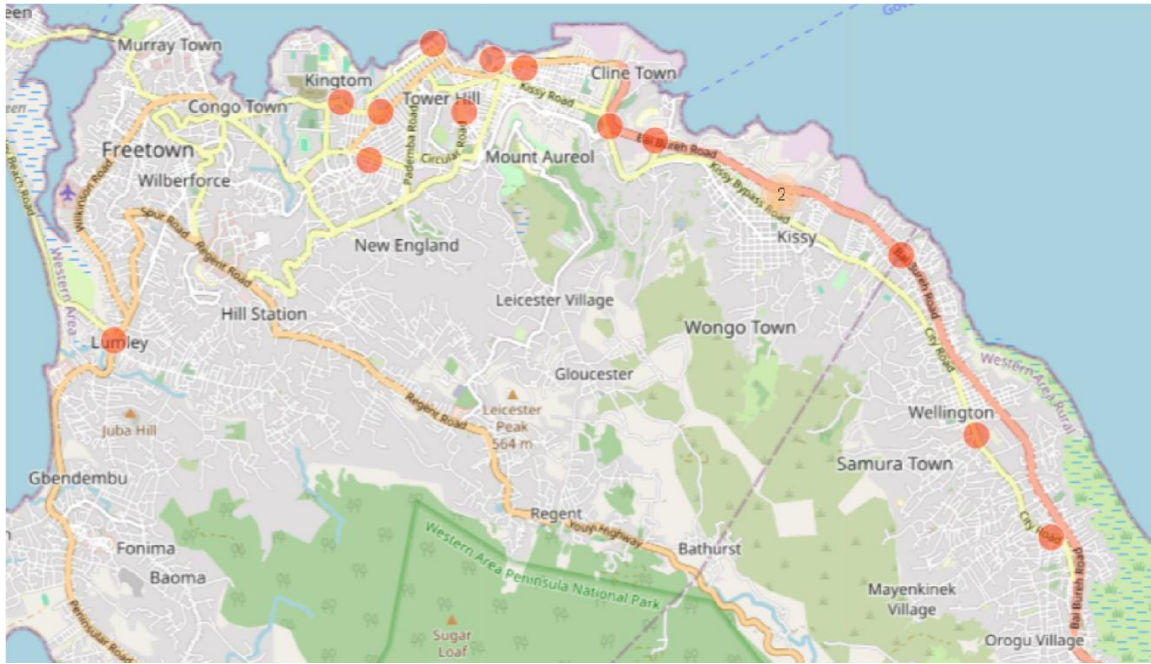# Truth in Weight:

How much does a bag of rice actually weigh?

Assessing Packaged Rice Accuracy in Freetown.

Meraki Analytics
17/12/2024

Overview

- Rice is Sierra Leone' s staple food and a critical part of daily diets. The World Food Programme estimates[1] that the per capita rice consumption in the country is 104 kg per year. This means that the average Sierra Leonean consumes about 104 kg or the equivalent of 2 bags of rice every year. This is one of the highest in West Africa.

- Due to gaps in local production, the country relies heavily on rice imports with a couple of major players responsible for the import and wholesale distribution in the local market.

- Yet, there have been persistent consumer complaints and suspicions about the quantity of rice sold. Nearly 87% of store owners we interviewed say they receive complaints frequently, or once in a while, about the weight/quantity of rice as well as the quality and price.

- In this study, we investigate some of these claims and specifically try to verify whether the net weight of a bag of rice is actually 50 kilograms as indicated on its packaging. We implement rigorous statistical methods including descriptive statistics and hypothesis testing to do this.

- The sample for this experiment consists of **sixty bags of rice** procured from **seventeen** <u>randomly selected</u> retail stores at **fifteen locations** in Freetown. To discover any variances, we focused on two popular brands of 'Pusawa' rice from **two major rice distributors**[2] in Sierra Leone. Using the same weighing scale, we took two independent measurements of the mass (in kilograms) of each bag of rice and computed the average weight per bag.

- We then computed summary statistics and applied hypothesis testing to see if:

  - *the average weight of a bag of rice is lower than the 50 kg specified in a statistically significant way.*

  - *there are any distributor-specific, statistically significant weight differences between the packages from the two suppliers*

Summary statistics

We will start exploring the data by looking at some summary statistics - the **mean, median, standard deviation,** and some **quantiles** and **counts** .

