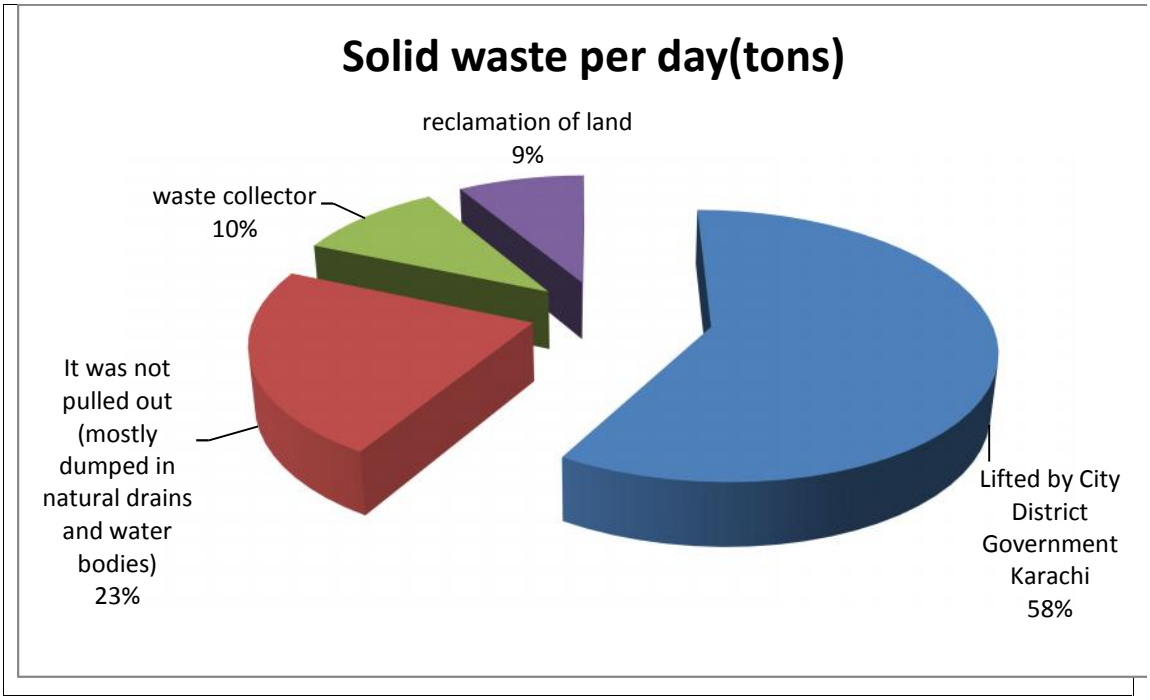

Fig.02: Karachi Waste Collection and dumping

According to a poll done by Karachi Strategic Development Plan 2020. KMC transportation is responsible for around 59% of the trash created (Khatri et.al, (2021).

3. METHODOLOGY

Research technique begins with a review of the literature on solid waste management, reduction options, and the adoption of essential success criteria for efficient, long-term solid waste management in Karachi.

Furthermore we design questionnaire for Data collection from different type of respondent in waste collecting expert, solid waste management board, general public and all stakeholders or municipal committees.

3.1 Research design

The study used a case study approach to uncover the critical success elements in waste management control in an expanding Karachi metropolis. One-on-one interviews with respondents were used to gather crucial information. Completely interviewing is a qualitative research method that entails conducting in-depth individual interviews with a small group of people to learn about their perspectives on a situation, concept, or program (Boyce 2006).Staff of the Karachi Municipal Corporation and Provincial Assembly, men and women, waste management companies, the SSWMB Agency, and landfill site workers were the main target

citizens for this study. Residents of the districts, union council members, and members of the provincial parliament were chosen for interviews using a simple probability sampling approach.. In all, two officials from Karachi Municipal Corporation and one officer from Sindh Environmental Protection Agency were questioned (SEPA),two officials from Sindh waste management firms operating in the study district, four members of the provincial legislature, three members of zonal councils, and ten locals.

