



Effects of Private Waste Collectors' Capacity, Experience and Trip-count on Revenue in Lagos State

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Abstract

Governments around the world have deemed the adoption of Public-Private Partnerships (PPP) worthy in the solid waste management (SWM) arising from budgetary constraint and service inefficiency associated with public provision of the service. However, literature on the sustainability of such private investment which determines the survival of such arrangement is sparse. Thus, this study examines the influence of such firms' capacity, trip count, and experience on the revenue of private solid waste collection and transport firms in Lagos, Nigeria, using Structural Equation Modeling (SEM)based path analysis. The results show significant positive relationships between each independent variable and revenue. Thus, firms' capacity, experience, and trip count, specified in the model following relations espoused in existing studies were all found to have statistically significant positive effect on revenue. Additionally, the flexibility of the path analysis adopted availed the simultaneous estimation of correlation among independent variables within the same model. Exploring such yielded significant positive correlations for the specified variables, allowing a more robust specification beyond multiple regression analysis. Findings from the study underscore the importance of firm size, operational activity (trip count), and industry experience in enhancing the financial performance of waste management firms. The study thus recommends the Lagos State Waste Management Authority (LAWMA) to create enabling environment for the survival of private sector participants (PSP) by targeting regulatory measures consistent with their expansion, expose them to trainings to leverage experience gaps and put in place measure to deter them from traffic congestion which could limit trip count.

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1. Introduction

Due to budgetary constraints and service inefficiencies, governments in developing and developed countries have adopted PPP under various arrangements to attract private

investments in infrastructure and provision of social amenities, including solid waste management (Katusiimeh, et al., 2012; Adam et al., 2015; Adamou et al., 2021; Greer et al., 2021; iCED-TERI, 2022; Luthfi & Naufal, 2023).

These partnerships involve the transportation of waste to dumpsites or transfer-loading stations. The PPP model practiced in SWM sector around the world has at different times and in different countries taken various forms, including privatization and divestiture, service contract, management contract, lease and concessions (Olukanni & Nwafor, 2019). Confronted by similar challenge, efforts by successive governments in the past led to the creation of Lagos Waste Management Authority (LAWMA). In Lagos, SWM started becoming an issue of concern in early 1970's, following the economic prosperity that characterized the country arising from oil-boom. Lagos, then the administrative capital as well as the economic nerve of Nigeria witnessed mass influx of people from other parts of the country. Since the volume of waste generation is tied to population, generated solid waste volumes began to rise rapidly. That threatened not only the scenery but public health by mid-1970s.

This scenario warranted the establishment of the Lagos Refuse Disposal Board in 1977. This body was charged with the task of collecting domestic waste and cleaning drains in Lagos metropolis. In 1981, the organization's responsibility was expanded to include the collection and disposal of commercial waste, industrial waste, scraps and abandoned vehicles. As a reflection of the expanded roles of the organization, its name was changed to Lagos State Waste Disposal Board (Adepitan, 2010). In similar vein, following the commercialization of the organization's services to both the state and local governments, its name was in accordance to Edict NO. 55 of the Lagos state government changed to LAWMA in 1999.

LAWMA coordinates the management of solid waste and disposal in the state. However, key regulatory and enforcement responsibilities still rest with the Ministry of Environment (Olugbenga, 2010). Between 1996 and 1998, the Ministry of Environment in Lagos played the pioneer role of introducing public-private

partnership (PPP) in the state's waste management industry (Olugbenga, 2010; Adam et al., 2015). The private waste collection firms which came to be known as private sector participants (PSPs) in the industry increased in number following the success of an earlier pilot project with just 22 companies (Adepitan, 2010). They operate as private waste collection firms in the capacity of franchisees while LAWMA assumes the role of franchisor. This was deemed necessary as a remedy to the abundance of uncollected waste which resulted from government's budgetary constraints. The pilot program began in the last quarter of 2008. All communities pilot-tested with franchised PSP services provision did not involve the low income neighborhoods. These include Victoria Island, Ikoyi, and Ikeja G.R.A. However, irrespective of economic groupings (low, middle or high income areas), virtually all political wards in Lagos were provided with franchised solid waste management services.

