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Factors influencing fuel retail site sales in South Africa pre- and post-COVID-19

Junaid Abdul Kader

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership

Johannesburg, 2022

ABSTRACT

The association between the volume of fuel sold at retail sites and predictor variables has been explored in prior research. The COVID-19 pandemic was at its height in South Africa between March 2020 and March 2022 and might have changed these associations due to restrictions on people's movements and lifestyles during the peak of the pandemic. Understanding changes in the retail fuel industry might help Government, together with the private sector, to ensure adequate fuel supply through efficient utilisation of resources. Therefore, the association between the volume of fuel sold at retail sites and predictor variables in South Africa before and after COVID-19 was explored through this quantitative study using regression analysis and Fisher transformations.

It was hypothesised that the volume of fuel sold at retail sites in South Africa was associated with the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres of the fuel retail site, saturation level, location metric, and site services. In addition, it was hypothesised that the associations did not change between 2020 and 2022.

Regression analysis showed that saturation level and site services had a statistically significant association, albeit with a low R-square, with the volume of fuel sold at retail sites, while the other variables did not have a statistically significant association. In addition, Fisher transformations showed that the associations did not change between 2020 and 2022. Perhaps, there was insufficient differentiation between fuel retail competitors in South Africa to influence consumer choice. Fuel could also be regarded as a commodity by consumers and their needs were equally served at any retail site.

KEY WORDS

COVID-19, fuel sales, fuel retail sites, South Africa, quantitative regression

DECLARATION

I, Junaid Abdul Kader, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name:Junaid Abdul Kader Signature:

Signed at ……Johannesburg……

On the …….. …..

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LIST OF ACRONYMS

D10	Diesel 10 parts per million (ppm)
D50	Diesel 50 ppm
D500	Diesel 500 ppm
GDP	Gross domestic product
IP	Illuminating paraffin
IRS	Index of Retail Saturation
LPG	Liquefied petroleum gas
ULP93	Unleaded petrol 93 research octane number (RON)
ULP95	Unleaded petrol 95 RON

CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

This research was a quantitative study, using regression analysis, to explore the change, before and after the peak of the COVID-19 pandemic, in the association between the volume of fuel sold at liquid fuel retail sites and predictor variables in South Africa.

1.2 Context of the study

This study was set in South Africa, across all provinces, and spanned the economic environment, and the retail fuel industry serving internal combustion engine road transportation. It compared a period before the advent of the COVID-19 pandemic (between January and March 2020) with a period after the restrictions enforced to control COVID-19 were removed (between January and March 2022).

1.2.1 Economic environment

South Africa, located at the southernmost tip of Africa, has a divided past. Apartheid, a system of legalised racial segregation, was stopped in 1994 when South Africa held its first democratic election, but apartheid had already created an economic and social divide that had not been rectified by 2022. South Africa is a developing country, has the world's most unequal wealth distribution (Chatterjee *et al*., 2020), growing unemployment, a shrinking economy and growing energy consumption, as shown in Table 1. The economic realities of South Africans would guide their choices on energy consumption, transportation, and lifestyle. Wealthy South Africans had vastly different choices, to survive and manage through the COVID-19 restrictions, as compared to those people not classified as wealthy (which would be the majority).

Table 1: Changes in unemployment, GDP and energy consumption in South Africa

Economic factor	Current measure	% change from 2010
Unemployment (% of total labour force)*	33.9% in 2022	+8.7%
GDP per capita (constant 2010 US$)**	6 994 in 2021	-16%
Energy consumption (in Terajoules)***	2 892 634 in 2022	+10%

Key: * = StatsSA, ** = World Bank, *** = International Energy Agency

(IEA, 2022b; StatsSA, 2022c; World Bank, 2022)

1.2.2 Retail fuel industry

South Africa's historical path had also created a liquid fuels industry in which government was heavily involved and that was uniquely regulated (DME, 1998). Shortly after 1994, South Africa started changing its policy and governance structures in order to establish its democracy. This process led to the 1998 White Paper on Energy Policy which envisaged a stable, deregulated and competitive liquid fuels industry that provided security of supply of liquid fuels to the economy, ensured sustainable retailing activities and created black economic empowerment. The vision laid out by the 1998 White Paper on Energy Policy had been partly achieved by April 2022 despite some structural modifications in the industry and changed economic circumstances.

In recent decades, local oil refining capacity supplied the needs of the local fuel retail industry. This began to change in 2006 when imports were needed to make up a shortfall in supply. By 2022, the crude oil refining sector claimed that it could not economically justify further investments, leading to the closure of the Enref oil refinery in 2021 (Creamer, 2021) and a spending freeze and operational pause of Sapref in 2022 (Papayya, 2022). The Astron (previously Caltex) refinery closed as a result of a fire in 2020 and was expected to reopen in 2022 (Steyn, 2022).

The PetroSA gas to liquids refinery ran out of gas in 2020[1] (Business Insider SA, 2019), leaving only one remaining operational crude oil refinery (Natref). The other local supplier of fuel is the synthetic coal and gas to liquid Sasol Secunda facility. Based on data from the International Energy Agency (IEA, 2022a) and after accounting for the Enref, Astron, and Sapref closures, crude oil was expected to supply 16 per cent per cent and synthetic fuel provides 18 per cent of South Africa's petroleum consumption, with imported fuels supplying the remaining 66 per cent of liquid fuel demand.

The government regulates the retail price of petrol and liquefied petroleum gas (LPG) but does not regulate the diesel price. Such continued price regulation was not envisaged by the 1998 White Paper on Energy Policy (DME, 1998).

Black economic empowerment is seen at work through ownership structures in which black South Africans own portions of major oil companies. Phembani, a black controlled company, owns 21.2 per cent of Engen (Engen, 2022), and black shareholders own at least 25 per cent of TotalEnergies Marketing South Africa (TotalEnergies, 2022). In addition, BP South Africa has 25 per cent black ownership (BP South Africa, 2022), Shell South Africa has 28 per cent black ownership via Thebe Investment Corporation (Shell South Africa, 2020), and Tshwarisano, a black empowerment company, owns 25 per cent of Sasol Oil (Sasol, 2006).

There are approximately 4 600 service stations in the retail sector of the industry, with the major brands being BP, Engen, Caltex, Sasol, Shell and Total (SAPIA, 2022b). Over 100 000 people are supported in the industry throughout the value chain (SAPIA, 2022b).

Petroleum fuels serve various energy needs. In South Africa, the main use of petroleum fuels is transport. Transportation accounted for 70 per cent of the liquid fuel demand in 2019, in South Africa, with the remainder being used in industry,

[1] PetroSA continues to operate a fraction of its capacity based on imported condensate.

residential, and other applications (IEA, 2022a). In contrast transportation accounted for 65 per cent of the liquid fuel demand globally in 2019, with the remainder being used in industry, residential, and other applications (IEA, 2022a).

The price of petrol in South Africa is regulated and is set by the South African Government. The price of petrol is generally made up of four parts. In December 2021, the price of unleaded petrol (ULP) 95 research octane number (RON) in the inland area, according to Statistics South Africa (2021a), was:

- *Basic fuel price*: R9.74 (48 per cent);
- *Taxes and levies*: R6.67 (33 per cent);
- *Retail and wholesale margins*: R2.74 (14 per cent); and
- *Storage and distribution costs*: R1.14 (6 per cent).

The basic fuel price is the deemed import parity price of petrol. Taxes and levies are the duties collected by the Government of South Africa. Retail and wholesale margins are the fees allocated to downstream and midstream businesses and storage and distribution costs are the cost to deliver petrol to the retail site. Within the storage and distribution costs there are magisterial districts which are grouped into pricing zones. There are 52 pricing zones in South Africa, shown in Figure 1. The zone differential is an allowance to cover the cost of transport by the most efficient means from the deemed port of importation to a pricing zone. There is also an allowance to provide for the delivery cost of petrol from a depot to a retail site in a pricing zone. The regulated retail price of petrol in each pricing zone is identical so consumers within a pricing zone would not choose petrol based on retail price of petrol. Consumers on the border of each pricing zone or travellers between pricing zones could choose petrol based on retail price of petrol.

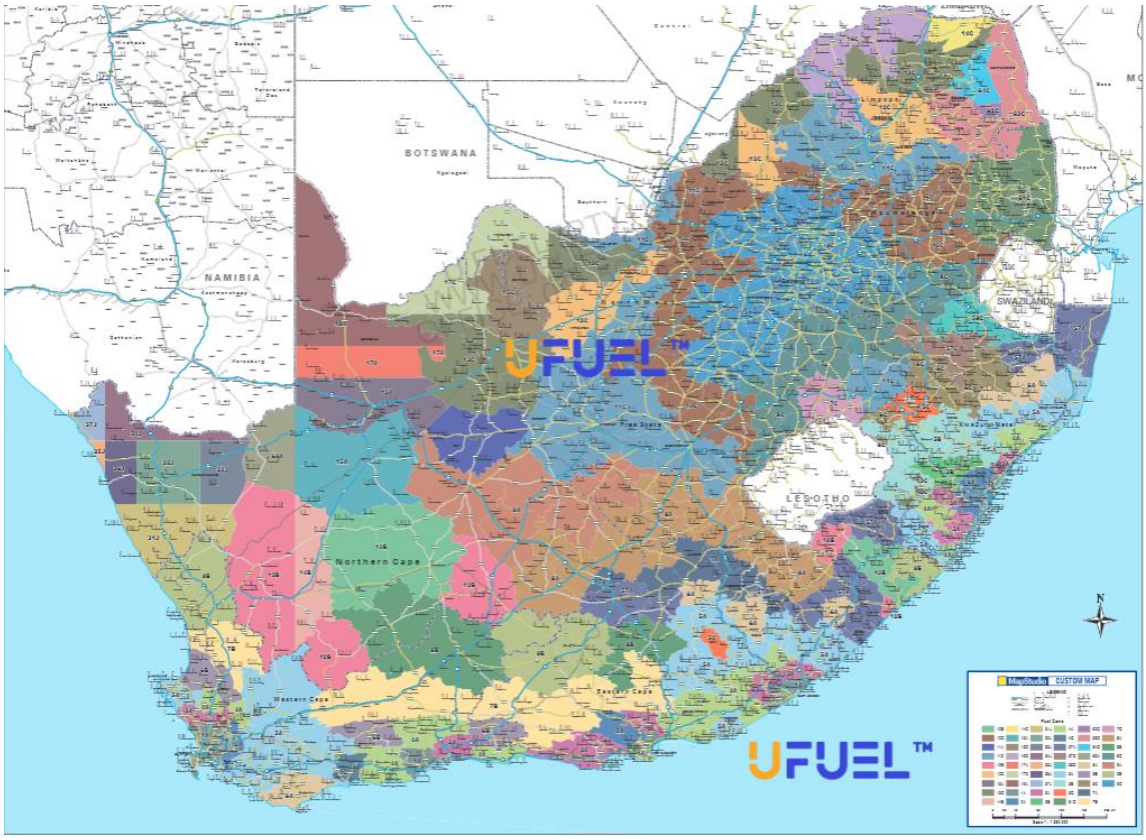

Figure 1: Magisterial districts in South Africa

(UFuel, 2020)