Table.02:Chart No of Respondents

AGENCIES	NO.OF RESPONDENTS	JOB DESCRIPTIONS
Landfill site operator	**20**	**Operation manager Transport manager**
EPA	**25**	**Sanitation officer**
MPA's	**30**	**Local government minister**
Waste management companies	**35**	**Operation managers**
Staff of the Karachi municipal corporation and SSWMB	**25**	**City Nazim / Administrative officers Municipal budget officer**
Union council members	**20**	**Town Nazim / District Administrative**
Students	**25**	**College / University**
Residents	**30**	**Owners / Renter**
Total No	**210**	

3.2 Data Collection & Analysis Technique

Interviews and questionnaires will be used to obtain primary data from 200. Secondary data will be gathered from national and international survey reports. A 25-question survey will be prepared and delivered to 210 Karachi entrepreneurs. Data from 210 populations, according to Hoyle, is trustworthy. PLS Smart will be used to assess the questionnaire's reliability as well as

the components and variables that I'll be working with, as well as other tests such as Cronebac Alpha, Regression, Correlation, Coefficient, and Anova.

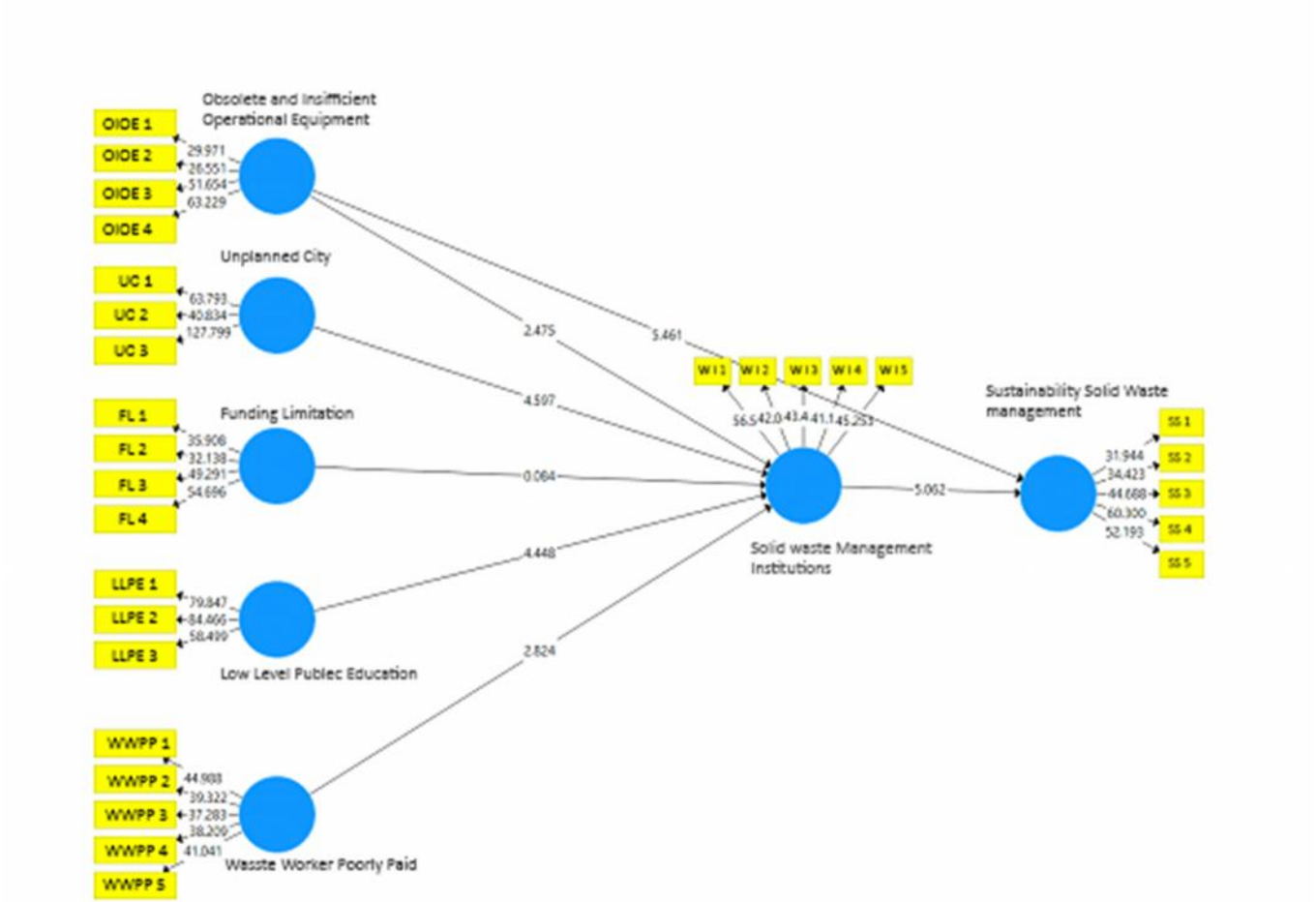

Fig.03 : Estimated Model

The above image shows the studies estimated model, which was calculated using the PLS-Algorithm method.With the context of SEM, the variables in the round form are termed constructs or latent variables. The rectangular-shaped elements are the indicators or manifest variables. Factor loading refers to the value between the arrows of indicators, whereas route coefficient refers to the value between the arrows of the construct. Although the coefficients of determination (R2) values are shown inside the constructions. The importance of these numbers

will be discussed in further detail.

Table.03:Descriptive Statistics