Presently over 350 PSP operators have been granted licenses in the state. In the beginning, the nature of business relationship between PSP and LAWMA had taken various forms, at times depending on communities-specific peculiarities such as the economic grouping of residences in an area. These include concession, contracting and franchising arrangements. However, since June 2009, waste collection services in virtually all political wards in Lagos were privatized and franchised irrespective of communities-specific peculiarities (Adepitan, 2010). The attraction of PSP operators into the industry has increased the amount of collected waste in the city. The increase in waste collection albeit coupled with increased population had improved urban aesthetics in the city.

Due to this improvement in waste collection, Lagos had achieved an appropriate waste collection target more than any other state in Nigeria (NBS, CBN & NCC, 2010; Adam et al., 2015). It is therefore, no coincidence that other states now copy her model. This justifies why the

enforcement and regulatory body - LAWMA has been commended for a job well done in achieving a cleaner city since the fairly recent past (Adeseri & Akoni, 2011; Olugbenga, 2008). However, there are concerns on the sustainability of the franchise arrangements between LAWMA and PSPs. Such sustainability is determined by the performance of the PSPs in their trucking services. Generally, studies on PSPs are scarce.

Notwithstanding, using structural equation model (SEM), Lun and Quaddus (2011) studied the effect of firm size on the performance of transport operators in Hong Kong. The study finds firm size, that is capacity, to positively influence sales growth. Similarly, Badenhorst-Weiss (2015) studied the performance of logistics trucking firms in South Africa. The study found that increase in transportation cost, human resource related problems, as well as operational management of infrastructure constitute some of the major challenges in the logistics industry. More succinctly in relation to LAWMA, Anestina et. al. (2014) found that the PSPs years of experience is waste collection, number of trips made by PSPs and the number of times trucks were maintained determined the performance of PSPs. However, the study used self-generated measures with performance in subjective dummy terms, leading to the use of more restrictive probit model. One of the dimensions yet to be explored is the use of the rich data generated by LAWMA on similar variables. This study thus analyses the effect of PSPs' experience in solid waste transport service provision, number of trips made (trip count) by PSPs and the waste collectors' capacity (firm size) on the survival of PSPs in Lagos state. Meanwhile, survival is measured by revenue generation.

The remainder of the paper is structured as follows. Section 2 discusses solid waste collection in Lagos State, disintegrated into PPP and the PSPs in Lagos State SWM sector. Section

3 presents the study's methodology, while section 4 contains results and discussions of findings. Section 5 presents the study's conclusion and recommendations.

2. Solid Waste Collection in Lagos State

2.1 Public-Private Partnership (PPP) and the Private Sector Participants (PSPs)

The Lagos state government through its PPP initiative had employed several privatization models for injecting efficiency into solid waste management service provision. In the beginning, the program was not much organized and the private companies operated only in the capacity of contractors, directly paid by the government based on claims through dockets. Later, the contract arrangement¹ was only limited to low income areas of the state while, in the high income areas, a franchise arrange was applicable where the companies operated as franchisees and LAWMA, the franchisor. Finally, with the introduction of what LAWMA called "bridging" payment, to mitigate companies' risk exposure in low income areas, franchise arrangement was extended across all political wards across the state.

Each zone allocated to a PSP operator was composed of one or more political wards, depending on their capacity. Each of the companies were required to possess a minimum of one truck, while solid waste collected from clients are required to be disposed at the dump sites. In addition, the government gave guidelines on the amount of waste bills payable across different economic groupings of clients. The exclusive allocation of zones to PSP was partly to ease each company's performance assessment. At the same time, to enhance the cleanliness of main roads, Highway Managers, who operated based on contracts were appointed to specifically collect, evacuate and transport solid wastes along road medial strips and pedestrian paths. Figure 1 shows a cross view of

highway managers' workers cleaning road medians and pedestrian access routes on the highways.

