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Significance of Subsidiaries for Improving Financial Performance in the Sugar Industry: A Quantitative Analysis on Carew & Co. (Bangladesh) Limited

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Abstract: *Sugar cane stands out as a plant that is very effective at converting solar energy into biomass and sugary substances. It is a plentiful supply of fuel, chemicals, fodder (green cane plant leaves and tops, bagasse, molasses, and to some extent press mud), food (sucrose, jaggery, and syrup), fibre (cellulose), and other nutrients. Bagasse, molasses, and press mud are the principal byproducts. Gud, sukker, or khandeswari, made from sugarcane, has been a traditional sweet in Bangladesh since ancient times. These sweeteners can also be made from palm and date juice. The study's objectives are to investigate the significance of subsidiaries in improving the sugar industry's financial performance. Multiple regression analyses has been used to evaluate the sugar industry's economic success based on secondary data. After accounting for the losses of other units, such as sugar and agro-firms, the analysis has found that the distillery unit dramatically increases net profit every financial year. The sugar division and the agro-farm units have positive impact on the net profit because losses from the sugar division and the agro-farm unit reduce day by day. The fertilizer unit also generates an adequate profit, which helps to prevent other units, such as sugar and agro-firms, from going bankrupt. The government and policymakers use this example as a benchmark for developing policies that address the government's losses in other sectors and transform them into profitable ones.*

Keywords: *Byproduct, sugar mills, distillery unit, cost minimization and sugarcane.*

1. Introduction

Sugarcane cultivation in the ancient region of Bangladesh has a long history. The Persian traders first introduced it in India in the 6th century AD (Reza, Riazi, and Khan 2016). Commercial sugar production in Bangladesh began during the

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colonial period, with Portuguese traders establishing sugar factories in the 16th century. The industry is vital to the country's economy, employing millions and contributing to the agricultural GDP (Rahman, Khatun, and Rahman, 2016; Kumar, 2019; Kumar, Adhikari, and Kumar, 2020). However, the industry has faced challenges, including low sugar production and poor recovery rates (Rahman & Kumar, 2018). The Indian sugar industry, which is a significant contributor to the country's socio-economic development, provides a potential model for the development of the Bangladeshi industry (Solomon, 2016). In the 16th century, Portuguese traders founded sugar factories in Chittagong. The sugar industry has been nationalized since Bangladesh gained independence, and the responsibilities to administer all the sugar mills in Bangladesh have been given to the Bangladesh Sugar and Food Industries Corporation (BSFIC).

Sugar occupies an important place in the industrial sector of Bangladesh, employing over 5 million people and contributing 0.74% of agricultural GDP in 2010, though, the industry has been running at a loss since the mid-1980s. Consequently, the government has shut down the Setabganj Sugar Mill in Dinajpur, the Panchagarh Sugar Mill, the Shyampur Sugar Mill in Rangpur's Badarganj upazila, the Pabna Sugar Mill, the Kushtia Sugar Mill, and the Rangpur Sugar Mill in 2020 due to ongoing losses. Nine state-run mills currently use sugarcane crushing to create sugar, and have produced 24,509.75 metric tonnes where the expectation was to produce 50,000 metric tonnes (Shakil, 2022). Production levels, owing to inefficiencies, mismatched raw material demand, antiquated technology, and low cane extraction rates, production levels fall well short of installed capacity. The average extraction rate is 8–9%, varying depending on factors like sugarcane quality, milling technology, and operational efficiency (Sabur, et al., 2023).

2. Overview of Carew & Co. (Bangladesh) Ltd

Carew & Co. (Bangladesh) Ltd., established in 1938, is a notable factory among Bangladesh's 15 sugar mills. Founded by Rozer Carew, the mill began crushing sugar cane in 1938 and later expanded to 150 million tons. The mill became a public corporation in 1968, after the government's privatization of the industrial sector. Following the liberation struggle, the government nationalized it in 1972, handing management to Bangladesh Sugar Mills Corporation, later known as BSFIC.

From 1990 to 1991, the Bangladesh Sugar and Food Industry Corporation (BSFIC) planned to enhance sugar cane crushing capacity from 10,000 to 11,500 metric tons. Launching an extension programme in 1951 led to the establishment of a pharmaceutical plant capable of producing 90,000 liters. The mill continues to progress with the help of sugarcane cultivators and the management committee's efforts.