Indicators	No.	Missing	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness
Gender	1	0	1.21	1	1	2	0.407	0.068	1.438
Age	2	0	2.186	2	1	4	0.98	-0.871	0.383
Status	3	0	1.429	1	1	2	0.495	-1.934	0.291
OIOE1	5	0	3.067	3	1	5	1.115	-0.871	0.137
OIOE2	6	0	2.971	3	1	5	1.146	-0.701	0.056
OIOE3	7	0	2.957	3	1	5	1.251	-1.036	-0.021
OIOE4	8	0	3.119	3	1	5	1.309	-1.196	-0.004
UPC1	9	0	3.224	3	1	5	1.188	-1.067	0.107
UPC2	10	0	3.024	3	1	5	1.123	-0.706	0.197
UPC3	11	0	3.029	3	1	5	1.345	-1.124	0.042
FL1	12	0	3.219	3	1	5	1.069	-0.671	-0.047
FL2	13	0	3.205	3	1	5	1.033	-0.602	-0.054
FL3	14	0	3.31	3	1	5	1.293	-1.002	-0.247
FL4	15	0	3.014	3	1	5	1.225	-0.903	-0.027
LLPE1	16	0	3.105	3	1	5	1.276	-1.096	-0.087
LLPE 2	17	0	3.071	3	1	5	1.261	-1.037	0.037
LLPE 3	18	0	3.152	3	1	5	1.089	-0.413	-0.218
WWPP1	19	0	3.133	3	1	5	1.113	-0.782	0.026
WWPP2	20	0	3.081	3	1	5	1.059	-0.551	0.055
WWPP3	21	0	3.067	3	1	5	1.149	-0.753	0.059
WWPP4	22	0	2.919	3	1	5	1.249	-0.902	0.066
WWPP5	23	0	2.995	3	1	5	1.153	-0.779	0.066
SWMI 1	24	0	3.21	3	1	5	1.285	-1.112	-0.031
SWMI 2	25	0	3.129	3	1	5	1.086	-0.601	-0.011
SWMI 3	26	0	3.095	3	1	5	1.147	-0.626	-0.15
SWMI 4	27	0	3.005	3	1	5	1.244	-0.939	-0.054
SWMI 5	28	0	2.957	3	1	5	1.176	-0.892	0.084
SSWM1	29	0	3.138	3	1	5	0.954	-0.536	0.118
SSWM2	30	0	3.11	3	1	5	1.066	-0.42	-0.125
SSWM3	31	0	3.105	3	1	5	1.041	-0.516	0.018
SSWM4	32	0	3.114	3	1	5	1.186	-0.883	0.07
SSWM5	33	0	3.024	3	1	5	1.251	-0.999	-0.104

The table below shows the various descriptive statistics measures, there are total 33 indicators. After cleaning the data, there are no missing values in any of the indicators. The table shows how to calculate central tendency by giving the mean and median values. The indicators 5 through 33

are scaled from 1 to 5, and they are used to operationalize the construct in the route model. the greatest standard deviation on a scale of 1 to 5 is 1.25.