2.2 Privatization Models

Solid waste management is the sole responsibility of local governments in Lagos. However, until 1991, environmental sanitation from solid waste pollution was in a bad state across Lagos. That was largely due to the local governments' inability to cope with the rising expenditure requirement for managing the increasing volume of solid waste. Although there

were few registered private operators prior to the 1998 privatization wave, the private sector participation in solid waste management was dominated by informal operators who were mostly cart-pushers (Adepitan, 2010). The two main problems at the time were the undesirable outcomes of cart-pushing operation and the uneconomical outcome of solid waste scavenging. The scavenging activities was virtually informal with sorting of recyclables done at dumpsites, bins or other destinations after the waste were comingled or mixed



Figure 1: Highway Managers in Lagos
Source: Adam (2014).

. This resulted in the further scattering of waste deposited at various unauthorized destinations, adding to the environmental eyesore which seriously impaired the city's scenery. Likewise, the cart-pushers (shown in Figure 2) were not registered by authorities. They collect and transport commercial and domestic solid waste to LAWMA dino-bins located at some intervals along main roads. A common problem with the informal operators lies in their noticeable nonchalant attitudes of transferring

waste from one part of the city to the other, instead of taking them to locations where LAWMA dino-bins were located. The refuse were deposited instead on vacant land or road sides. This was usually the case where the bins are located far from the generating sources. In some cases due to the lax control, cart-pushers dump collected wastes in overflowing government-dino-bins. All these culminated into the attribute that characterized Lagos of then;

dirty city with wastes overflowing bins on road-sides preventing free-flow of traffic.

As such in 1998, the privatization of services was deemed a necessary strategy to improve solid waste management service delivery while at the same time, reducing government budgetary commitments. As such, private-public-partnership (PPP) was introduced as a feasible strategy by the state government. The PPP strategy is a partnership arrangement which entails the operation and funding of solid waste management services provision by the government in collaboration with private sector investors. As a starting point, the entire market was divided into smaller manageable market units (Adepitan, 2010). Each of the market

partitions which were mostly political wards was serviced by one Private Service Provider (PSP).

In the beginning, 624 private refuse collection firms were authorized to collect and transport household waste. The companies which were licensed by the Ministry of Environment collect waste on the streets to designated landfills. The cost of the services was borne by households. In 2001, the privatization program was evaluated and conceived successful. As a result, the Lagos state government was conferred a national award for best practices by the Federal Ministry of Housing (Adepitan, 2010).



Figure 2: Cart-Pushers prior to 1998 Privatization wave
Source: Adam (2014).

It is apparent that the post-1998 improvement had addressed much of one of the problems highlighted above; solid waste collection and transportation. Not much was achieved in terms of modernizing waste sorting (as done by scavengers) despite its indispensability in solid waste diversion from

landfill through recycling. The second major problem that characterized solid waste management in Lagos during pre-1998 privatization wave was the operation of informal private sector scavengers. The scavengers sort recyclables from the waste deposited in the dino-bins and other locations such as road-sides and

vacant lands. Meanwhile, sorting at the generating source prior to waste mingling which is tagged source-separation provides the cleanest, economical, and least contaminated recyclables (Coffey and Coad, 2010; Kiely, 2007). Eventually, franchise model was adopted, where LAWMA served as the franchisor and the private waste collection firms constitute the franchisees.