Petrol prices are an important factor in the economy as fuel is an important intermediate input (Crompton *et al*., 2020). The 1998 White Paper on Energy Policy called for deregulation of the liquid fuels industry, but petrol prices had not been deregulated by 2022. In the fuel sector, Government intervention had focused on industry policy, import controls, and limiting competition and not on deregulating the petrol price (Crompton *et al*., 2020). Between 2000 and 2019, South Africa's petrol price has steadily increased due to increased regulated margins, taxes and levies (Crompton *et al*., 2020). These factors combined with the Russia-Ukraine war resulted in record petrol prices in South Africa in April 2022 (Mofokeng, 2022). Record petrol prices then prompted Government to intervene by temporarily reducing the fuel levy for April and May 2022 and proposing to reduce the basic fuel price, terminating the demand side levy on ULP95 petrol, reviewing the retail price of petrol, and introducing partial

deregulation by limiting ULP93 petrol to a price cap (rather than a fixed price) (RSA, 2022b). No changes in the structure of the basic fuel price and petrol price regulation had been implemented by 5 May 2022.

1.2.3 Public / personal / private transportation

Public transport is one of South Africa's challenges, as it does not enable social cohesion and economic activity. Government seeks to improve the public transport system, which would alter transportation trends and could reduce transportations' petroleum consumption (Department of Transport, 2020). Until then, the trends shown in a study by Statistics South Africa (2021b) should hold true. The Statistics South Africa (2021b) study was based on data in early March 2020, before travel was restricted due to COVID-19, and is taken as representative of transportation trends before COVID-19. Statistics South Africa (2021b), as shown in Table 2, showed that walking accounted for 41.7 per cent of peoples' transport needs and 56 per cent of peoples' transport needs was via bus, taxi, car, and truck, which almost exclusively use petroleum liquid fuels in South Africa. Statistics South Africa (2021b) showed that 36.8 per cent of travel was for education, 26.3 per cent was for work and 14.4 per cent was for shopping, with other categories making up about 20 per cent. Statistics South Africa (2021b) showed that people's movements, apart from walking, are powered by liquid fuels and are mainly for education, work, and shopping purposes. Changes in education, work, and shopping behaviours would change people's movement patterns hence influencing the overall demand of liquid fuels and the association of fuel sales at retail sites to predictor variables.

Table 2: Mode of transport used in South Africa

Mode of transport	**Percent of mode of transport used in South Africa in 2020**
Train	0.7

Bus	4.5
Taxi	25.7
Car/truck	25.9
Walking	41.7
Other	1.5

(Statistics South Africa, 2021b)

1.2.4 COVID-19 movement restrictions

The management of COVID-19 in South Africa was required from March 2020 onwards to save lives. The South African Government imposed restrictions on people's movement, together with other interventions, in order to manage the COVID-19 pandemic.

COVID-19 emerged in December 2019 and is a disease caused by a coronavirus called SARS-CoV-2 (WHO, 2021). Eighty per cent of people who develop symptoms from COVID-19 recover without hospitalisation while 15 per cent become seriously ill and five per cent need intensive care (WHO, 2021). COVID-19 has raged throughout the world with 456 million confirmed cases and six million confirmed deaths due to COVID-19 as at 14 March 2022 (Our World in Data, 2022a). South Africa was likewise affected by COVID-19, with 3.79 million confirmed cases and 99712 confirmed deaths due to COVID-19 as at 14 March 2022 (Our World in Data, 2022a).

The South African Government restricted personal movements and business activities in order to manage the impact of COVID-19 by declaring a National State of Disaster. Peoples' movements were restricted through regulating the number and types of activities and gatherings that could occur. The South African

Government declared various alert levels, from Alert Level 5 (which had the most restrictions) to Alert Level 1 (which had the least restrictions) (RSA, 2022a).

Peoples' movements create a demand for fuel. Changes in peoples' movements change the demand for fuel, and these changes might further change the association of fuel sales at retail sites with predictor variables.

1.2.5 Fuel demand and COVID-19 movement restrictions

Statistics South Africa (2021b) showed that people's movements are mainly powered by liquid fuels and are mainly for education, work, and shopping. Travel for education, work, and shopping was restricted in 2020 to manage the impact of COVID-19 based on the various alert levels declared by Government (RSA, 2022a). Travel restrictions were changed and later nearly eliminated. These restrictions in movements might have affected the association of volume of fuel sold at retail sites with predictor variables. This study compared a period before the advent of the COVID-19 pandemic (January to March 2020) with a period of constant Alert Level 1 during the pandemic (January to March 2022), to explore the change in the association between the volume of fuel sold at liquid fuel retail sites and predictor variables in South Africa.

1.3 Research problem

The association between the volume of fuel sold at retail sites and predictor variables has been explored by Turhan *et al*. (2013), Chan *et al*. (2005), Sartorius *et al*. (2007), Tawia (2018), Siddique and Jalil (2018), and King *et al*. (2018). However, since these studies, the association between the volume of fuel sold at retail sites and predictor variables might have changed as the management of COVID-19 by the South African Government forced restrictions on people's movements, thereby altering people's lifestyles in 2020 and onwards. Therefore, this research investigated the association between the volume of fuel sold at retail sites and predictor variables in South Africa pre- and post-COVID-19. Understanding the association and changes thereof, could help Government and

industry improve management of the fuel retail industry in a post-COVID-19 era. The fuel industry could use this improved understanding of fuel sales drivers to increase profit and the Government could ensure efficient and sufficient placement of fuel retail sites.

1.4 Research questions

The intention of this research was to explore the change in association, pre- and post-COVID-19, between the volume of fuel sold at retail sites and predictor variables; as such, two questions were posed:

1. What main predictor variables are associated with the volume of fuel sold at retail sites in South Africa?
2. Has the association of volume of fuel sold at retail sites with predictor variables changed between January to March 2020 and January to March 2022?

1.5 Significance of the study

This study applied the retail performance model put forward by Turhan *et al*. (2013), together with variables known to be associated with fuel sales, to expand the understanding of variables associated with fuel sales at retail sites.

A better understanding of the variables associated with the volume of fuel sold at retail sites could assist the private fuel industry and Government. For example, the number of retail sites is restricted by regulation set by the Minister of Mineral Resources and Energy. This research might assist the Minister to be transparent and consistent, and prevent an oversupply or an under supply of retail sites. The fuel industry might be able to better forecast fuel sales and profitability leading to a more efficient utilisation of resources and improvement in profits. This understanding might help Government, together with the fuel industry, to ensure an adequate fuel supply.

Despite the global aspiration for lower carbon emissions, liquid fuels are likely to be part of South Africa's energy mix based on both policy-led and sustainability-led scenarios (SANEA, 2022). COVID-19 was an exogenous economic shock, and exploring how fuel retail sites were impacted would enable the fuel retail sector to remain profitable and continue to deliver liquid fuel to consumers. It is therefore important to understand the factors associated with fuel sales at retail sites to ensure constant fuel supply and retail site profitability. A better understanding of factors associated with fuel sales at retail sites would also help private sector evaluate retail sites during acquisition and establishment of new retail sites.

1.6 Delimitations of the study

The following factors were delimitations of the study:

- Fuel sales of a single brand of fuel retailer;
- Forecasting fuel sales volumes;
- Impact of loyalty programs;
- Sales from the convenience store or other services at the fuel retail site; and
- Any variables that influence fuel retail sites non-fuel sales.

1.7 Definition of terms

- *COVID-19*: Coronavirus disease caused by a virus (WHO, 2022).
- *Retail site*: Facility licenced under the Petroleum Products Act to retail petroleum products (RSA, 1977).
- *Petroleum product*: Any petroleum fuel or lubricant, whether used or unused, including any other substance that might be used for a purpose for which petroleum fuel or lubricant might be used (RSA, 1977).
- *Retail*: Sale of petroleum products to an end-consumer at a site.

1.8 Assumptions

- Fuel shortages did not affect sales in the periods studied. Fuel shortages would directly influence the variables as fuel scarcity results in availability being the most important as shown by Alvi *et al*. (2016).
- The distribution of Household Income Level per ward[2] is the same as the Taxable Income per ward and that this distribution has been the same from 2011 to 2022 (RSA, 1998).
- The distribution of voter registration per voting district[3] is the same as the adult population per voting district (IEC, 2023).
- The standard of service would be similar across all fuel retail sites under the same brand.
- The location metric was assumed to be the same for 2020 and 2022 as construction activities were restricted during the COVID-19 National State of Disaster in order to manage the impact of COVID-19 (RSA, 2022a). The location metric was a scale designed to grade a fuel retail site on four components:
  a) proximity to a major road route,
  b) entrances to the retail site,
  c) vehicle flow around the retail site,
  d) proximity to work, schools and malls.

[2] Ward is a delimitation of metropolitan municipalities into wards for elections onto ward councils. A ward can be made up of multiple voting districts.
[3] Voting districts are boundaries drawn to efficiently plan and administer elections in which an urban voting district radius is 7.5 kilometre and rural voting station is 10 kilometre. There are 22 933 voting districts in South Africa.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This research explored the change, before and after COVID-19, in the association between the volume of fuel sold at retail sites and predictor variables. Predictor variables and possible changes in the associations were explored through a review of relevant literature.