The mill consists of six equipment units: a sugar-producing unit, a distillery, a pharmacy, a commercial farm, an akundabaria farm, and a composite fertilizer factory. The distillery and compound fertilizer facilities are the only lucrative

ones. Molasses, bagasse, and press mud are used to make alcohol and liquor. The distillery unit produces 8,00,000 litres of denatured spirit, 26,00,000 litres of country spirit, and 10,80,000 proof litres of alcohol. The mills make the most money from alcohol, manufacturing brands such as Yellow Level Malted Whisky, Gold Ribbon Gin, Fine Brandy, Cherry Brandy, Imperial Whisky, Orange Curacao, Tsarina Vodka, Rosa Rum, and Old Rum. At the time of COVID, the Carew and Co. (Bangladesh) Ltd., a state-run sugar mill, has developed vinegar to prevent COVID-19 (Bangladesh Post, 2022).

In a joint manufacturing process, the main product is an output that significantly contributes to the net realizable value (NRV), whereas by-products are goods recovered from materials wasted in the main process or from the creation of certain key products. A variety of industries, including soft drinks, convenience foods, fast food, candy and sweets, confectionery, and baking products, use sugar as their major product. By-products, such as molasses and bagasse, are secondary or subsidiary products that arise from the manufacture of the primary product. Biotechnology can transform sugarcane byproducts into valuable goods for the production of sugar cane and other crops. Interest in biocontrol has increased due to its potential to combat insects and epidemics by focusing on harmful bacteria and germs.

Sugar mills use bagasse, the fibrous substance left over from extracting juice from sugarcane stalks, as a captive fuel, a raw material for paper mills, and a biofuel. Various mills in countries like Australia, Brazil, and Mauritius burn bagasse to produce steam, which powers sugar refineries (Deepchand, 2005). Compostable and biodegradable food service goods, clay-based green construction bricks, sugarcane bagasse ash, long-lasting acoustic absorbers, effective bio sorbents, and wastewater management products can also make use of bagasse (Kumar, Hasan, and Pathak, 2016). For example, bagasse is an effective absorber of common pollutants found in synthetic wastewater, including chromium, cadmium, copper-nickel, and pigments (Meena et al., 2020). Particleboard (Chakraborty & Priya, 2020) and fiber board (Almazan, 1994) both use bagasse as a building material. Recently, Muttil et al. (2014) used bagasse to make panels, both for the resin and the fibers in the board.

Press mud, a solid byproduct of sugar cane processing, is an excellent source of potassium, salt, phosphorus, and organic material. Bio-earth, which serves as a foundation material. In Bangladesh, press mud is an important fertilizers and organic carbon source for maintaining soil fertility and promoting crop cultivation. In India, bio composting has become popular (MDiaz, 2016; Partha & Sivasubramanian, 2006). Press mud can serve as plant fertilizer and animal feed due to storage concerns (Dotaniya & Datta, 2014).

Manufacturers use molasses, a byproduct of sugar manufacture, to produce alcohol, yeast, cow feed, citric acid, glutamine, and bovine feed. India has traditionally used it to make rectified spirits and alcohol, as it comprises around 50% sugar. Technological advancements have made it possible to utilize it for the production of bio-ethanol, which when combined with gasoline, can create

fuel. Molasses production is cyclical, occurring every three to five years (Inamdar, 1994), affecting dependent industries and necessitating precise forecasting and planning.

Absolute alcohol is the chemical ingredient in alcoholic beverages, while foreign liquor refers to domestically made hard liquor. Historically, people have used acetic acid, a byproduct of sugarcane production, in pickling, cuisine, industry, medicine, and the home. Ethanol, a byproduct of sugarcane processing, is a biofuel that can replace gasoline. One acre of sugarcane produces 4000 liters of ethanol per year, with a 5% mix resulting in higher liter-mileage, fewer environmental pollutants, and a longer engine life. Ethanol's ability to knock quickly enhances engine life, making it a valuable resource in many industries.

3. Literature Review

This study has explored the various aspects of the sugar industry and its byproducts, including bagasse, molasses, ethanol, spent wash, press mud, and trash from secondary sources. Alcohol production and the preparation of food and animal feed use molasses, a commercially significant byproduct. Yeast dilutes the fermentable sugars in molasses with water and ferments them. After fermentation, the spent wash contains lower-order sugars, water-soluble amino acids, lignin, and other organic fractions that remain unfermented. Processing sugarcane entails cleaning and sugar extraction, followed by treatment, concentration, and sterilization (Chen & Chou, 1993). Mills extract sugar from juice, treat, clarify, and dewater it before crystallizing and centrifuging it.