3. Methodology

3.1 Data and Data Source

The data used in this study was sourced from LAWMA in September, 2022. The data are all ratio scale data collected on several variables related to the operations of PSPs in Lagos state. The data set is a cross-section data for 261 waste transporting firms who are all LAWMA franchisees. Data was collected on trucks trip count (operational activity), PSPs revenue, firm size (measured as capacity by LAWMA) and firms experience in the sector. All data sets are observed variables, measured by LAWMA on a scale of “0” to “10” where “0” indicated the least score and “10” the highest score. It is also worth noting that, although a total of 261 firms are contained in the data set, only 260 was analyzed since the franchise company named Gureje Technical Services was exempted from the analysis arising from missing data on trip count. This study is deemed imperative as no study has previously used the rich data set compiled by LAWMA to gain insight into the sustainability of PSPs performance in Lagos state. In addition, previous studies on the sustainability or survival of waste collection business in Nigeria have not used data generated from the operators to gain insight on the determinants of the PSP revenue. Below is a brief description of the variables.

3.1.1 Variables Description and Measurement Revenue

Considering the peculiarity of PSPs in Lagos, Nigeria, revenue describes the stream of incomes generated from their operations. This includes fees charged to households, businesses, and

governmental entities for waste collection, transportation, and disposal services. The revenue varies with factors such as the waste collection frequency, volume of collected waste, firm’s efficiency of operations, and pricing strategies, which varies between eyebrow and low-income communities in the city (Adam et al., 2015). Revenue generation is vital as it determines the sustainability and expansion of PSPs, ensuring that they are well positioned to pay staff wages and salaries, maintain equipment and comply with regulatory standards of LAWMA.

Firm Size (measured by the capacity of the trucking transport company)

Firm size in the context of PSPs is measured by the capacity of PSP's truck fleet. This capacity is quantified by the number and size of trucks available for waste collection and transportation by a PSP. LAWMA has the perception that larger waste collection companies with larger capacity trucks can collect more waste, service larger areas, and operate more efficiently. In Lagos, where waste generation is high due to the large population, PSPs with greater truck capacity can provide more reliable services, thereby, reducing cases of missed collections and untimely waste collection, thereby increasing revenue.

Truck Trip Count (Operational Activity)

Truck trip count describes the number of trips waste collection trucks make during a specified period. This variable measures PSPs service coverage capacity as well as operational efficiency. For instance, higher trip count indicates high frequency of waste collection, which accounts for better waste management and enhances customer’s satisfaction. Due the peculiarly high congestion in Lagos State, trip count is determined by route planning, the travel distance between the point of waste collection and waste disposal sites and traffic conditions. Hence, a prudent management of trip counts optimizes PSPs’ fuel usage, reduces operational

costs and ensure timely collection of waste, thereby increasing PSP's revenue.

Experience of the Firms in the Industry

Experience in the industry measures the number of years a PSP has operated in Lagos solid waste collection and transportation sector. Experienced PSPs are expected to have better knowledge of waste management regulations in the state. They are expected to establish relationships with customers as well as regulatory bodies (most especially, LAWMA). This is expected since LAWMA organises meetings with all PSPs fortnightly (Adam et al., 2015). These help such PSPs to have profound understanding of the challenges and opportunities within the industry, thereby increasing revenue.

3.2 Theoretical Framework

The theory of production function is a fundamental framework for analyzing the technical relationships that underlie how various inputs are transformed to outputs. In the peculiar case of waste collection and transporting firms such as PSPs, the inputs include, among others, firm size (measured by the capacity of the trucking transport company), the truck trip counts and the experience of the firms in the industry (Kawai & Tasaki, 2016; Mahdavi et al., 2022; Yadav et al., 2022). These inputs contribute to the output (the total value of waste transport service-p+rendered), which in this context is the revenue of the waste collecting companies, conceptualized as profit by Yadav et al (2022). This theoretical framework elucidates the relationships among these variables through the lens of production function theory. Each of the aforementioned variables have been justified to be technically related to firms' revenues (profits) in solid waste management trucking business. For instance, Lun and Quaddus (2011), Cesinger et al (2018) and Oshim et al (2023) studied the effect of firm size on sales growth. Meanwhile, Fasakin (2001), Anestina et (2014), as well as Aljohani and Thompson (2021)

studied the effects trip count on profit and revenue. On experience, Parola et al (2015) shows that firms years of experience determine their success. This is reasonable due to reduction in information asymmetry. However, Siverman et al (1997) found a rather unexpected empirical relationship between firm experience and survival in the industry for trucking firms in the United States, arising from increased liability of older trucks by more experienced firms.