Fuel retailing is a subset of the retail industry therefore there could be generic retail industry knowledge that applies to fuel retailing. Variables associated with a generic retail store's sales volumes were first reviewed before exploring variables relevant to the South African fuel retail sites. The inclusion of variables in this study was then justified.

Thereafter trends affecting the association of fuel sales to predictor variables were discussed to explore what changes could be expected before and after COVID-19.

2.2 Variables associated with generic retail store's sales volumes

The variables associated with the sales performance of generic retail stores has been studied from both a consumer decision-making perspective founded by Dewey (1910) and a store attribute perspective, founded on Central Place Theory (Christaller, 1933), Spatial Interaction Theory (Reilly, 1929), and Principle of Minimum Differentiation (Hotbllino, 1929).

2.2.1 Consumer decision perspective

Understanding variables associated with sales from a consumer perspective typically revolved around the purchase decision process and the consumers'

psychological characteristics. The consumers' decision-making process has been modelled by Busch and Houston (1985), as six steps: problem recognition, internal search, external search, information receipt, decision, and post decision. The psychological characteristics are influenced by personal situation, social forces, environmental influences, and marketing programs (Kotler & Keller, 2012). The consumer's decision to purchase fuel was studied by Saini and Matinise (2013) through the use of the Consumer Style Inventory (CSI) model. Saini and Matinise (2013) found that the CSI did not provide insight into the consumer's choice of a fuel retail site in South Africa, but rather that fuel consumers were looking for service speed and convenience. Therefore, variables associated with sales, from a consumer decision perspective, were not considered.

2.2.2 Store attribute perspective

The location of generic retail stores has been the foundation of interest in the variables associated with the sales performance of generic retail stores, based on the Principle of Minimum Differentiation (Hotbllino, 1929), Spatial Interaction Theory (Reilly, 1929), and Central Place Theory (Christaller, 1933). The Principle of Minimum Differentiation (Hotbllino, 1929) stated that producers would produce similar products while explaining that customers would purchase from the most convenient location. Spatial Interaction Theory (Reilly, 1929) theorised that people's movements depends on the need and the distance involved, thus the location of stores influences sales. The Central Place Theory (Christaller, 1933) similarly explained that the extent of people's movements to purchase goods depends on the cost and frequency of the purchase. The influence of location was further progressed with the Attraction Model by Huff (1964) in which the probability of a consumer stopping at a site is dependent on distance and relative competition. Non-location factors that influence retail sales such as surrounding population characteristics, economics, saturation level, and magnets was then studied by Timmermans (1986), Redinbaugh (1987), Hasty (1997), and Dune and Lusch (2008).

However, Turhan *et al*. (2013) believed that there was a lack of coordinated research into the evaluation of retail store performance. This belief lead Turhan *et al*. (2013) to review approximately 60 studies of retail store performance that spanned 40 years to propose a model that can be used to evaluate retail store performance. The Turhan *et al*. (2013) model was successfully applied by Chang and Hsieh (2018), Larpcharoen *et al*. (2022), Sabzali Yamaqani *et al*. (2022), Udokwu *et al*. (2022) and Lee (2022) in a variety of industries and countries. The well-rounded basis and the successful application of the Turhan *et al*. (2013) model justifies its use as a good starting point for understanding the factors that affect retail stores. Appendix A provides a brief overview of the authors of the Turhan *et al*. (2013) model.

Turhan *et al*. (2013) put forward five metrics to evaluate retail store performance and proposed six categories of factors that determine the retail stores' performance, shown in Figure 2. The store performance metrics in the Turhan *et al*. (2013) model were sales volumes, profits, market share, patronage, and price elasticity, which were thought to be associated with population structure, economic factors, competition, saturation level, store characteristics, and magnet. This study focused on sales volumes as the dependant, performance metric and as such it used one of the performance metrics in the Turhan *et al*. (2013) model. Each independent, predictor variable was defined and justified by using studies within fuel retail before being applied to this study.

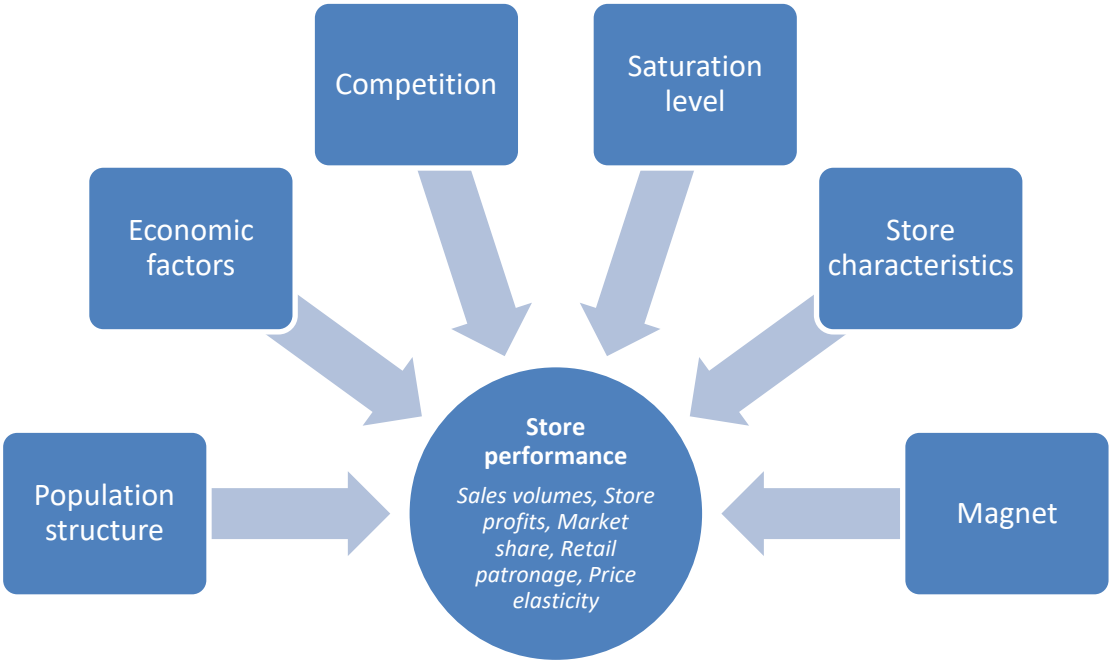

Figure 2: Theoretical model

(Turhan *et al*., 2013)

2.2.3 Population characteristics

Population characteristics are demographic factors that portray customers purchasing habits and lifestyle choices. Population characteristics was deemed to be one of the most important factors in retail store performance by Turhan *et al*. (2013) based on studies by Hasty (1997), Berman *et al*. (2010) and Redinbaugh (1987). Turhan *et al*. (2013) explained that including population demographics greatly increases a model's performance as it can show if the target market is congruent with the retailer's offering.

2.2.4 Economic factors

Economic factors are metrics that show customers buying power and willingness to spend. Economic factors were included by Turhan *et al*. (2013) as a separate factor although it could be part of population structure. Consumers buying power dictates the possibility of retail sales and economic features of the population

close to a retail site has been proposed by Turhan *et al*. (2013) to influence retail sales, based on studies by Ingene and Lusch (1980), Redinbaugh (1987), and Reinartz and Kumar (1999).

2.2.5 Competition

Competition concerns the strength and availability of competing stores that customers evaluate during the purchase decision. Retailers compete against each other for consumers' expenditure; therefore, all retailers are indirect or direct competition (Turhan *et al*., 2013). Turhan *et al*. (2013) noted that little is known about the effects of competition on retail performance and is likely more linked to price elasticity.

2.2.6 Saturation level

Analysts often use the Index of Retail Saturation (IRS) to understand the viability of a market (Turhan *et al*., 2013). The IRS or saturation level shows the extent to which customers' needs are being serviced by existing stores, as defined by Dune and Lusch (2008). The IRS or saturation level is determined as "demand for product or service divided by the available supply" (Turhan *et al*., 2013, p. 407). The upper bounds of retail saturation is when there are enough retail stores to service consumer needs while still returning a fair profit to retailers (Turhan *et al*., 2013). Low retail saturation means too few stores and a high probability of large profits and sales.

2.2.7 Store characteristics

Store characteristics, such as ease of access, image, and store costs[4], determine advantages over other stores. Store characteristics are linked to competition as retailers can gain advantage by having better store characteristics than

[4] Store costs such as cost of building, renting, buying and renovating.

competitors have. Dune and Lusch (2008) cited by Turhan *et al*. (2013) mentioned that access (to a store) is one of the most studied features in retail store selection.

2.2.8 Magnet

Magnets are other stores that attract customers to the vicinity of the store in question. Turhan *et al*. (2013) revealed that most research marketing has dealt with other variables influencing store performance. Turhan *et al*. (2013) relied on Timmermans (1986) and Kuo *et al*. (2002), who believed that magnets influence a retail sites performance, when including magnet as a variable.

Turhan *et al*. (2013) reviewed approximately 60 studies that spanned 40 years to distil six categories of factors that determine retail store performance: population structure, economic factors, competition, saturation level, store characteristics, and magnet. These generic retail store performance influencing variables were used as a foundation for identifying variables influencing fuel retail site performance in South Africa.

2.3 Main predictor variables associated with fuel retail sites

Fuel sales at retail sites could be dependent on many predictor variables. The variables associated with sales was gleaned from the Turhan *et al*. (2013) model describing generic retail store sales performance. However, fuel retail is a subset of the overall retail industry and is unique in many aspects. Therefore, variables in this study were supported by the Turhan *et al*. (2013) model and included by reviewing studies based on the fuel retail industry.

2.3.1 Demographics

The study by Chan *et al*. (2005), based on Singapore, was the only study found that explored the association between volume of fuel sold at retail sites and

demographics such as population, income levels, and number of cars within the neighbourhood of the retail site. Chan *et al*. (2005) found that fuel demand is positively correlated with population, income levels, and number of cars within the neighbourhood of the retail site.