Reza, Riazi, and Khan (2016) found that producing sugarcane benefits farmers, and intercropping boosts profit margins. However, high input costs, low output prices, payment delays, and a lack of scientific knowledge consider as major problems in sugarcane production (Nazir, Jariko, and Junejo, 2013). Haider, Ahmed, and Mallick (2011) found that farming experience and credit availability positively affect profitability and productivity of sugar industries. Redefining and redesigning credit instruments are necessary for long-term sustainability. The use of fertilizer, insecticides, and seed significantly affects sugarcane production, with seed having a negative impact. Tilling and insecticides have a positive impact on sugarcane output with intercrop, whereas human labor is somewhat unfavorable.

Dotaniya and Datta (2014) found that using sugarcane industry byproducts reduces fertilizer doses and improves soil organic matter during crop production. These byproducts alongside commercial fertilizers, or use them in combination with inorganic chemical fertilizers, molasses, and press mud are the three principal byproducts of sugarcane production. Sugarcane businesses use bagasse, a fibrous residue, as fuel and burn it to produce ash. In Ethiopia 2.7 million tons of leftover bagasse produces annually, which serves as biomass for ethanol production (Berhanu, Jabasingh, and Kifile, 2017). Further fermentation processes include distillation and dehydration. However, Ethiopia has not significantly utilized this waste, prompting an essay on how sugarcane

byproducts can help reduce climate change (Habte, Mulatu, and Ahn, 2018). Akhtar et al. (2017) suggests that developing nations can reap benefits from the sustainable utilization of sugarcane industry byproducts, particularly press mud and bagasse fly ash. In the sugar industry, the combination of inorganic fertilizers and compost can reduce solid waste and air pollution problems.

Bangladesh's agriculture industry, particularly sugarcane, can boost revenue and employment by providing long-lasting cash crops. Sugarcane byproducts can be used for wood, fuel, cement replacement, soil mitigation, water and wastewater treatment, and soil treatment (Sarker, Rahman, and Rupa, 2018). Hossain (2021) found that Bangladesh's sugar mills faced uncompetitive production costs due to high production costs. The removal of import restrictions on inexpensive sugar has worsened their situation, leading to increased losses for state-owned sugar enterprises. Raza et al. (2021) suggested that proper, organized disposal of sugar industry byproducts in agriculture is crucial for raising awareness and fostering goodwill between farmers and industrialists. Ungureanu, Vlăduţ, & Biriş (2022) discussed a sustainable sugarcane processing process and analyzed waste and byproducts. They emphasized the potential for valorizing each waste and by-product to produce biofuels and other products, thereby contributing to global environmental, agricultural, and human health sustainability.

Many academics and professionals in Bangladesh have explored the various uses and possible advantages of byproducts, in addition to the intricacies and difficulties related to the sugar industry only. Therefore, it is crucial to explore the ability of sugarcane industry to transform and improve the sector's overall operations. This study provides an in-depth understanding of the various ways that Carew & Company Bangladesh Limited's business units contribute to the company's overall profitability and financial stability. In order to enable management and stakeholders to make more informed decisions that will improve profitability and sustainability across all business divisions, the study intends to give them a better understanding of the company's financial dynamics.

4. Objectives of the Study

The objectives of the study are to:

- ✓ Evaluate the correlation between the net profit and loss of Carew & Company Bangladesh Limited's distillery unit and the company's overall net profit and loss, and determine if they move together.
- ✓ Observe the relationship between Carew & Company Bangladesh Limited’s net profit and loss and that of its sugar unit to see if they are positively correlated.
- ✓ Examine the connection between Carew & Company Bangladesh Limited's net profit and loss and the net profit and loss of its fertilizer unit, and determine whether there is a positive link.
- ✓ Study the correlation between the net profit and loss of Carew & Company Bangladesh Limited's Agro-Firm unit and the company's total net profit and loss, and determine whether they are definitely correlated.

5. Hypothesis of the Study

H_1: Carew & Company Bangladesh Limited's distillery unit's net profit and loss and the company's overall net profit and loss are positively correlated.

H_2: Carew & Company Bangladesh Limited's net profit and loss and the net profit and loss of its sugar unit are positively correlated.

H_3: Carew & Company Bangladesh Limited's net profit and loss and the net profit and loss of its fertilizer unit are positively correlated.

H_4: The net profit and loss of Carew & Company Bangladesh Limited's Agro-Firm unit and its net profit and loss are positively correlated.

6. Methodology of the Study

6.1 Research Design

In Bangladesh, fifteen sugar mills are now operational. Carew & Company (Bangladesh) Limited is one of the top sugar mills out of these fifteen due to its significant size and the presence of Bangladesh's sole distillery unit. This study uses a quantitative research design to examine the performance and financial health of Carew & Company (Bangladesh) Limited. Multiple regression analysis has been utilized to assess secondary data gathered from diverse sources, aiming to uncover significant predictors of the business's financial performance.