In summary:

- On average, the net weight is 49.45 kg
- The net weight of a full bag should be 50 kg
- The gross weight is typically 49.6 kg
- Ideally, the gross weight should be 50.15 kg
- The weights range from 45.75 kg to 50.2 kg
- The median net weight is 49.85 kg
- Most bags have a net weight of 49.85 kg
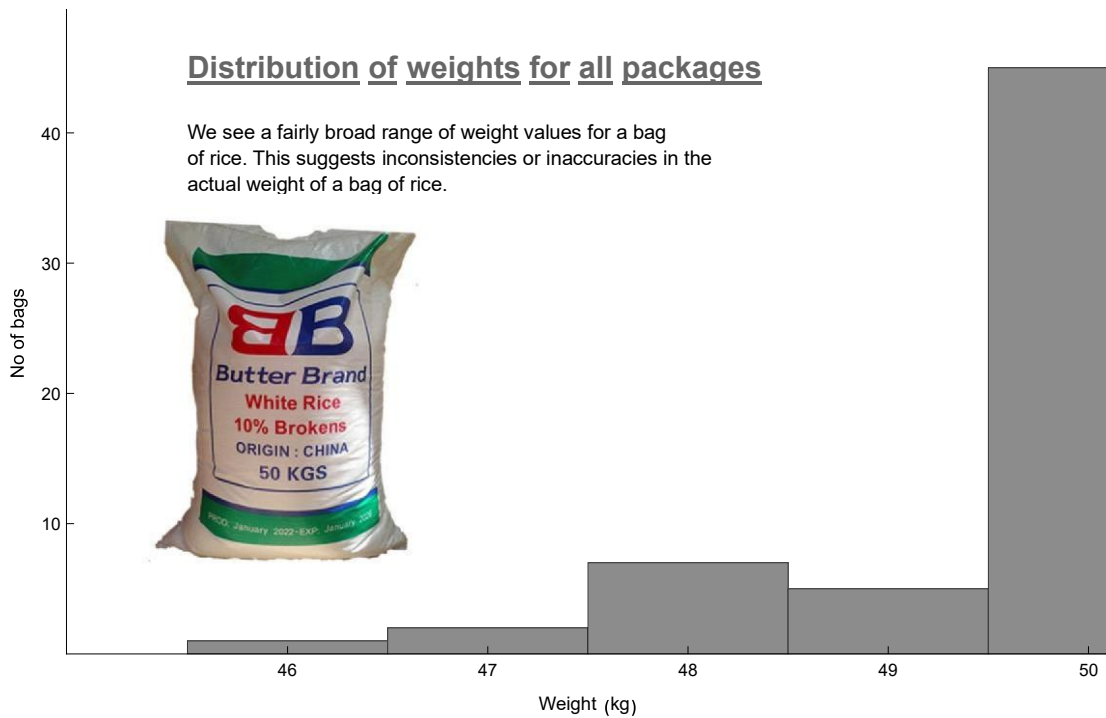- The standard deviation is 0.96 kg.

	Net weight (kg)	Gross weight (kg)
Mean	**49.45**	**49.6**
Standard Deviat ion	0.96	0.96
Min	**45.75**	**45.9**
25%	49.3	49.45
Median	49.85	50.
75%	49.95	50.1
Max	50.2	50.35
Mode	49.85	50.

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[1] https://executiveboard.wfp.org/document_download/WFP-0000108572

[2] We have anonymized the data, so we'll simply refer to these distributors as **Supplier A** and **Supplier B.**

How are the weights distributed?

Let us plot the histogram of the **net weight** for all suppliers:

Distribution of weights for all packages

We see a fairly broad range of weight values for a bag of rice. This suggests inconsistencies or inaccuracies in the actual weight of a bag of rice.

As shown, our assessments found inconsistencies in the net weights which ranged from 45.75 kg to 50.2 kg.

Are there differences between the two suppliers?

A good way to visualize this is by plotting the histograms for each of the two major rice suppliers/distributors side-by-side:
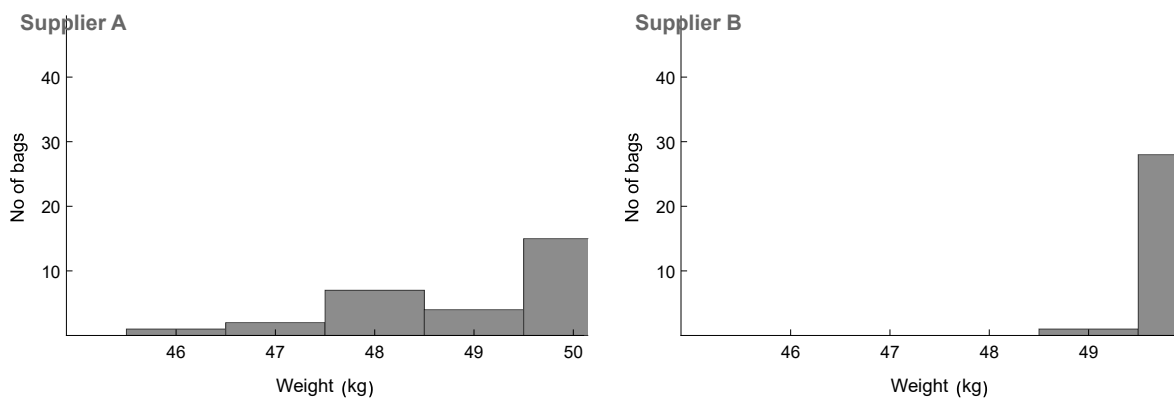
	Average weight (kg)	Median weight (kg)	Standard deviation (kg)	Mode(kg)
Supplier A	49.025	49.6	1.21341	49.85
Supplier B	49.875	49.875	0.185579	49.85