3.3 Model Specification

The Theoretical Path Model Specification

Path analysis is a special form of structural equation model (SEM) that does not require a measurement model to estimate equations. It has the strength of exploring all possible linkages between theoretically relevant variables (Lleras, 2005). It has the strength of decomposing the relation between or among variables into causal direct and indirect relationships (Streiner, 2005; Lleras, 2005; Wuensch, 2012). However, unlike the more general SEM, it uses only observed variables. Hence, its suitability to the data obtained from LAWMA. This is because each observed variable is a form of summated score which is a requirement for path analysis (Mustafa et al., 2011). In addition, unlike multiple regression analysis, using SEM-Path analysis allows for a more accurate modeling of complex relationships, including the estimation of measurement error, which makes it a superior choice when dealing with summated score data and intricate causal structures (Grace et al., 2010; Hair et al., 2014; Blanthorne et al., 2006; Hair et al., 2017; Hair et al., 2019).

Based on the variables espoused under the theoretical framework, Lun and Quaddus (2011) specified SEM-based path model for transport firms' profitability as:

$$Profit_i = \beta Firm\ size_i + \alpha Sales_i + \gamma Customers'satisfaction_i + \epsilon_i \quad 1$$

This specification conforms to that of Cesinger et al (2018) which like Lun and Quaddus (2011) deemed firm size but in addition, also specified age in the industry (experience) as determinant of sales growth (their proxy for revenue/profit). Meanwhile, Aljohani and Thompson (2021) added beyond facility size, trip count (number of deliveries) as determinants of profit in freight transport services. Hence, this study modified equation (1) by Lun and Quaddus (2011), to include both experience and trip count justified in later studies. Customers' satisfaction included in the model was not specified since the data obtained from LAWMA does not capture the variable. The model adopted for this study is thus specified in equation (2).

$$\text{Revenue}_i = \beta \text{Capacity}_i + \alpha \text{Trip Count}_i + \gamma \text{Experience}_i + \epsilon_i \quad 2$$

The major difference between the path specification in equation (2) and multiple regression specification is the restrained constant term. However, such is theoretically accounted for since the path model framework estimates the error term which according to studenmund (2014) constitute the composition of the constant term.

4. Results and Discussion

Capacity

Capacity has a mean value of 6.75 which suggests that PSPs have moderately high capacity, on average. It is quite important to verify such as Aljohani and Thompson (2021) noted that incorrect assumption about the capacity (size) of the firm may lead to questionable estimate of its effect on profitability. Thus, the averagely high index for firms' capacity indicates its importance and likely effect on the firms' profitability (revenue), as espoused in related studies. The range value of 0 to 10 shows wide variation, capturing both extremes of the data values on company sizes with high sum of 1754 which also emphasizes a

general higher capacity across the sampled PSPs. This could be the result of monitoring by LAWMA where licenses could be revoked if firms lack the requisite minimum trucking fleet (Adam et al., 2015).

Revenue

The mean of revenue is 3.67, which is obviously lower than other variables. In terms of its dispersion, the data just like capacity, ranges from 0 to 10. This shows significant variability despite a lower sum of 955. This sum value in conformity with the low mean reveals many PSPs have lower revenue scores relative to other variables on same scale. Although this may not imply low revenue in absolute terms since some companies scored as high as "10" under revenue while the mode shows that majority scored the average of "5" point on the scale. This is justified in Adam et al (2015) which found that PSPs as at year 2012, earned between ₦600,000 to ₦5,000,000 monthly, depending on whether the firms are allocated to low-income or high-income areas.