6. 2 Data Collection

6.2.1 Period of study and sources of data

The study has been conducted between 2001 and 2021. The secondary data was collected from a variety of sources, including Carew & Company (Bangladesh) Limited's published annual reports, books, journals, and articles pertinent to the sugar industry and financial analysis; seminar papers; publications from national and international research institutions; reports from financial institutions; public records and statistics; and more.

6.2.2 Data Variables

The net profit of Carew & Company (Bangladesh) Limited is dependent variable to assess the company's financial health. Net profits for several business divisions or product lines, on the other hand, are considered independent variables.

6.3 Data Analysis

6.3.1 Data Preprocessing with R Software

The researcher preprocessed the acquired data using R software before performing multiple regression analysis. This includes using descriptive statistics to comprehend the distribution and summary of the data, as well as data cleansing to deal with outliers and missing numbers.

6.3.2 Multiple Regression Analysis

To investigate the link between the dependent and independent variables, multiple regression analysis has been done. The model can be shown as follows:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+...+\beta_nX_n+\epsilon$$

Where:

Y =Net profit of Carew & Company

$X_1, X_2,...X_n$ = Independent Variables

$\beta_0, \beta_1, \beta_2,...\beta_n$ = Regression coefficients

ϵ = Error term

6.3.3 Diagnostic Tests of Regression

After the multiple regression analysis, the researcher has run the following diagnostic tests to confirm the assumptions of the regression model:

Normality: Used Q-Q plots and the Jarque Bera test to determine whether the error terms have a normal distribution.

Homoscedasticity: Used the Breusch-Pagan test and the residual vs. fitted values plot to ascertain the error terms' constant variance.

Independence: Used the Durbin-Watson test to determine whether the error terms are independent.

Non-collinearity test: Used Multicollinearity Diagnostics (VIF) to determine the autocorrelation between the independent variables.

Model fitness: Used residual value to determine the perfect fit of the model. The mean value of residuals is zero, suggesting that the regression line goes precisely throughout all of the data points, implying that the model fits the data perfectly.

7. Data Analysis and Interpretation of the Data

7.1 Descriptive Analysis of the Carew & Company Bangladesh Limited

The distillery sector of *Carew & Company* has the highest average net profit of $4375.91, while the bio fertilizer sector has a somewhat disappointing average net profit of -$31.79. The sugar industry and agri. units both had negative average net profits of -$3117.42 and -$207.87, respectively. The average net profit for all sectors is around $1160.68.

The distillery sector of *Carew & Company* has a median net profit of $4360.36, and the general net profit is $1109.36, the bio fertilizer sector has a median of -$50.61, the sugar sector has a median of -$2685.00, and the agri. unit has a median of -$155.95. These median net profit values closely mirror the mean values.

The standard deviation represents the variability or dispersion of net profit figures. The distillery sector has the most variation, with a standard deviation of $3236.45, followed by general net profit, which has a standard deviation of $999.95. The standard deviations for the bio fertilizer, sugar, and agri-units are $51.91, $2495.80, and $149.93, respectively.

Table 1: Represent the descriptive analysis

	Net profit	Net profit distillery	Net profit bio fertilizer	Net profit sugar	Net profit agri-unit
Mean	1160.68	4375.91	-31.79	-3117.42	-207.87
Std. dev	999.95	3236.45	51.91	2495.80	149.93
Min	-259.87	574.40	-98.56	-7086.25	-489.28
Q1	427.97	1262.08	-71.61	-4908.22	-326.64
Median	1109.36	4360.36	-50.61	-2685.00	-155.95
Q3	1894.89	5971.91	18.60	-777.97	-74.09
Max	4044.79	10397.62	32.88	-291.61	-12.08
MAD	1030.33	4455.52	71.09	2828.19	136.78
IQR	1466.92	4709.83	83.82	4130.25	252.55
CV	0.86	0.74	-1.63	-0.80	-0.72
Skewness	0.93	0.36	0.08	-0.34	-0.53
SE.Skewness	0.50	.50	0.79	0.50	0.50
Kurtosis	0.90	-1.32	-1.99	-1.55	-1.30

The standard deviation represents the variability or dispersion of net profit figures. The distillery sector has the most variation, with a standard deviation of $3236.45, followed by general net profit, which has a standard deviation of $999.95. The standard deviations for the bio fertilizer, sugar, and agri-units are $51.91, $2495.80, and $149.93, respectively.