Demographics, as a part of population structure, was one of the categories put forward by Turhan *et al*. (2013) and was therefore included as a variable in this study. The demographic variables included in this study was average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, and car ownership by people residing within two kilometres of the fuel retail site. The two kilometre radius was chosen as done by Gagné *et al*. (2004), in order to fix an area from which to source the predictor variable data.

2.3.2 Competition

Competition was included as a variable in this study despite Siddique and Jalil (2018) being the only study found that showed the association of proximity to competition with the volume of fuel sold at retail sites. This evidence of association between proximity to competition and volume of fuel sold at retail sites is strengthened by the nature of the South African retail market. It has had an overpopulation of retail sites for many years because of regulatory rents being shifted towards retailers, as mentioned by Crompton and Matsika (2021) Oqubay *et al*. (2021) based on retail sites growth of 2.3 per cent per year whilst petrol volume sales shrunk by 9.3 per cent between 2016 and 2019. The growth of retail sites in contrast to shrinking sales volumes indicates overpopulation of retail sites. Consequently, to exclude proximity to competition might have significantly detracted from the findings of this study.

Competition was included as a variable in this study as it was one of the categories put forward by Turhan *et al*. (2013). The inclusion of competition is supported by the overpopulation of fuels retail sites in South Africa.

2.3.3 Saturation level

The IRS or saturation level generally refers to the ratio of demand and supply (Turhan *et al*., 2013), was one of the categories put forward by Turhan *et al*. (2013), and was based on a study by Dune and Lusch (2008). Demand can be calculated by using either population, retail expenditure, or total market sales, and supply can be calculated by using either number of stores, or trading area of stores (Turhan *et al*., 2013). Saturation level, in this study, was measured by adult population residing within two kilometres of the fuel retail site divided by the number of sites within two kilometres of the fuel retail site. No studies were found that explored the relationship of saturation level to fuel sales at a retail site. Nevertheless, it was included as a variable in this study based on its inclusion in the model used by Turhan *et al*. (2013).

2.3.4 Site services (magnets)

Turhan *et al*. (2013) included magnets as a variable associated with retail store performance. Magnets was defined by Turhan *et al*. (2013) as other, non-competing, stores that attracted consumers to the general vicinity of a retail site, thus increasing customer numbers and sales. Magnets in the fuel retail sector could be site service (non-fuel services and products) that attract consumers to the fuel retail site. It was included in this study for the following reasons:

- Fuel retail sites are trying to beat competitors and increase profits by expanding into non-fuel services and products (Stavrakakis & Chountalas, 2015). Kakunu (2012) found that added services was a factor in a consumer's choice of a fuel retail site, while King *et al*. (2018) found that there was some association between additional facilities and fuel sales volumes.
- Site services are non-fuel services offered by a retail site and have been shown to influence fuel sales (Kakunu, 2012; King *et al*., 2018). Site services, as a magnet, is one of the categories put forward by Turhan *et al*. (2013). In South Africa, there has been a marked trend for retail sites

to shift away from motor vehicle repairs to other site services such as tyre puncture repairs, sale of LPG, convenience stores, fast food outlets and bank automatic teller machines. Some upmarket retail sites even offer coffee lounges with Wi-Fi internet connections.

For the purposes of this study site services were rated and measured in the following manner: 0 = no other services were offered by the site, 1 = convenience store exists, 2 = convenience store plus at least one other service (fast food, tyre fitment etc.) offered by site. A simple, linear scale was chosen for ease of use.

2.3.5 Location

Location of the fuel retail site has consistently emerged as the major variable associated with the volume of fuel sold at retail sites. Miller (1979) was the earliest study found in South Africa that recognised that location and convenience are particularly significant for fuel sales at retail sites. This was largely due to fuel being an “inconvenience good” (Miller, 1979, p. i); consumers would thus choose a site, based on location and ease of use, which minimises their inconvenience. Sartorius *et al*. (2007) and Abrams (2009) have subsequently confirmed that location is a signification factor for fuel retail sales in South Africa. The association of location with volume of fuel sold at retail sites has been consistently found across countries. Chan *et al*. (2005), Mwenda and Oloko (2017), Siddique and Jalil (2018), Tawia (2018), and King *et al*. (2018) have all found that location significantly affects fuels sales in Singapore, Kenya, Pakistan, and Ghana. However, location is not a significant variable when there is fuel scarcity as consumers select sites based on fuel availability (Alvi *et al*., 2016).

Location of a fuel retail site has been assessed differently by different authors, for example Chan *et al*. (2005), Sartorius *et al*. (2007), Tawia (2018), and King *et al*. (2018). Chan *et al*. (2005) evaluated location of a fuel retail site as proximity to transport hubs. Sartorius *et al*. (2007) used a graded scale based on four factors while Tawia (2018) used traffic flow, and King *et al*. (2018) used a subjective scale. The scale used by Sartorius *et al*. (2007) is believed to be the

most objective as it clearly defines the factors and scoring mechanism and encompasses many factors. Sartorius *et al*. (2007) graded the location of a fuel retail site based on proximity to major routes, accessibility, rural or urban location, and proximity to shops.

Location of the fuel retail site, as a part of store characteristics, was included in the categories put forward by Turhan *et al*. (2013) and was included as a variable in this study. The location metric used was based on the combined suggestions of Sartorius *et al*. (2007) and Smalley (1999). Sartorius *et al*. (2007) defined a location metric based on proximity to a major route, accessibility, proximity to rural/urban area, and proximity to a shopping centre and scored locations from 1 to 10. Smalley (1999) scored a fuel retail site location from 0 to 2 depending on its position relative to a major signalised intersection, minor non-signalised intersections, and mid-block. This study quantified the location metric by rating each fuel retail site on a scale of 1 to 10, with 1 being lowest and 10 being highest. The rating had four components:

(1) Proximity to a major route (potential of 2 points): 1 for more than one kilometre, 2 for less than one kilometre;
(2) Entrances to fuel retail site (potential of 2 points): 1 for one entrance, 2 for more than one entrance.
(3) Vehicle flow (potential of 3 points): 1 for being mid-block (not at an intersection), 2 for being at an intersection, plus 1 if accessible to two way traffic flow.
(4) Work, school, mall proximity (potential of 3 points): 1 each for being within one kilometre of a work area, school, or shopping mall.

2.3.6 Brand

The brand of a fuel retail site was also found to be associated with the volume of fuel sold at fuel retail sites in South Africa, Kenya, and Pakistan (Abrams, 2009; Gagné *et al*., 2004; Siddique & Jalil, 2018). Brand, as part of store characteristics, was a part of the categories put forward by Turhan *et al*. (2013) but was not

included as a variable in this study as it was based on a single brand's retail sales data; as such brand could not be used as a variable.

2.3.7 Price

The association of price with the volume of fuel sold at retail sites in the short term depends on the variability of price at sites. Gagné *et al*. (2004) and King *et al*. (2018) found that price is associated with sales in an unregulated market, where the retail site determines price. However, statistically, price cannot explain any variability across sites within a pricing zone in South Africa where the petrol price is regulated by the Government at the same price within each pricing zone, as mentioned in sub-section 1.2.1. It follows that Sartorius *et al*. (2007) found that price did not influence sale volumes of fuel retail sites.[5]

Diesel retail prices are not regulated therefore diesel price could be a variable. However, diesel sales are a smaller portion of total sales with diesel accounting for roughly 30% of the total sales in the data set used for this study.

This study considered and compared data from January to March 2020 with January to March 2022. Between these periods, the price of ULP95 in Gauteng had increased by 22 per cent, from an average of 1 601 cents per litre in January to March 2020 to an average of 2 045 cents per litre in January to March 2022 (SAPIA, 2022a). Akinboade *et al*. (2008) concluded that petrol demand is price inelastic in South Africa while Abrams (2009) found that consumers were sensitive to the absolute price of petrol but could not conclude on petrol price elasticity in South Africa.

Price, as an economic metric, was one of the categories put forward by Turhan *et al*. (2013) but price was not included as a variable in this study as petrol price

[5] The removal of the demand side levy, which reduced the price difference between ULP95 and ULP93 was not within the period of this study.

is fixed by Government and is constant in a pricing zone in South Africa, and petrol was found to be price inelastic (Akinboade *et al*., 2008) even though diesel price, which account for 30% of sales, is not regulated. Excluding price from this study was justified by the petrol price inelasticity and with petrol making up the vast majority of sales but this might prove to be a limitation.

2.3.8 Quality of service

Quality of service was found to be associated with the volume of fuel sold at retail sites in Canada and Kenya (Gagné *et al*., 2004; Mwenda & Oloko, 2017). However, it was excluded from this study not only because it was not included by Turhan *et al*. (2013), but also because quality of service is a subjective description, as it is experienced by people who are inherently individual beings with individual experiences. It is notoriously difficult to measure such subjective factors. It was assumed that the standard of service would be similar across all fuel retail sites under the same brand and because a single brand was used in this study, it was assumed that the quality of service was similar. This assumption is possible because the brand owner is responsible for training all the forecourt attendants who all receive the same training. In addition, in South Africa, self-service by consumers at retail sites is prohibited (RSA, 2003) thereby limiting service delivery innovations.

2.3.9 Boundary

The boundary refers to radius around the fuel retail site, which was not a variable in the study, however, a boundary around the fuel retail sites had to be set to determine the income, population, car ownership, competition, and saturation index within this area. The radius should be a geographic area served by the fuel site. However, consumers might purchase fuel at any point of their journey, which can be between 35 to 63 minutes per journey for education and work (StatsSA, 2015). The potential to purchase fuel at any site along the journey limits the

application of a fixed radius around a fuel retail site. Nevertheless, a radius of two kilometres was chosen as done by Gagné *et al*. (2004).

2.3.10 Summary of variables chosen

In this study, variables put forward by Turhan *et al*. (2013) were integrated with other known variables, put forward by Chan *et al*. (2005), Sartorius *et al*. (2007), Tawia (2018), Siddique and Jalil (2018), and King *et al*. (2018). This resulted in seven variables thought to be associated with the volume of fuel sold at retail sites, as shown in Figure 3.