Clearly, the weights of bagged rice from supplier B are more consistent than those from supplier A. In fact, as shown below, while the **average weight** of a bag of rice from Supplier B is **49.875 kg**, it is only **49.025 kg**

among the supplies from <u>supplier A.</u> The standard deviation among packages from Supplier A is also considerably higher than for Supplier B.

So, we have found differences between the weights of rice packages from the two major suppliers. We have also seen that net weight of a bag of rice is lower than the 50 kg specified .

But are these differences statistically significant?

We' ll implement **hypothesis testing** using the **Student' s T Test**, the **Mann-Whitney U Test** and the **Wilcoxon Signed Rank Test** to make these inferences. These tests are appropriate here because:

- ■ Some of the data (Supplier B) approximates a normal distribution well; some (Supplier A) not so perfectly.
- ■ The sample size for each supplier is <= 30
- ■ We don't know the specifications of the standard deviation of weights from the suppliers
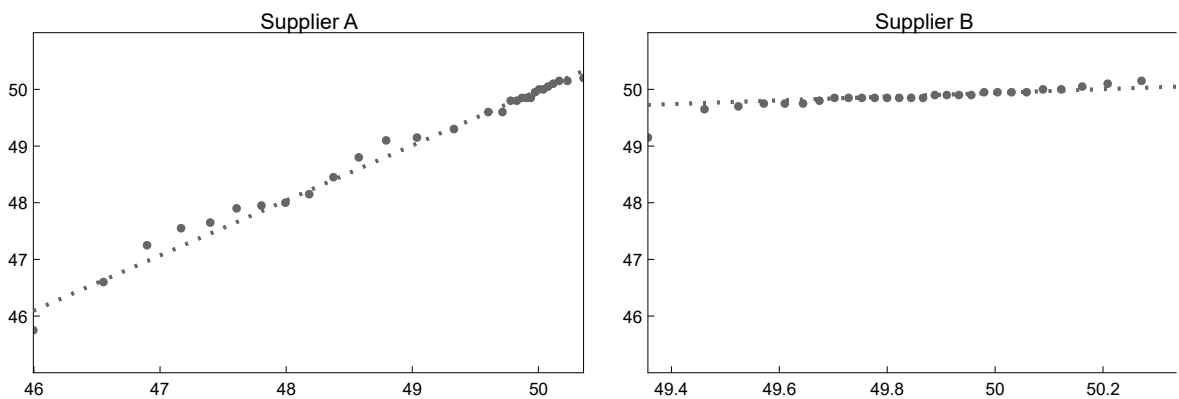
In the **quantile plots** above, most weights from Supplier B are pretty close to the diagonal. This shows that the data approximates the normal distribution very well. The weights from Supplier A show more pronounced fluctuations, indicating inconsistencies in the weight of rice from that distribution channel.

Both **the Student's T Test** (p-value of `0.000538422, significance level 0.01`) and the **Mann Whitney U Test** (p-value of 0.00910192, `significance level 0.01`) reject the null hypothesis that the weights of the rice samples from both distributors/suppliers are the same. In other words, there is strong statistical evidence that the rice samples from Supplier A have less weight than those from Supplier B.

So, is a bag of rice actually 50 kg?

- ▪ The null hypothesis that the average weight of a bag of rice from <u>Supplier A</u> is greater than or equal to 50 kg is rejected at the 1. percent level based on both the **T test** (p-value of 0.0000536679) and the **Signed Rank Test** (p-value of 0.0000569082).

- ▪ Similarly, the null hypothesis that the average weight of a bag of rice from <u>Supplier B</u> is greater than or equal to 50 kg is rejected at the 1. percent level based on the T test.

The very small p - values suggest that we can statistically make the claim that the net weight of a bag of rice sold in Freetown is typically below 50 kg, based on the T Test and the Signed-Rank Test.