The range of net earnings varies greatly between sectors. The distillery industry has the highest maximum net profit of $10397.62 and the highest minimum net profit of $574.40. On the other hand, the sugar industry has the poorest net profit of -$291.61 and a maximum net profit of -$7086.25.

The interquartile range (IQR) measures the dispersion of the middle 50% of data. The distillery industry had the highest IQR ($4709.83), showing a broad range of net earnings within the sector. The overall net profit has an IQR of $1466.92, the bio fertilizer sector has an IQR of $83.82, the sugar sector has an IQR of $4130.25, and the agricultural unit has an IQR of $252.55.

The coefficient of variation (CV) is a normalized measure of dispersion around the mean. A greater CV suggests more relative variability. The general net profit has the greatest CV (0.86), followed by the distillery industry (0.74). The bio fertilizer sector has a negative CV of -1.63, suggesting that the standard deviation exceeds the mean, as do the sugar sector and the agricultural unit, which have CVs of -0.80 and -0.72, respectively.

Skewness assesses the asymmetry of a data distribution. A positive skewness implies that the data is biased to the right, whereas a negative skewness suggests

that the data is biased to the left. The general net profit, distillery industry, and bio fertilizer sector all show positive skewness, indicating a right-skewed distribution. The sugar industry and the general agricultural unit have negative skewness, indicating a left-skewed distribution.

Kurtosis calculates the "tailedness" of a data distribution. A positive kurtosis suggests a distribution with large tails and a sharp peak, whereas a negative kurtosis indicates a distribution with small tails and a flat peak. The net profit has a kurtosis of 0.90, indicating a mesokurtic distribution. The distillery sector, bio fertilizer sector, sugar sector, and general agriculture unit all have negative kurtosis values, implying platykurtic distributions.

In conclusion, the distillery industry has the highest average and fluctuation in net profit, whereas the bio fertilizer sector has the lowest variability but also the lowest average net profit. The sugar industry and the overall agriculture unit both have negative average net earnings and left-skewed distributions with platykurtic shapes.

7.2 Graphical presentation of the profit scenario of the Carew & Company Bangladesh Limited.

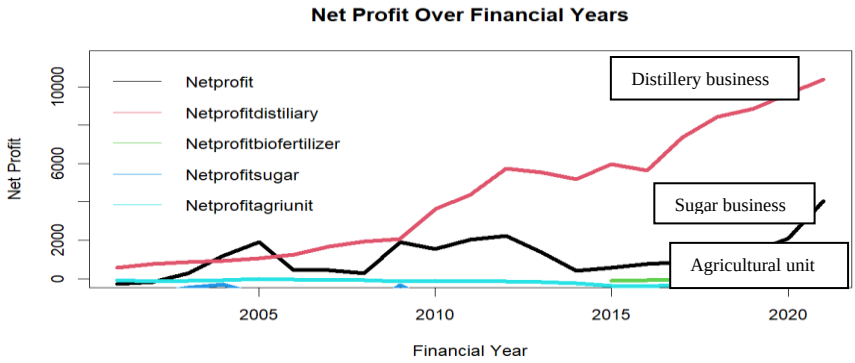

Figure 1: Represent the sequence plot of net profit of the Carew & Company Bangladesh Limited.

The graph displays the net earnings for multiple divisions of company or product lines from 2005 until the end of 2020. The black line illustrates Carew & Company Bangladesh Limited's total net profit. The graph illustrates that the company had an adverse value in 2001 and 2002 before transforming positive in 2003. It has been gradually rising over the years, with significant highs in 2005 and 2009, as well as substantial growth after 2014. By 2021, the net profit had risen substantially and achieved a high. The distillery business (pink line) began with a negative net profit in 2001 and 2002, but soon turned positive after 2003.

The distillery business (pink line) started with a negative net profit in 2001 and 2002 but quickly turned positive from 2003. There is a substantial increase in profits from 2004 to 2007, followed by fluctuations. The business demonstrates a significant rise from 2014 onwards, with a sharp increase in 2021. The bio

fertilizer sector started with a negative net profit and remained negative until 2004. From 2005 onwards, there has been steady growth, with fluctuations in between. By 2021, the business shows a positive net profit, although not as high as the other units. The sugar business (Blue line) starts with a negative net profit and remains negative until 2009. There's substantial growth from 2010 to 2014, followed by fluctuations. The business demonstrates a significant rise from 2018 onwards, with a considerable increase in 2021.The agricultural unit (cyan line) starts with a negative net profit and remains negative until 2008. From 2009 onwards, there's a consistent growth, with minor fluctuations. By 2021, the business shows a positive net profit but remains the lowest among the categories.