Trip Count

This variable has a mean of 5.10 which suggests a moderate number of trips on average, with a minimum value is 2. This shows that no company reported fewer than two trips daily. Besides, a mode value of "5" score and the maximum of 10 score, evidently shows high level of activity by some of the PSPs. The sum of 1325 reflects a relatively high score for trip counts, which further adduces the fact that PSPs were generally active during the time the data was collected. Thus, considering the findings of Aljohani and Thompson (2021), where higher deliveries were associated to higher profit, this variable is expected to profoundly influence revenue. In terms of variability, the dispersion is relatively small as the minimum and maximum score of "2" to "8" do not capture the extremes as the case with capacity and revenue.

4.1 Descriptive Statistics

Table 1: Summary Statistics of all Variables

	CAPACITY	REVENUE	TRIP COUNT	EXPERIENCE
Mean	6.746154	3.673077	5.0961538	4.842307692
Standard Error	0.158571	0.15941	0.0841276	0.125020617
Median	5	3	5	5
Mode	5	2	5	5
Standard Deviation	2.556879	2.570407	1.3565174	2.015896876
Sample Variance	6.53763	6.606994	1.8401396	4.063840214
Kurtosis	-0.83147	1.045433	1.4985751	-0.420010984
Skewness	0.102819	1.301904	0.8250319	0.394185411
Range	10	10	8	8
Minimum	0	0	2	1
Maximum	10	10	10	9
Sum	1754	955	1325	1259
Count	260	260	260	260
Largest(1)	10	10	10	9
Smallest(1)	0	0	2	1
Confidence Level(95.0%)	0.312252	0.313904	0.1656613	0.246186293

Experience

In terms of experience, PSPs on average have mean value of 4.84, suggesting moderate experience levels in the industry. This is further underscored by the sum of experience for all firms which stood at a total of 1259. The value is lower in relative terms to the sum for both capacity and trip count. In addition, although the mode score is “5”, some companies recorded “1” with a maximum of “9” score. This shows that despite Lagos state waste management is said to be the most sophisticated with the largest number of PSPs, most of such private waste collection companies are still learning and thus, further regulating the sector is important to sustain waste collection services. This is important since the variable is found to influence firms’ performance (Cesinger et al., 2018).

Generally, analysis of the above summary statistics reveals significant variability across all variables on solid waste trucking service provision, with capacity being the highest, followed by trip count, experience, and revenue. The wide dispersions in the capacity of PSPs and

their revenue underscore the diversity in their sizes and finances, while experience and trip count show more stability albeit considerable variability. These comparisons avails understanding the dataset thus, creating a foundation for comprehending the outcomes of the empirical analysis that will be further explored on the relationships between these variables and company revenue.

4.2 Discussion of SEM-Based Path Analysis

Based on the path analytic equation specified in the methodology, the following path analysis was estimated using IBM SPSS AMOS 24. The graphic output of the results are shown in Figures 3a and 3b. Figure 3a shows all standardized estimates with the correlations among the independent variables as well as the R^2 while Figure 3b shows all unstandardized estimates with the covariances among the independent variables as well as the error variance which is an estimate of the error term (epsilon).

The SEM-Path analysis results indicate significant relationships between the independent variables (Capacity, Experience, and Trip count) and the dependent variable

(Revenue). The standardized and unstandardized estimates, along with their respective standard errors, critical ratios, and p-values, are presented in Table 2.