Table.04:Consistency Reliability and Convergent Validity

Constructs	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Indicators	Outer loadings
OBSOLETE AND INSUFFICIENT OPERATIONAL EQUIPMENT	0.845	0.896	0.684	OIOE1	0.813
				OIOE 2	0.782
				OIOE 3	0.843
				OIOE 4	0.867
UNPLANNED CITY ASPECTS	0.856	0.912	0.776	UC1	0.878
				UC 2	0.833
				UC 3	0.929
FUNDING LIMITATIONS	0.839	0.892	0.673	FL1	0.810
				FL 2	0.795
				FL 3	0.836
				FL 4	0.839
LOW LEVEL PUBLIC EDUCATION ON SOLID WASTE MANAGEMENT	0.854	0.911	0.773	LLPE1	0.881
				LLPE2	0.888
				LLPE3	0.868
WASTE WORKERS POORLY PAID AND UN TRAINED	0.858	0.898	0.637	WWPP 1	0.820
				WWPP 2	0.790
				WWPP 3	0.794
				WWPP 4	0.787
				WWPP 5	0.799
SOLID WASTE MANAGEMENT INSTITUTION	0.868	0.904	0.655	SWMI 1	0.847
				SWMI 2	0.796
				SWMI 3	0.795
				SWMI 4	0.796
				SWMI 5	0.810
SUSTAINABLE SOLID WASTE MANAGEMENT	0.863	0.901	0.647	SSWM1	0.762
				SSWM 2	0.768
				SSWM 3	0.817
				SSWM 4	0.835
				SSWM 5	0.835

The Cronbach's Alpha and Composite reliability values are in the range of 0.65 to 0.9, indicating

that the manifest variables are consistent and reliable.It demonstrates the degree to which one construct measure is positively correlated with another construct measure of the same construct. The indicator's validity is demonstrated by a value of outer loading larger than 0.708Similarly, an AVE value larger than 0.5 indicates that the indicators of a certain construct cover more than 50% of the variance. The fact that all AVE values are more than 0.5 confirms the existence of convergent validity .Moreover, the outer loadings of all indicators are greater than 0.708, demonstrating the indicators' validity as well as their convergent validity.

The Fornell- Larcker criterion is shown in Table 5, The top value in the second column is the square root of the AVE which is 0.804, which is greater than the correlation of all variables. This demonstrates that the construct has discriminating validity. The same phenomenon holds true for all constructs, and it can be seen that all square root AVE values are higher than all correlations.

Table.05: Fornel-Larcker criterion shows Discriminate Validity

	Unplanned City	Sustainable SWMB	Management institutions	Low-l Pub Edu	Operation Equipment	Waste worker	Funding limitation
Unplanned City	**0.881**						
Sustainable SWMB	0.490	**0.804**					
Solid Waste Management institutions	0.568	0.702	**0.809**				
Low level public education	0.406	0.717	0.734	**0.879**			
Obsolete and Insufficient Operational Equipment	0.430	0.703	0.654	0.657	**0.827**		
Waste Workers	0.407	0.669	0.674	0.669	0.585	**0.798**	
Poorly Paid Funding limitation	0.407	0.755	0.553	0.617	0.629	0.502	**0.820**

The variance inflation factor (VIF) is a metric for assessing co linearity statistics. The fact that

VIF is less than 5 indicates that there is no problem with multi-co linearity. Tables 5 and 6 exhibit the VIF values of all indicators and all exogenous constructs, respectively. Because all of the numbers are less than 5, there is no problem with co linearity.

Table.06: Outer VIF values

Indicators	Variance inflation factor (VIF)	Indicators	Variance inflation factor (VIF)
UC1	2.113	LLPE 2	2.194
UC 2	2.009	LLPE 3	2.194
UC 3	2.815	OIOEI 2	1.590
SSWMI 1	2.319	OIOEI 3	2.110
SSWMI 2	1.837	OIOEI 4	2.197
SSWMI 3	1.870	WWPP1	1.991
SSWMI 4	1.959	WWPP 2	1.873
SSWMI 5	2.092	WWPP 3	1.971
SSWM 1	1.750	WWPP 4	1.767
SSWM 2	1.887	WWPP 5	1.799
SSWM 3	2.032	FL1	1.873
SSWM 4	2.217	FL 2	1.784
SSWM 5	2.173	FL 3	1.926
LLPE 1	1.981	FL 4	1.795