Overall, the graph suggests that the distillery business has been the most profitable over the years, with a significant increase in net profit, while the agricultural unit has been the least profitable with little to no growth. The overall net profit trend seems to be influenced heavily by the distillery's performance, given its dominant rise compared to the other categories.

7.3 Regression analysis to demonstrate how Carew & Company Bangladesh Limited's net profit is affected by its distillery, bio fertilizer, sugar, and agricultural divisions.

Table 2: Represent the result of multiple regression

lm (formula = Net profit ~ Net profit distillery + Net profit bio fertilizer + Net profit sugar + Net profit agri-unit)

Residuals:

1	2	3	4	5	6	7
-5.7118	3.8518	2.7287	0.6831	-2.4945	1.5062	-0.5635

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	38.072236	36.171373	1.053	0.40295
Net profit distillery	0.997361	0.003630	274.751	0.0000132 ***
Net profit bio-fertilizer	1.057472	0.106789	9.902	0.01004 *
Net profit sugar	1.000957	0.003939	254.123	0.0000155 ***
Net profit agri-unit	1.016370	0.045938	22.125	0.00204 **

Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**

Residual standard error: 5.665 on 2 degrees of freedom (14 observations deleted due to missingness). Multiple R-squared:1, Adjusted R-squared:1

F-statistic: 6.847e+04 on 4 and 2 df, p-value: 0.0000146

Table 2 depicts the analysis findings, which reveal a substantial association between Carew & Company Bangladesh Ltd.'s net profit and the net profits of its subsidiaries, which include the Distillery Unit, Bio-Fertilizer, Sugar Unit, and Agricultural Firm Unit.

The model's overall p-value is 0.0000146, and its F-statistic is 6.847e+04. This

suggests that the model is statistically significant as a whole.

At the 0.00 significance level, distillery net profit is statistically significant. Specifically, the model output coefficient indicates that, when all other factors are held constant, a rise of one unit in distillery net profit is linked to an average increase of 0.997361 units in net profit.

At the 0.01 significance level, net profit bio fertilizer is statistically significant. Specifically, the coefficient derived from the model output indicates that, if all other factors remain same, an increase of one unit in net profit bio-fertilizer corresponds to an average gain of 1.057472 units in net profit.

Net profit sugar has statistical significance at the 0.00 significance level. In particular, the coefficient produced from the model output shows that an average gain of 1.000957 units in net profit corresponds to a one-unit rise in net profit sugar, assuming all other factors stay the same.

At the 0.001 significance level, net profit as an agricultural unit has statistical significance. Specifically, the coefficient derived from the model output indicates that, under the assumption that all other variables remain constant, an average increase in net profit of 1.016370 units equates to a one-unit rise in net profit agri- unit.

It demonstrates that the alternative hypothesis H_1, H_2, H_3, and H_4 are acceptable. As a result, Carew & Company Limited's net profit and loss in Bangladesh are significantly related to the net profits and losses of the distillery, sugar, bio-fertilizer, and agro-firm units.

The regression analysis summary includes information about the regression model's goodness-of-fit. The correlation coefficient (R) represents a perfect correlation between the independent and dependent variables. An R^2 score of 1.000 implies that the independent factors fully explain the dependent variable's variance. A modified R^2 value of 1.000 ensures a flawless fit, and the predictors explain all of the variability. The regression model is highly significant ($p < 0.05$), suggesting that at least one predictor has a non-zero effect on Carew & Company Bangladesh Ltd.'s net profit.

The residual standard error measures the average distance that the observed values fall from the regression line. The observed values fall an average of 5.665 units from the regression line**.**

The following multiple linear regression equation infer from the model is output:

Net profit of Carew & Company Bangladesh Ltd. = 38.072 + 0.997 * (Net profit of Distillery Unit) + 1.057 * (Bio-Fertilizer) + 1.001 * (Sugar Unit) + 1.016 * (Agricultural Firm Unit).

7.4 Diagnostic tests of Regression analysis

7.4.1 Jarque Bera test for identifying the normality of residuals

The results of the Jarque Bera Test show that the X-squared is 0.57357, the df is 2, and the p-value is 0.7507. Given that the p value in the current study is more

than 0.05, the null hypothesis—that is, that the residuals are normally disturbed—is not successfully rejected.