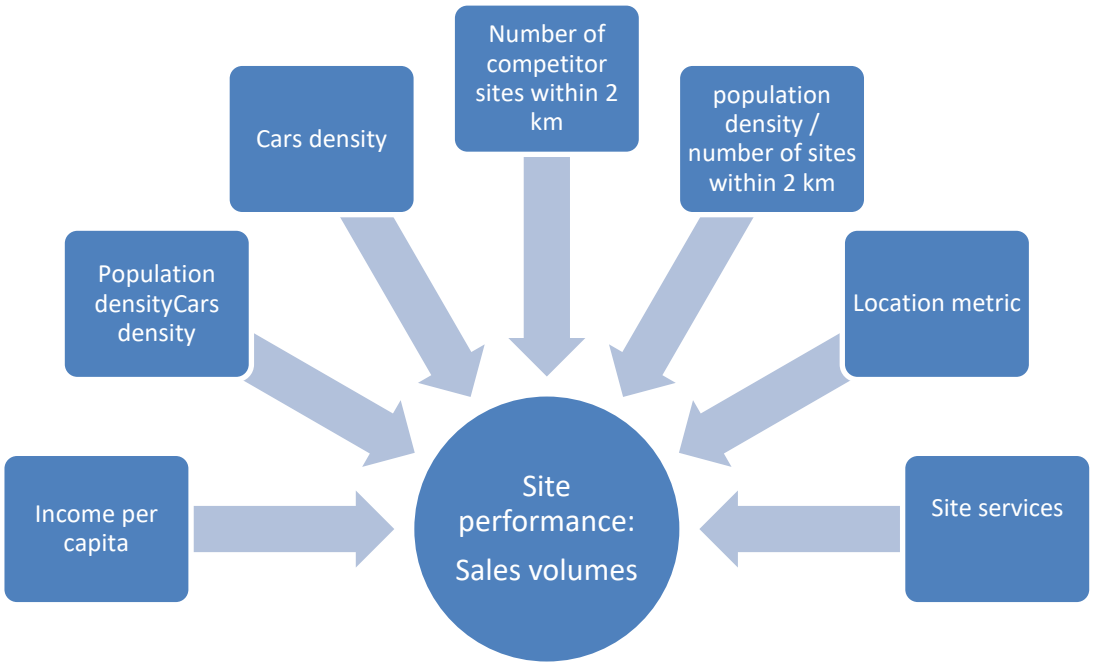

Figure 3: Summary of variables chosen for this study

Having identified the seven variables, it was possible to develop the first hypothesis for this study.

2.3.11 Hypothesis 1

The volume of fuel sold at retail sites in South Africa is associated with the average income per adult residing within two kilometres of the fuel retail site, adult

population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric and site services.

This can be written as the equation:

$$V = f(I, P, C, O, S, L, SS)$$

Where
V = volume sold in litres per month
f = value of the formula
I = average income per adult residing within two kilometres
P = adult population residing within two kilometres of the fuel retail site
C = car ownership by people residing within two kilometres of the fuel retail site
O = number of competitor sites within two kilometres of the fuel retail site
S = saturation level which is adult population residing within two kilometres of the fuel retail site divided by number of sites within two kilometres
L = location metric
SS = site services

The location metric (L) was based on the combined suggestions of Sartorius *et al*. (2007) and Smalley (1999), as detailed in sub-section 2.3.5, and the site services (SS) metric as detailed in sub-section 2.3.4.

2.4 Changes in association of fuel sales volumes at retail sites with predictor variables between 2020 and 2022

Google Mobility Trends for South Africa, as presented by Our World in Data (2022b), and studies of lifestyle changes due to COVID-19 were used to explore the impact of restricted personal movements and business activities on peoples' movements. No studies had been found that describe the lifestyle changes entrenched by the response to COVID-19, as these changes are relatively new. There have been studies that describe the lifestyle changes during the early phases of the COVID-19 pandemic such as Wang *et al*. (2020), Zannat *et al*. (2021), and Matli (2020). These studies were used, together with the Google Mobility trends, to understand changes in the association between volume of fuel sold at retail sites and a number of variables in South Africa.

2.4.1 South African's movement trends since the start of COVID-19

COVID-19 raged throughout the world and South Africa was not spared. The South African Government declared a state of disaster and restricted personal movements and business activities in order to manage the impact of COVID-19 in early 2020 (RSA, 2022a). South Africa went through various phases of alert levels, with the most restrictive Alert Level 5 being from 26 March 2020 to 30 April 2020.

These restrictions severely reduced mobility. Our World in Data (2022b) compared Google mobility trends during COVID-19 against a baseline before COVID-19 (the baseline period was January 3 to February 6, 2020). Our World in Data (2022b) indicated that during Alert Level 5, South Africans' visits to residential sites (homes) increased by 33 per cent, visits to retail and recreation sites was 74 per cent below baseline, visits to grocery and pharmacy stores was 45 per cent below baseline and visits to workplaces was 70 per cent below baseline. This was due to movement restrictions that allowed only essential activities, which resulted in most people staying within residences. Alert Level 5 was the highest level of restriction enforced and only allowed essential activities.

Subsequently, the level of restrictions was gradually eased. Various alert levels were enforced with the most recent being adjusted Alert Level 1 from 1 October 2021 to 4 April 2022 (RSA, 2022a). This adjusted Alert Level 1 allows nearly all activities to be performed, albeit with social distancing, restrictions on attendance at indoor functions, wearing of masks and isolation of people who test positive for COVID-19. Google mobility trends shown by Our World in Data (2022b) indicated that during adjusted Alert Level 1 South Africans' visits to retail and recreation sites was eight per cent above baseline, visits to grocery and pharmacy stores was 30 per cent above baseline and visits to workplaces was at baseline levels. Although people's movement was initially severely restricted, this data shows that people were moving about more in the period October 2021 to April 2022 than they did before COVID-19, as illustrated in Figure 4.

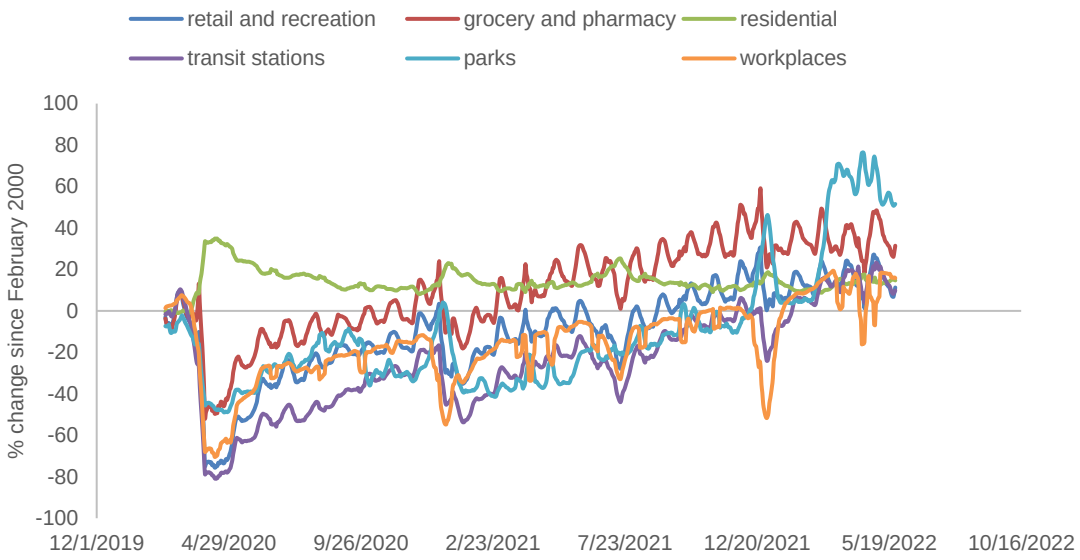

Figure 4: Changes in peoples' movements in South Africa since February 2020

(Our World in Data, 2022b)

2.4.2 Global trends in people movements

Wang *et al*. (2020) found that during the height of COVID-19, American consumers had reduced travel time and frequency of grocery shopping while trebling online grocery shopping. Wang *et al*. (2020) also expected these trends to continue post-COVID-19. Lu *et al*. (2021) also found an increase in the purchase of fresh food online in China. Zannat *et al*. (2021) studied shopping modes in Bangladesh and India during the height of the pandemic and found that consumers in the two countries behaved differently. In Bangladesh, high income, car-owning people chose to shop more online but in India high income and car ownership did not correlate to people choosing to shop online (Zannat *et al*., 2021). Zannat *et al*. (2021) surmised that the context and local conditions of a country would influence the increase in online shopping.

Online shopping has increased during COVID-19 in some countries (Lu *et al*., 2021; Wang *et al*., 2020); however, this might not be generalised to other countries (Zannat *et al*., 2021). Shopping accounts for 14.4 per cent of travel in

South Africa (Statistics South Africa, 2021b) though it is not clear if an increase in online shopping would change the association of volume of fuel sold at retail sites with predictor variables.

2.4.3 South African trends in people movements

Matli (2020) found that working from home increased during the height of the pandemic. However, Matli (2020) anticipated that the large divide in availability of resources (such as work space at home and domestic workers) might hinder the permanent adoption of remote working in South Africa. Remote working might thus not change the association between fuel sold at retail sites and predictor variables.

Leisure in South Africa was arguably the most restricted facet of people's lives during the pandemic. Young (2020) reviewed social media to show that the restrictions imposed by the Government of South Africa had a large impact on leisure and tourism. People resorted to using technology to connect with each other and embraced leisure activities at home. Young (2020) then forecasted that there would be a large and far reaching social and economic impact on the tourism industry post-COVID-19. However, Our World in Data (2022b) showed that that during adjusted Alert Level 1 South Africans' visits to retail and recreation facilities was eight per cent above baseline, showing that people's affinity for online leisure activities was short lived. As such, change in leisure activities might not change the association between fuel sold at retail sites and predictor variables.

2.4.4 Summary of Google Mobility Trends and literature on lifestyle changes

The literature review identified that South Africans were moving about more in the period October 2021 to April 2022 than they did before COVID-19 (Our World in Data, 2022b) and that online shopping trends cannot be generalised between countries (Zannat *et al*., 2021), and that remote working might not be permanent

in South Africa. Therefore, it was possible to develop the second hypothesis for this study.