Key insights and takeaways

This study reveals significant discrepancies in the weight and quantity of rice distributed and sold in Freetown, with key findings summarized below:

- **Average Net Weight of Rice Bags**

  The average net weight of a 50 kg bag of rice was measured at 49.45 kg, falling short of the specified weight by 0.55 kg

- **Supplier-Specific Discrepancies**

  - **Supplier A:** The weight shortfall for a 50 kg bag of rice is approximately 1 kg, significantly higher than Supplier B.

  - **Supplier B:** The shortfall is 0.125 kg per bag.

  - These differences are statistically significant at the 1% level, indicating a consistent and measurable disparity between the suppliers.

49.0   49.9
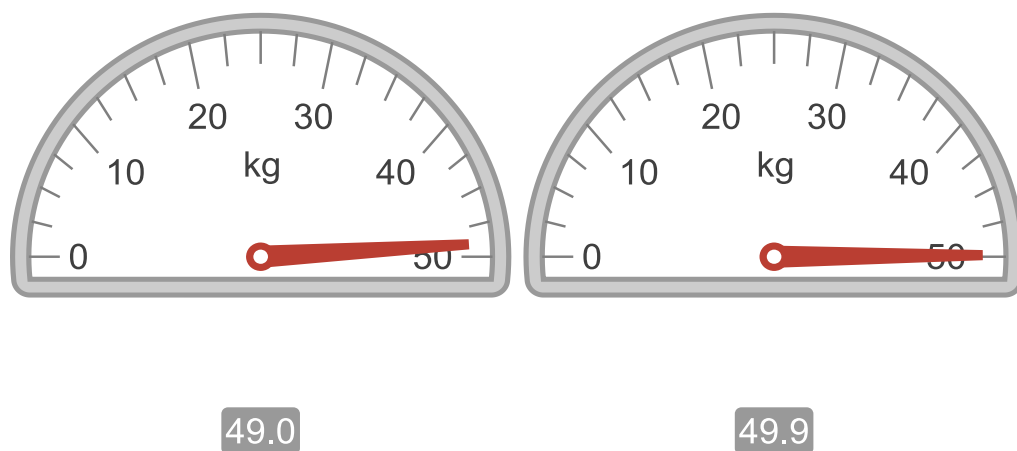
- **Implications of Weight Shortages**

  - Supplier A: **For every 50 bags** of rice purchased, consumers lose the equivalent of **1 bag**.

  - Supplier B: Consumers lose **1 bag** for every **400 bags** purchased.

- **National Impact**

  - With Sierra Leone's annual rice consumption estimated at 988,000 metric tonnes (988 million kilograms), procuring all rice from Supplier A would result in a loss of approximately 19.8 million kg annually, equivalent to about 395,200 bags.

  - The monetary value of this loss is approximately **NLe 367,536,000** per year.

These findings highlight the urgent need for stricter regulatory oversight and quality control measures in the rice distribution chain to safeguard consumers from significant financial and nutritional losses.

How can stakeholders protect consumers?

Recommendations on Enhancing Packaging and Quality Control in the Rice Distribution Chain

0.0.1. **Transparent and Tamper - Evident Packaging:** *Packages from Supplier B utilize transparent bags designed to break if tampered with, thereby reducing the likelihood of pilferage during transit. Conversely, Supplier A employs woven bags that are more susceptible to tampering and theft. Adoption of tamper - evident packaging across all suppliers is strongly recommended to improve product security.*

0.0.2. **Mandatory Use of Weighing Scales in Retail:** *The Ministry of Trade, in collaboration with the Standards Bureau and the Consumer Protection Agency, should enforce regulations requiring all rice retail outlets to utilize weighing scales. This will ensure accurate measurements and enhance consumer confidence in the fairness of transactions.*

0.0.3. **Strengthened Quality Control Across the Supply Chain:** *Distributors should implement robust quality control mechanisms at all stages of the rice distribution process, including packaging, warehousing, and transit. This will help maintain product integrity and minimize losses.*

0.0.4. **Verification of Consignment Weights by Retailers:** *Retailers should routinely verify the weights of a representative sample from all incoming consignments. This practice will serve as an additional safeguard against discrepancies in weight and prevent distribution of short - measured products to consumers.*

These measures could greatly enhance efficiency, accountability, and trust throughout the rice supply chain in Sierra Leone.

References

0.1. https://riceforafrica.net/sierra-leone-january-2023/

0.2. https://executiveboard.wfp.org/document_download/WFP-0000108572

About Meraki Analytics

Meraki Analytics (SL) Ltd. is a data and technology consulting firm that specializes in high impact research, technical evaluation, training, digital data collection, and advanced analytics. We provide an integrated approach to data discovery, mobilization, and analysis through the application of relevant knowledge and tools that transform data into useful insights and help our clients make impactful decisions.

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