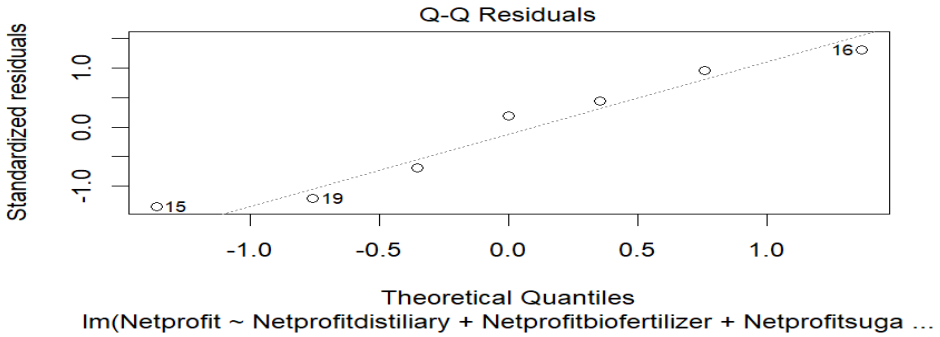

Figure 2: represent the standard residuals and theoretical quantiles

7.4.2 Breusch-Pagan test for determining the heteroscedasticity

At every level of the predictor variable, the residuals are assumed to be distributed with equal variance, which is one of the fundamental premises of linear regression. Homoscedasticity is the name given to this presumption.

Using R software, the Studentized Breusch-Pagan test result shows that the p-value is 0.3278, the df is 4, and the value of BP is 4.6265. Thus, the null hypothesis cannot be rejected. In other words, there is homoscedasticity among the residuals.

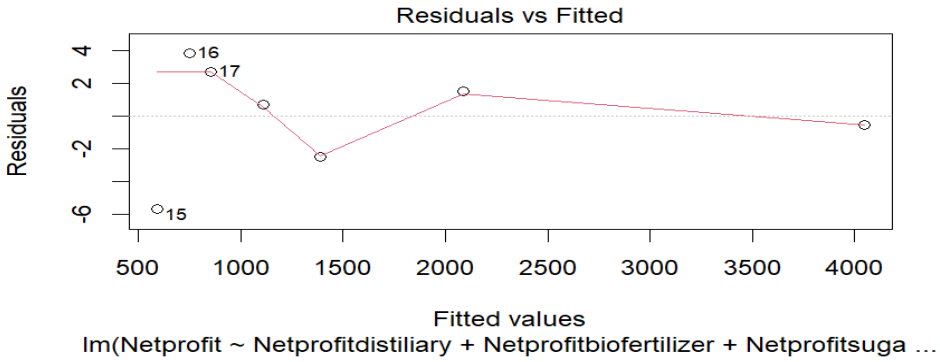

Figure 3: represent the residuals and fitted values

7.4.3 Durbin-Watson test for detecting the autocorrelation

The Durbin-Watson test result indicates DW = 1.9833 and p-value = 0.05186, which indicates that the null hypothesis—that is, that there is no correlation among the residuals. Thus, null hypothesis cannot be rejected.

7.4.4 Model fitness

According to the R software, the mean value of the residuals is 0.00000000000000004440892. That is, it validates a key assumption of linear regression. The regression line runs precisely across all of the data points, indicating that the model fits the data properly.

7.4.5 Non-collinearity test

Given that multiple regressions are being used in this study, it is imperative to understand that if the independent variables have a high degree of correlation with one another; it will be challenging to determine the genuine correlations between the independent and dependent variables.

Table 2: Represent the Individual Multicollinearity Diagnostics Result

	VIF
Net profit distillery	8.019444
Net profit bio-fertilizer	5.746103
Net profit sugar	3.284591
Net profit agri-unit	1.621015

It can be observed from the R software that the independent variable's VIF value is less than the threshold of 10 **(**Hair et al., 1998; Pallant, 2010**)**. It follows that there isn't a significant multicollinearity issue.

In summary, all of the regression analysis's diagnostic tests were satisfied by multiple regression analysis. Therefore, the model created for this study is appropriate.

Major Findings

The diagrams indicate that Carew & Company Bangladesh Limited's net profit increased despite its lack of revenues from FY 2001–2002 and FY 2002–2003. The distillery unit significantly increases net profit each fiscal year to compensate for the losses experienced by other units, including the sugar and agro-firm units. Annual losses in profitability are observed in both the sugar business and the agro-farm unit. The fertilizer unit's considerable profit has a positive impact on other units, including sugar and agro-firms, which experience less loss. The bio-fertilizer unit was ultimately operational in 2015 and 2016.