2.4.5 Hypothesis 2

There was no change between 2020 and 2022 in the association between the volume of fuel sold at retail sites in South Africa and the average income per adult residing within two kilometres, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric and site services.

2.5 Conclusion of Literature Review

The six variables put forward by Turhan *et al*. (2013) were integrated with other known variables, put forward by Chan *et al*. (2005), Sartorius *et al*. (2007), Tawia (2018), Siddique and Jalil (2018), and King *et al*. (2018). This resulted in seven variables thought to be associated with the volume of fuel sold at retail sites. Location, income, population, car ownership, saturation, competition, and site services were expected to be associated with the volume of fuel sold at retail sites. Price, quality of service, and brand were not included in the study.

People's movement was severely restricted initially, but since October 2021 people are moving about more than before COVID-19 (Our World in Data, 2022b). No studies have been found that positively describe the lifestyle changes entrenched by the response to COVID-19, as these changes are relatively new. Online shopping, remote working, and leisure restrictions during the height of COVID-19 is not expected to have a permanent impact on fuel sales and is not expected to change the association of fuel sold at retail sites with predictor variables.

The hypotheses are restated below:

- *Hypothesis 1*: The volume of fuel sold at retail sites in South Africa is associated with the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric and site services.
- *Hypothesis 2*: There was no change between 2020 and 2022 in the association between volume of fuel sold at retail sites in South Africa and the average income per adult residing within 2km, adult population residing within 2km of the fuel retail site, car ownership by people residing within 2km of the fuel retail site, number of competitor sites within 2km, saturation level, location metric and site services.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research approach

A quantitative approach was used for this research as it sought to understand and quantify a mathematical relationship between retail sales volumes and certain variables. Sukamolson (2007) explained that quantitative research comprises explaining phenomena, collecting numerical data, and using mathematical methods to analyse the data, all of which was done in this research. The phenomenon of fuel sales was studied through the collection of retail fuel sales volumes data and metrics related to sales and then analysed using regression analysis. Regression analysis was used as it illustrates the association between dependant variables and predictor (independent) variables (Lee, 2015) and was used successfully in similar studies on fuel sales (Gagné *et al*., 2004; Mwenda & Oloko, 2017; Sartorius *et al*., 2007; Tawia, 2018). In this study, the dependant variable was the volume of fuel sold at retail sites and predictor variables were the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric, and site services.

Sukamolson (2007) elaborated, stating that quantitative research has an underlying realist or positive worldview, in that it seeks to uncover an existing reality by using objective means. However, as beings who experience and partake in that reality, researchers can never truly detach themselves from reality to be truly objective (Sukamolson, 2007). This research sought to limit the subjectivity by only using data that was physically measurable and did not rely on people's interpretation. This objective data was retail fuel sales volumes, distance between two points, number of retail sites, number of entrances, existence of site services, income levels, and number of people.

3.2 Research design

A quantitative longitudinal approach was used to explore the change, before and after COVID-19, in the association between the volume of fuel sold at retail sites and predictor variables in South Africa. The association and change thereof could be determined through analysis of multiple data points across time periods. The longitudinal approach enabled collection of multiple data points through structured observation of the sample of fuel retail sites using 2020 and 2022 data.

3.3 Data collection methods

Sales data was collected by accessing the volume of fuel sold at retail sites per month from a single oil company for 2020 and 2022. A single oil company was chosen, based on permission given to use data and the use of a single oil company eliminated the impact of brand which is a subjective choice that consumers make. The oil company data was known to be valid as it was used in the company's financial reporting and other official publications. The sales data was anonymised by multiplying it by a common factor known only to the researcher to ensure that the data cannot be translated back into actual sales data, thus protecting the company's information. Permission to use this data was obtained from the company's management.

Google search results and Google Maps views were used to determine the location metric, site services, and competitor's proximity. Income levels per ward were sourced by combining data from Statistics South Africa and the South African Revenue Service. Population levels per voting district was sourced by combining data from Statistics South Africa and the Independent Electoral Commission.

3.4 Population and sample

3.4.1 Population

The population consisted of 355 fuel retail sites using the oil company's brand in South Africa, however the process of reviewing the data reduced the dataset from 355 to 285 fuel retail sites.

3.4.2 Sample and sampling method

The sample consists of all 355 fuel retail sites using the oil company's brand in South Africa. The entire population was chosen as the sample to ensure that any relationships within the population were found and to improve this study's external validity. That is, when applying findings to the South African fuel retail industry.

Data from January to March 2020 was used to determine the association of variables pre-COVID-19. The same quarter (January to March) was used for pre- and post-COVID-19 data to remove the effect of seasonality on fuel sales. The first COVID-19 related alert level commenced on 26 March 2020; therefore, data from January to March 2020 was used to determine the association of variables pre-COVID-19. Data from January to March 2022 was used to determine the association of variables post-COVID-19 as the Alert Level 1 had very few restrictions on people's movements and it was the same throughout January to March 2022 (RSA, 2022a). It was assumed that peoples' movements during Alert Level 1 would be similar after the State of Disaster has ended.

3.5 The research instruments

No instrument was used as this research was conducted solely with secondary data.

3.6 Procedure for data collection

Sales data was requested from the oil company by following up on the prior approval from the oil company.

Google search results and Google Maps views were accessed via an internet browser to determine the location metric, site services and competitor's proximity.

Income levels and population was collected from Statistics South Africa, the South African Revenue Service, and the Independent Electoral Commission websites.

3.7 Data collection

Data was collected for 355 fuel retail sites and a sample of the data is shown in Appendix B. The various metrics are discussed in the sub-sections that follow.

3.7.1 Sales metric data collection (V)

The volume of petroleum fuel (ULP93, ULP95, D10, D50, D500, IP, LPG) sold per fuel retail site per month for January 2020 to April 2022 was received from the oil company. Sales data for January to March 2020 and January to March 2022 was extracted and anonymised by applying a factor to ensure that the data could not be translated back into actual sales data, thus protecting the company's information.

3.7.2 Location metric data collection (L)

The location metric for each site was scored by determining the fuel retail site's proximity to a national or provincial road, number of entrances, vehicle flow potential, and proximity to a work area, school, and/or mall. Google Maps Satellite View was used to determine the scoring.

Each site was viewed on Google Maps Satellite View to determine the number of entrances and vehicle flow potential. Thereafter, the ‘measure distance’ function in Google Maps was used to draw a radius of one kilometre around the fuel retail site to determine proximity to a national or provincial road, and work area, school, and/or mall. Most often, Google Maps Satellite View clearly showed the name and appearance of work areas, schools, and malls, and to ensure completeness the ‘search nearby’ function offered by Google Maps was used to highlight work areas, schools, and malls. The phrases searched were ‘business’, ‘office’, ‘warehouse’, ‘factory’, ‘mall’, and ‘school’.

The location metric was assumed the same for 2020 and 2022, as construction activities were restricted during the COVID-19 National State of Disaster to manage the impact of COVID-19 (RSA, 2022a).

3.7.3 Site services metric data collection (SS)

The services offered for each fuel retail site was scored using Google Maps Satellite View and Google Maps Street View. Most often, Google Maps Satellite View showed the services (shop, fast food outlet, tyre fitment etc.) offered, and the view from the street visually confirmed the services offered.

Site services were assumed the same for 2020 and 2022, as construction activities were restricted during the COVID-19 National State of Disaster to manage the impact of COVID-19 (RSA, 2022a).

3.7.4 Competition metric data collection (O)

Each fuel retail site was viewed on Google Maps Satellite View to determine the number of competitors in the vicinity. The Google Maps measurement function was used to draw a radius of two kilometres around each site. The Google Maps ‘search nearby’ function was used to find and count competing fuel retail sites within a two kilometres radius. The phrases searched were ‘fuel’ and ‘petrol’.

Competitors were assumed the same for 2020 and 2022, as construction activities were restricted during the COVID-19 National State of Disaster to manage the impact of COVID-19 (RSA, 2022a).

3.7.5 Income metric data collection (I)

Average income per adult residing within two kilometres of the fuel retail site was not found in any of Statistics South Africa and the South African Revenue Service databases; therefore, a substitute had to be sourced. The substitute used in place of average income per adult residing within two kilometres of a fuel retail site was average taxable income per ward, which was determined by combining data from Statistics South Africa and the South African Revenue Service and is shown in Appendix C.

Average taxable income per province for 2015 to 2020 was sourced from the South African Revenue Service (SARS, 2022). Using this data, Average Taxable Income per province for 2021 and 2022 was estimated using a linear progression. The linear progression provided an acceptable forecast as the R-square of the regression was calculated to be between 0.90 and 0.96.

Household income level per ward was based on the 2011 Census performed by Statistics South Africa, which was the most recent census (StatsSA, 2022a). The distribution of household income level per ward was determined and applied to the average taxable income per province to determine the average taxable income per ward. Inherently, this procedure assumes that the distribution of household income level per ward was the same as the Taxable Income per ward and that this distribution has been the same from 2011 to 2022.

Finally, the ward in which the fuel retail site is located was obtained from the Independent Electoral Commission, concluding the substitute for taxable income per adult residing within two kilometres of the fuel retail site (IEC (2022b).

3.7.6 Population metric data collection (P)

Adult population residing within two kilometres of a fuel retail site was not found in any of Statistics South Africa databases; therefore, a substitute had to be sourced. The substitute used in place of adult population residing within two kilometres of the fuel retail site was adult population per voting district, which was determined by combining data from Statistics South Africa and the Independent Electoral Commission respectively; shown in Appendix D.

Adult population per province for 2002 to 2021 was sourced from Statistics South Africa (StatsSA, 2022b). Using this data, adult population per province for 2022 was estimated using a linear progression. The linear progression provided an acceptable forecast as the R-square of the regression was calculated to be between 0.96 and 1.

Voter registration per voting district was extracted from the Independent Electoral Commission (IEC, 2022a). The distribution of voter registration per voting district was determined and applied to the adult population per province to determine the adult population per voting district. Inherently, this procedure assumed that the distribution of voter registration per voting district was the same as the adult population per voting district.