Table.07: Inner VIF values

Indicators	SSWM Success	SSWM Intentions
• Unplanned city		1.320
• Sustainable SWM		
• SWM institution	1.747	
• Low level Public Education SSWM		2.457
• Obsolete and insufficient	1.747	2.202
• Waste Worker poorly paid		1.987
• Funding Limitations		1.926

In Path Analysis PLS-SEM algorithm technique used for obtaining several measures that are

commonly used for reporting reliability and validity, in PLS-SEM, the bootstrapping technique is used to determine the significance of these correlations. The standard error value use to obtain empirical t-value and probability (p-values). T-values greater than 1.96 and p-values less than 0.05 indicate a meaningful relationship between variables at the 0.05 significance level. Although the t-value value is larger than 2.23 and the p-value is less than 0.01 at the 0.01 significance level, the hypothesis is supported.

Table 7 depicts both the direct and indirect effects. It concludes that, of the five causes, four have a substantial impact on old and insufficient operating equipment: solid waste management institution, unplanned city aspect, financing limitation, and low-level public education on solid waste management.

Table.08: Path analysis with PLS-SEM method

	Value	T Stat	P Val	Hypothesis
Direct Effect				
Unplanned city -> SWMI	0.253	4.597	0.000	Supported
SWMI -> SSWM	0.423	5.062	0.000	Supported
Low Level P Edu SWM -> SWMI	0.368	4.448	0.000	Supported
OIOE -> Sustainable solid waste management	0.427	5.461	0.000	Supported
OIOE -> SWMI	0.169	2.475	0.014	Supported
Waste Worker Poorly paid -> SWMI	0.224	2.824	0.005	Supported
Funding limitations ->SWMI	0.004	0.084	0.933	Not Supported
Indirect Effect				
Unplanned City -> SWMI -> SSWM	0.107	3.894	0.000	Supported
Low Level Public Education-> SWMI ->SSWM	0.156	3.344	0.001	Supported
OIOE -> SWMI -> SSWM	0.072	2.163	0.031	Supported
Waste Worker Poorly Paid -> SWMI -> SSWM	0.095	2.216	0.027	Supported
Funding Limitation -> SWMI -> SSWM	0.002	0.079	0.937	Not Supported

The coefficient is used to assess the model's predictive accuracy. The R square represents the

combined effect of exogenous and endogenous variables on the endogenous variable. There are two endogenous variables in the path model. Five exogenous variables, namely obsolete and insufficient operational equipment and solid waste management institutions, explain solid waste management institutions, while two exogenous variables, namely obsolete and insufficient operational equipment and solid waste management institutions, explain sustainable solid waste management.

Table.09:Coefficient of determination (R^2)

	R Square	R Square Adjusted
Sustainable Solid Waste management	0.597	0.593
Solid Waste Management Institutions	0.678	0.670

When the R^2 number is more than 0.5, it means that the independent factors explain more than 50% of the dependent variable.

4. CONCLUSION:

This study discovered that waste separation, which is one of the first stages in reducing waste volume and/or toxicity, was not done prior to ultimate disposal.

Similarly, because roughly 57.5 percent of trash in the Metropolis is plastic, the goal of decomposition of waste in the landfill for reclamation of land for usage would fail if waste is not separated before disposal in landfill.Because the SSWMB and industrial growth are directly related to the country's economic circumstances, which finally improve with the success of a firm, sustainability is the most significant factor in connection to monetary development and other social situations in Karachi.

5. RECOMMENDATIONS

- Improvement in health condition of the city residents in the existing conditions many diseases outbreak due to waste mishandling.
- • Sorting of waste it is a procedure in which trash is divided into distinct components in order to be processed and disposed.
- Trash segregation is the process of separating waste into elements that can be reduced, reused, or recycled.
- The recycling sector is critical to waste collection and disposal, as well as the economy.
- Further more Solid waste Management Board providing Vending Machine for Collection of recycling Material like Plastic bottles, papers, steel, aluminum, wooden furniture etc.
- SSWMB started a Public awareness programs through social media, electronic media and print media.

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