The regression study reveals a strong relationship between Carew & Company Bangladesh Ltd.'s net profit and its subsidiaries, which include the Distillery Unit, Bio-Fertilizer, Sugar Unit, and Agricultural Firm Unit. It shows that at the 0.00 significance level, distillery net profit increases by 0.997361 units. At the 0.01 significance level, net profit of the bio fertilizer increased by 1.057472 units. Net profit sugar also has statistical significance at the 0.00 significance level. At the 0.001 significance level, net profit as an agricultural unit increases by 1.016370 units. The model demonstrates that Carew & Company Limited's net profit and loss in Bangladesh are significantly related to these units.

Conclusion

The financial status of Carew & Company Limited is significantly affected by its several divisions; the sugar, bio-fertilizer, agri-unit, and distillery units have the most impact. The whole financial performance of the company depends on its subsidiary's profitability. The general net profit is favorably connected with the net profit of the sugar, bio-fertilizer, agri-unit, and distillery units. Improving the financial status of the company depends on efficient management at every level. The financial performance of the sugar company is much improved by the founding and running of affiliates. They assist in recovery from losses, avoidance of bankruptcy, restoration of profitability, and presentation of investment prospects in yet unexplored sectors. They also enable sugar companies to reach economies of scale and reorganize their procurement systems. Effective methods of corporate governance among associates help to improve financial sustainability even further. Therefore, careful use of subsidiaries will greatly increase sugar industry profitability and lifespan. On the other hand, the Government could address these issues to improve productivity by reducing input costs and by improving management practices.

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APENDIX

Table 1: Summary of Sugar, Molasses, Distillery, Fertilizer and Agro-firm production, Profit & Loss in Carew & Company (Bangladesh) Limited.

Threshing Season/Fiscal Year	Molasses (Metric Ton)	Profit/Loss Distillery Factory (Medicine Factory)	Bio-Fertilizer	Profit/Loss Sugar Factory (Taka in Lakh)	Profit/loss Agro-farm (Including Experimental farms) (Taka in Lakh)
2001-2002	8500.76	574.40		-760.18	-74.09
2002-2003	7859.00	767.75		-777.41	-158.30
2003-2004	5695.42	856.17		-483.76	-109.41
2004-2005	5726.64	917.88		-291.61	-70.34
2005-2006	7110.35	1062.59		-820.22	-12.08
2006-2007	8083.75	1262.08		-777.97	-56.19
2007-2008	6171.82	1670.91		-1291.27	-63.69
2008-2009	3623.25	1928.08		-1575.60	-67.35
2009-2010	3880.00	2059.00		-351.81	-155.95
2010-2011	4586.00	3629.89		-1241.77	-123.03
2011-2012	2534.03	4360.36		-2685.00	-137.69
2012-2013	3131.73	5749.62		-3384.70	-142.27
2013-2014	4677.00	5539.97		-3976.36	-163.43
2014-2015	3818.00	5186.44		-4522.98	-250.15
2015-2016	2870.10	5971.91	-98.56	-4908.22	-380.25
2016-2017	3134.30	5634.00	-71.61	-4405.75	-416.01
2017-2018	3141.00	7365.57	-65.33	-6144.93	-308.04
2018-2019	3208.00	8434.22	-50.61	-6857.84	-416.61
2019-2020	4139.00	8872.15	32.88	-7077.44	-444.38
2020-2021	4486.76	9653.52	12.09	-7086.25	-489.28
2021-2022	2152.86	10397.62 (Provisional)	18.60 (Provisional)	-6044.79 (Provisional)	-326.64 (Provisional)

Table 2: Summary of Net profit & losses in Carew & Company Bangladesh Limited of Last 21 years (Taka in Lakh).

Year	Net profit (without interest)	Amount of interest	Net profit (with interest)
2001-2002	105.22	365.09	-259.87
2002-2003	205.06	372.94	-167.88
2003-2004	614.53	351.53	263.00
2004-2005	1325.07	149.43	1175.64
2005-2006	2187.40	292.58	1894.89
2006-2007	642.31	214.39	427.97
2007-2008	667.03	237.24	429.79
2008-2009	666.70	382.45	284.25
2009-2010	2410.96	511.42	1899.54
2010-2011	2359.92	826.59	1533.33
2011-2012	3370.28	1338.62	2031.66
2012-2013	4545.04	2312.59	2232.45
2013-2014	2364.61	968.43	1396.18
2014-2015	1731.92	1317.58	414.41
2015-2016	2164.79	1579.9	584.89
2016-2017	2576.57	1824.03	752.54
2017-2018	2778.36	1924.41	853.95
2018-2019	3046.14	1936.78	1109.36
2019-2020	3403.89	2020.68	1383.21
2020-2021 (Actual)	4296.79	2206.71	2090.08
2021-2022 (Budgeted)	6194.79	2150.00	4044.79