Finally, the voting district in which the fuel retail site resides was found on the Independent Electoral Commission's website, which concluded the substitute for adult population within two kilometre of the fuel retail site (IEC, 2022b).

3.7.7 Car ownership metric data collection (C)

Data on car ownership by people residing within two kilometres of the fuel retail site could not be found in any public database. Therefore, this metric was removed from the data analysis.

3.8 Data analysis and interpretation

3.8.1 Data analysis and interpretation for Hypothesis 1

Regression analysis was used to develop the association between volume of fuel sold at retail sites in South Africa and predictor variables to explore Hypothesis 1. Regression analysis was used as it illustrates the relationship between dependant variables and predictor (independent) variables (Lee, 2015). SAS® software was used to perform the regression analysis for the 2020 and 2022 data sets. The regression procedure described by Lee (2015) was followed, which includes checks for multicollinearity, nonlinearity, heteroscedasticity, outliers, normality of residuals, and autocorrelation. The regression procedure described by Lee (2015) culminated in a R-square and analysis of variance (ANOVA) test and a review of regression parameters to determine the significance of the correlation.

3.8.2 Data analysis and interpretation for Hypothesis 2

A Fisher z-transformation has been widely accepted as a suitable test for determining if two correlation coefficients are equal (Ramseyer, 1979). Hypothesis 2 was explored by using the Fisher z-transformation and a two-sample analysis to determine if the correlations were equal at a 0.05 significance level.

3.9 Limitations of the study

Brand and price were not included as a variable and might limit the value of the findings in this study.

The brand of a fuel retail site has been found to be associated with the volume of fuel sold at the fuel retail site (Abrams, 2009; Gagné *et al*., 2004; Siddique & Jalil, 2018) but different brands were not used or compared in this study.

This study did not include fuel price as a variable as the petrol price in South Africa was regulated at the same price within each pricing zone, while diesel was not regulated, and the maximum retail price of LPG and IP was regulated. This study might therefore only be applicable to an industry with similar price regulation. Record petrol prices have prompted Government to review its long running market interventions in petrol pricing by proposing to review its basic fuel price methodology and to change from a fixed price to a price cap on for ULP93 petrol (RSA, 2022b). These changes in basic fuel price and petrol price regulation had not been implemented by 5 May 2022. Consequently, this study was not affected by these proposed changes. This study's value and findings might be limited and would have less validity if the petrol price was partially deregulated to a price cap as it appears government intends. The effect of price competition on a fuel retail site sales volumes would be suggested as a future study if the proposed partial deregulation of petrol prices materialises.

Motorists can refuel their vehicles at any fuel retail site along their journey. The distance travelled for work and education, which are the main reasons for motor vehicle travel by South Africans, could not be measured; however, the distances could be inferred to highlight a possible limitation of this study. The time travelled for work and education are on average 44 minutes and 41 minutes respectively (Statistics South Africa (2021b). The travel times would mean distances of about 40 kilometres at the maximum urban speed limit of 60 kilometres per hour or roughly 20 kilometres at half the maximum urban speed limit. Either approximation means that travel distance was larger than the radius of two kilometres from a fuel retail site chosen for this study, as done by Gagné *et al*. (2004), to determine the income, population, competition, and saturation index. The large distances travelled for work and education, compared to the small radius chosen for this study could limit the results of this study.

3.10 Validity and reliability

3.10.1 External validity

External validity relates to the generalisability of the study and whether these research results can be relied upon outside of the context of this specific research (Bryman, 2015).

This study was based on retail fuel sales data of a single oil company in South Africa. The oil company has operated retails sites in South Africa for over 15 years and operates 355 fuel retail sites, which was about 7.7 per cent of the total fuel retail sites in South Africa. This was a significant proportion and might result in this study being applicable to the entire industry, particularly if it supports the findings of previous studies in South Africa by Sartorius *et al*. (2007) and Abrams (2009).

External validity might also be high as the sample of 355 gives a 95 per cent confidence level with five per cent margin of error, according to Calculator.net (2022), within the entire industry of approximately 4 600 South African fuel retail sites (SAPIA, 2022b). This study accessed data of at least 355 fuel retail sites, making it the widest public study of this nature in South Africa. Similar studies in South Africa by Sartorius *et al*. (2007) and Abrams (2009) employed a sample of 31 sites and 201 people respectively.

South Africa has the world's most unequal wealth distribution (Chatterjee *et al*., 2020) and the income levels of South Africans guide their choices on energy consumption, transportation, and lifestyle. Wealthy South Africans would have more options and make different choices as opposed to those people not classified as wealthy (which would be the majority). The distribution of retail sites' locations in rich or poor residential areas might limit the generalisability of the study results.

3.10.2 Internal validity

Internal validity is whether the study data shows a causal relationship (Bryman, 2015). The study was expected to have enough power to find a relationship between volume of fuel sold at retail sites and predictor variables within the sample, as the entire population was used.

Internal validity was also ensured by using an ANOVA regression analysis method shared by Lee (2015), which included checks for multicollinearity, heteroscedasticity, outliers, and autocorrelation.

3.10.3 Reliability

Reliability is whether the results of the study are repeatable (Bryman, 2015). These results were expected to be repeatable as good practices were used to collect and analyse the data.

3.10.4 Objectivity

Objectivity was enhanced by using objective data. Sukamolson (2007) stated that a researcher can never truly detach from reality to be truly objective. This research sought to limit the subjectivity by only using data that was physically measurable and did not rely on people's interpretation. This objective data was retail fuel sales volumes, distance between two points, number of retail sites, number of entrances, existence of site services, income level, and number of people.

3.11 Ethical considerations

This research was conducted solely on a desktop, with secondary data, without collection of personal data and without involving human participants. As such there was no human related ethical risk.

This research relied on the oil company's data and the protection of this data was the most important ethical consideration. The researcher committed to anonymising the data and never to reveal the factor used to do so.

Data was stored in a password protected laptop and will be deleted after five years to ensure protection of data.

There were no other ethical concerns identified. Data from Google, that was used, was open source data as it was pictures and maps taken from the public domain. Data sourced from Statistics South Africa, the Independent Election Commission and the South African Revenue Service was also open source as it exists on their public websites.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results of the data analysis carried out. The results of the regression analyses and Fisher z-transformation are presented to assess each hypothesis. The data review process is described before sharing the results pertaining to Hypothesis 1 and Hypothesis 2. The results for Hypothesis 1 include tests for multicollinearity, non-linearity, heteroscedasticity, outliers, normality of residuals and autocorrelation based on the Quarter 1 (Q1) 2020 dataset. This is followed by results from an R-square and analysis of variance (ANOVA) test with review of regression parameters based for both the Q1 2020 and Q1 2022 datasets. The results for Hypothesis 2 include a Fisher z-transformation and a two-sample analysis.

4.2 Data review

Data was reviewed to remove any fuel retail sites with incomplete data, which could have been due to zero sales in a period or voting district or ward inconsistency between datasets sources (IEC, 2022b; StatsSA, 2022a). Zero sales could be due to the fuel retail site being sold or decommissioned and inconsistent voting district or ward could be due to demarcation changes. The process of reviewing the data reduced the dataset from 355 to 285 fuel retail sites.

4.3 Results pertaining to Hypothesis 1

Hypothesis 1 assumed that the volume of fuel sold at retail sites in South Africa was associated with the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail

site, number of competitor sites within two kilometres, saturation level, location metric, and site services.

4.3.1 Multicollinearity

Multicollinearity was tested by using linear regression between each predictor variable, variance inflation, and condition index. All tests indicated no multicollinearity.

The linear regression between each variable showed low R squared values as shown in Table 2, indicating a very low association between predictor variables. The highest association between competition (O) and location (L) could be due to good locations attracting more competition and vice versa.

Table 3: Results of linear regression between each predictor variable

Variables	R squared
I:P	0.08
I:O	0.02
I:L	0.01
I:SS	0.01
P:O	0.04
P:L	0.00
P:SS	0.00
O:L	0.12
O:SS	0.01
L:SS	0.01

Table 3 shows variance inflation was under 2.5 and therefore no multicollinearity existed. Variance inflation above 10 would have indicated multicollinearity (Lee, 2015). The highest variance inflation was for the saturation level (S) which was expected as it was a composite of population and competition.

Table 4: Variance inflation results

Component	Variance Inflation
Sat_2020	2.4
I_2020	1.1
P_2020	1.7
O	1.7
L	1.1
SS	1.0

Condition index was 20 at most, therefore no multicollinearity existed as shown in Table 4. Condition index inflation above 100 would have indicated multicollinearity (Lee, 2015).

Table 5: Condition index results

Number	Condition Index
1	1
2	3
3	5
4	6
5	8
6	10
7	20

4.3.2 *Non-linearity and heteroscedasticity*

Non-linearity and heteroscedasticity were tested by reviewing partial residual plots. The partial residual plots, shown in Figure 5, did not show any obvious non-linear pattern or groupings, indicating that it was not likely that there was any non-linear pattern. The partial residual plots also did not have any obvious shapes (such as fan or diamond), indicating that was not likely that there was a heteroscedasticity issue.