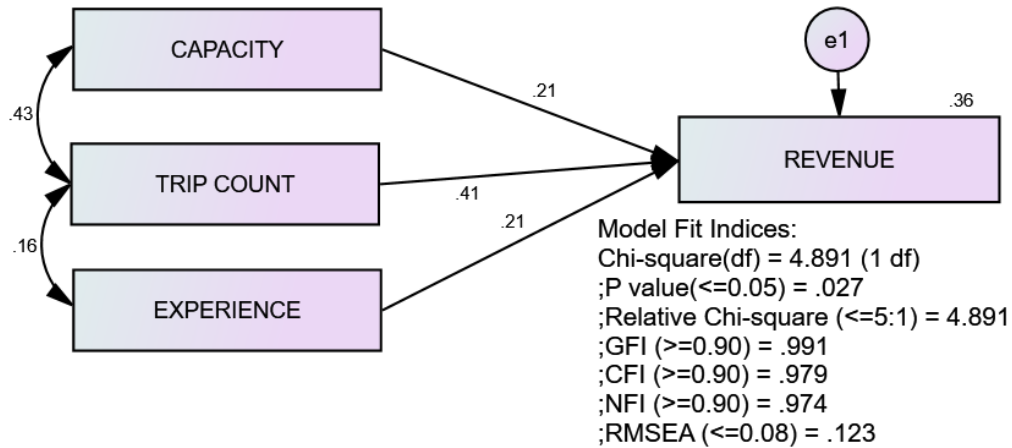


Figure 3a: Standardized estimates of the determinants of PSPs' Revenue

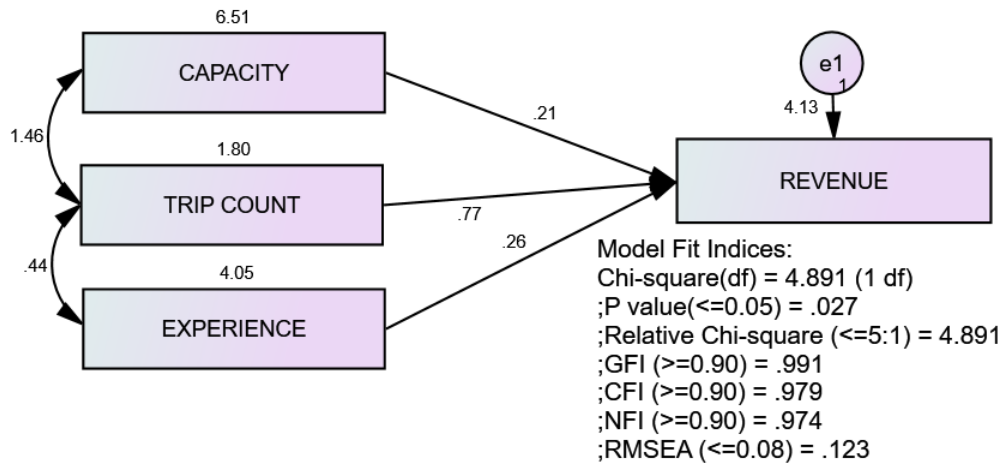


Figure 3a: Unstandardized estimates of the determinants of PSPs' Revenue

Table 2: Standardized and Unstandardized estimates of the determinants of PSPs' Revenue

			Estimated Parameters		S.E.	C.R.	P
			β	B			
REVENUE	<---	CAPACITY	0.212	0.210	0.055	3.799	0.0000
REVENUE	<---	EXPERIENCE	0.206	0.259	0.064	4.017	0.0000
REVENUE	<---	TRIPCOUNT	0.409	0.771	0.106	7.290	0.0000
Correlations/Covariances:							
CAPACITY	<-->	TRIPCOUNT	0.425	1.455	0.230	6.329	0.0000
EXPERIENCE	<-->	TRIPCOUNT	0.164	0.443	0.156	2.846	0.0040
R-Square	0.355						

Note B= Unstandardized. β = Standardized

The findings of the study evident in Table 2 shows that firms' capacity (firm size), experience and trip-count are statistically significant determinants of firms' performance (revenue). Considering the effect of capacity or PSP size on revenue, estimated standardized coefficient is 0.212, and the unstandardized coefficient is 0.210. The critical ratio (C.R.) is 3.799, with a p-value of 0.0000. This indicates that PSPs' capacity has statistically significant positive effect on firms' revenue. This implies that as the capacity of the trucking company increases, the revenue also increases. This conforms to our expectation and the findings by Aljohani and Thompson (2021).

The same is true for firms' experience. The estimated standardized coefficient of the effect of experience on revenue is 0.206, while the unstandardized coefficient is 0.259. These values as shown in Table 2, have equivalent critical ratio (C.R.) of 4.017, and a p-value of 0.0000. The result indicates a statistically significant positive effect of experience on revenue, such that the more a trucking company's experience in the SWM industry, the higher revenue earned by the PSP. Although this conforms with the expectations of this study and the impression of Cesinger et al., (2018), but the study found a rather negative relationship.

Finally, higher trip-count implies increased activity which could increase firms' revenue. In the peculiar outcome of this study, the standardized coefficient of the effect of trip-count on revenue is 0.409, while the unstandardized coefficient is 0.771. The estimates have an associated critical ratio (C.R.) of 7.290, and p-value of 0.0000. The values imply that trip-count have statistically significant positive effect on revenue such that, increase in the number of trips is followed by increase in revenue. The profoundly conforms with the findings of Aljohani and Thompson (2021), which shows that higher trips are associated to higher profits.

In addition, in a demonstration of one of the strengths of path analysis over multiple regression models, correlation and covariances were estimated along with the regression coefficients discussed. These are represented by the double-headed arrows included in Figures 3a, 3b and Table 2, which were specified and simultaneously estimated with the regression coefficients. Accordingly, the correlation between capacity and trip count was estimated as with a correlation coefficient of 0.425 and a corresponding critical ratio of 6.329 with a p-value of 0.0000. This significant positive correlation between the variables indicate that a higher firm capacity is associated with higher

number of truck trips. This is logical since PSPs will larger fleets would conveniently collect waste with higher frequency.

Besides, the correlation between experience and trip count was also explored. The result shows a correlation coefficient of 0.164, a critical ratio of 2.846 with a corresponding p-value of 0.0040. The significant positive correlation implies that PSPs with more experience tend have higher trip count and vice versa. The is logically related to the association between capacity and trip count since more experienced firms are likely to have larger capacity resulting from growth over time. This shows a tripartite correlation. Thus, specifying the third line of correlation between capacity and experience did not yield an interpretable result as the model's result yielded near perfect estimates and Model fit indices.

Finally, the model fit indices provide information about the diagnostics of the estimated results. Traditionally, model fit indices are used in SEM. The R-squared value is 0.355, which indicates approximately 35.5% of all variance in Revenue is explained by the specified independent variables. While this value is moderately low, such is not unusual for cross-section data due to the effect of heteroskedasticity. Other indices assessed and reported in Figures 3a and 3b are the root mean square error of approximation (RMSEA), GFI, NFI, CFI and Relative Chi-Square; all of which fall within the specified threshold, except the value for RMSEA. This further adduces validity to the model.

5. Conclusion and Recommendation

This study examines the determinants of the sustainability of PPP arrangement in in SWM by estimating factors that determine their revenue based on a production function model espoused in economics theory. The SEM-Path analytic model of the determinants of revenue estimated reveals significant relationships between SWM firms' capacity, experience, and trip-count with

revenue. The study thus concludes that all three factors profoundly determine revenue, highlighting their importance in the profitability of PSPs in SWM industry of Lagos State.

To enhance revenue growth, private solid waste collection and transporting firms in Lagos State are thus recommended to expand their trucking fleets through investments in additional trucks and technology for optimized route planning. Also, leveraging industry experience by implementing best practices and training programs for new employees can streamline operations, leading to higher revenues. In addition, the Ministry of Environment and the sector's coordinating organ-LAWMA could help by creating enabling environment for the survival of PSPs by targeting regulatory measures consistent with their expansion, expose them to trainings to leverage experience gaps and put in place measures to deter them from traffic congestion which could limit trip-count. By implementing these recommendations, firms can significantly enhance operational efficiency and revenue, contributing to better waste management practices and environmental sustainability in the state.

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