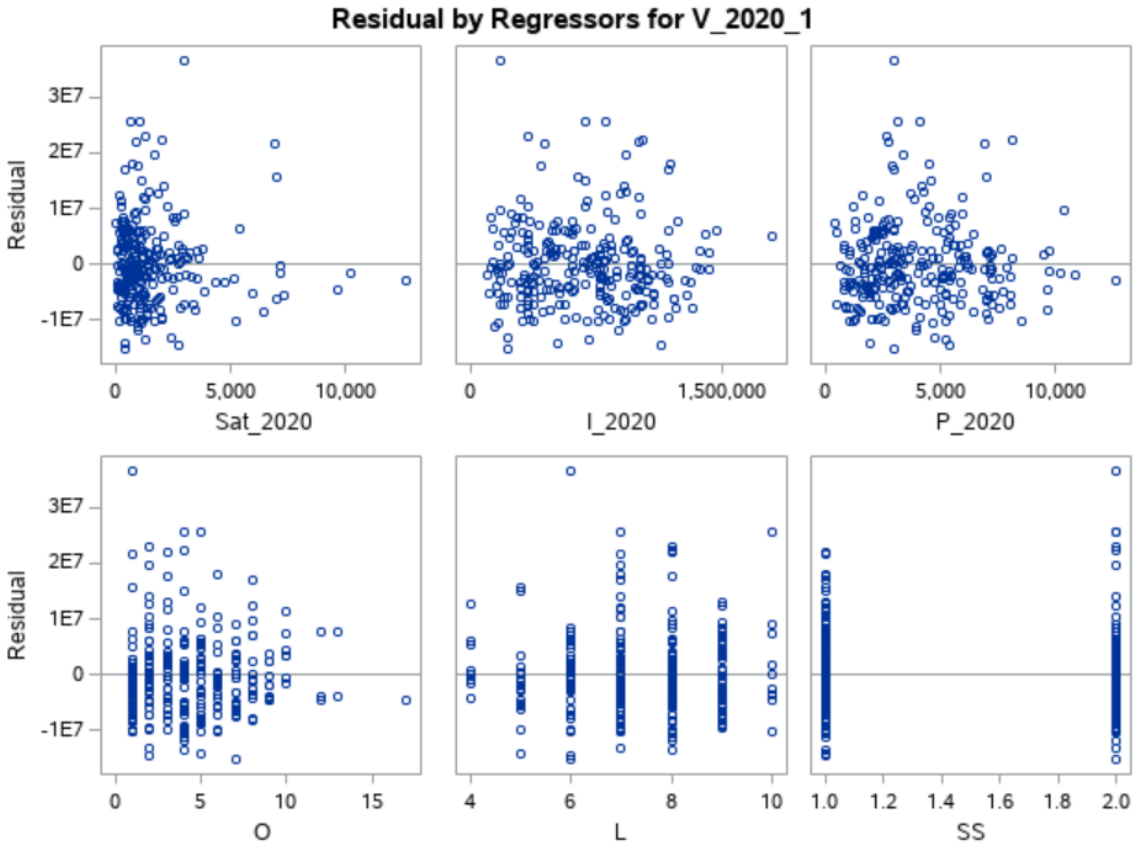

Figure 5: Partial residual plots

4.3.3 *Outliers*

The presence of influential outliers was tested by reviewing Cook's D, studentized residuals and leverage scores (Hats). Table 5 shows the first 11 rows of the results of the influential outlier's tests, sorted by Cook's D. Site number 308 was the only site that appeared to have slightly higher Cook's D and studentized

residual value, indicating that it might have been an influential outlier. However, the R-square value did not improve after removing site number 308 from the dataset, therefore it was concluded that there were no influential outliers.

Table 6: Influential outlier results

Site number	Studentized Residual	Cook's D	Hats
308	4.84	0.09	0.03
170	2.91	0.07	0.05
144	3.39	0.04	0.02
45	2.09	0.03	0.05
105	2.94	0.03	0.03
295	3.03	0.02	0.02
49	2.91	0.02	0.02
325	1.33	0.02	0.07
312	-2.02	0.02	0.03
355	3.35	0.02	0.01
35	2.24	0.02	0.02

4.3.4 Normality of residuals

Normality of residuals was tested by reviewing residual normality plots. Figure 6 shows the residual normality plots, from which it is seen that the residuals were normal as they fall mainly on the diagonal line, though they were slightly skewed from the normal bell curve shape.

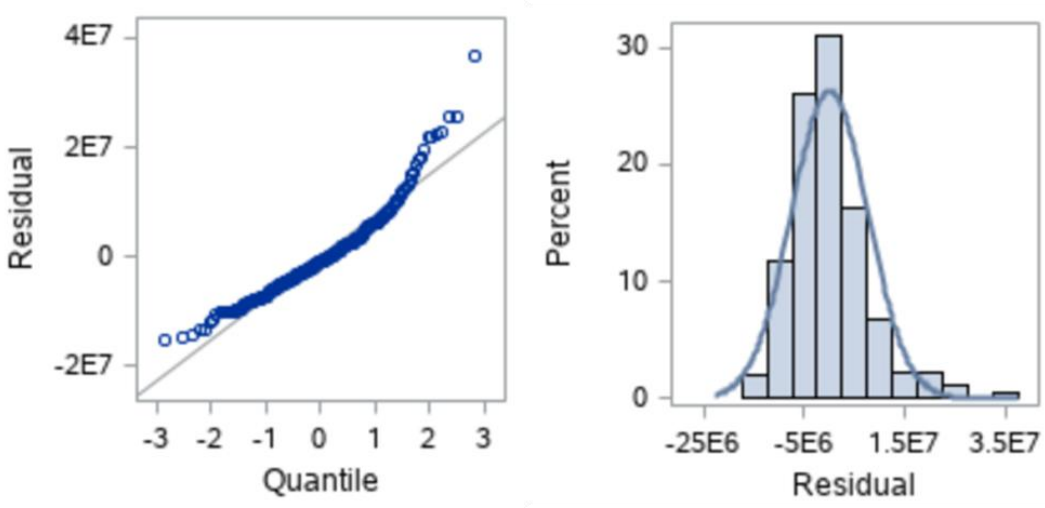

Figure 6: Residual normality plots

4.3.5 Autocorrelation

Autocorrelation was tested by reviewing the Durbin Watson statistic. There was no significant autocorrelation as shown by the Durbin Watson statistic of about 2 and P values above 0.05 as shown in Table 6.

Table 7: Durbin Watson statistic results

Test	Result
Durbin-Watson D	2.003
Pr < DW	0.5015
Pr > DW	0.4985

4.3.6 R-square and Analysis of variance (ANOVA)

The fit of the regressing line was measured with R-square, shown in Table 7. The R-square was 0.10 and the adjusted R-square was 0.08, both of which were low. The regression line calculated does not explain most of the variation in the dependant variable.

Table 8: R-square results

Test	Result
Root MSE	7662504
Dependent Mean	19078176
Coeff Var	40.16371
R-Square	0.10
Adj R-Sq	0.08

The significance of the regression fit was tested with an analysis of variance (ANOVA) test, shown in Table 8. The p-value was low, below 0.0001, indicating a significant straight line fit.

Table 9: ANOVA results

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1.73E+15	2.89E+14	4.92	<.0001
Error	257	1.51E+16	5.87E+13		
Corrected Total	263	1.68E+16			

4.3.7 Regression parameters

The regression parameters (intercept, slope, and significance thereof) are shown for Q1 2020 and Q2 2022 in Tables 9 and 10 respectively. The slope and significance thereof were of interest to understand the association between the dependant and predictor variables.

The saturation level (S) was found to have a low p value of 0.0028 and 0.0009 (should be < 0.05) and the confidence interval excludes zero, therefore the association of saturation level (S) was statistically significant.

Income was found to have a high p value of 0.8815 and 0.8058 and the confidence interval includes zero, therefore the association of income (I) was statistically non-significant.

Population (P) was found to have a high p value of 0.2045 and 0.1079 and the confidence interval includes zero, therefore the association of population (P) was statistically non-significant.

Competition (O) was found to have a high p value of 0.2009 and 0.4532 and the confidence interval includes zero, therefore the association of competition (O) was statistically non-significant.

Location (L) was found to have a high p value of 0.11 and 0.0794 and the confidence interval includes zero, therefore the association of location (L) was statistically non-significant.

Site services (SS) was found to have a low p value of 0.09 and 0.0362 and the confidence interval excludes zero for the Q1 2022 dataset, therefore the association of site services (SS) was statistically significant.

Table 10: Regression parameters for Q1 2020

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardised Estimate	95% Confidence Limits	
Intercept	12,997,984	3,162,186	4.11	<.0001	0	6,770,888	19,225,080
Sat_2020	1,283	426	3.02	0.0028	0.276	445	2,121
I_2020	0	1	0.15	0.8815	0.009	-3	3
P_2020	-338	266	-1.27	0.2045	-0.099	-862	185
O	-282,123	219,994	-1.28	0.2009	-0.100	-715,344	151,098
L	579,661	365,665	1.59	0.1141	0.100	-140,420	1,299,741
SS	1,651,512	977,210	1.69	0.0922	0.102	-272,846	3,575,870

Table 11: Regression parameters for Q1 2022

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardised Estimate	95% Confidence Limits	
Intercept	11,263,407	2,941,188	3.83	0.0002	0	5,471,510	17,055,304
Sat_2020	1,287	382	3.37	0.0009	0.308	535	2,039
I_2020	0	1	-0.25	0.8058	-0.015	-3	2
P_2020	-384	238	-1.61	0.1079	-0.125	-852	85
O	-153,668	204,565	-0.75	0.4532	-0.059	-556,506	249,170
L	598,907	340,070	1.76	0.0794	0.111	-70,772	1,268,585
SS	1,913,234	908,756	2.11	0.0362	0.127	123,678	3,702,789

The saturation level (S) and site services (SS) were found to have a statistically significant association with the volume of fuel sold at retail sites, while all other variables did not have a statistically significant association, therefore a further regression with only saturation level (S) and site services (SS) was performed. This regression resulted in a R-square of 0.0781 and 0.0788 for the Q1 2020 and Q1 2022 datasets as seen in Tables 11 and 12 respectively. The tables also show that the low P-values and non-zero confidence interval confirmed saturation level (S) and site services (SS) association with volume of fuel sold at retail sites remained statistically significant.

Table 12: Parameter estimates for Q1 2020 dataset with S and SS

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardised Estimate	95% Confidence Limits	
Intercept	14,555,273	1,504,478	9.67	<.0001	0	11,592,814	17,517,732
Sat_2020	1,170	276	4.24	<.0001	0.252	626	1,713
SS	1,939,360	959,904	2.02	0.0444	0.120	49,218	3,829,501

Table 13: Parameter estimates for Q1 2022 dataset with S and SS

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardised Estimate	95% Confidence Limits	
Intercept	13,297,356	1,401,273	9.49	<.0001	0	10,538,117	16,056,595
Sat_2020	1,011	248	4.08	<.0001	0.242	522	1,499
SS	2,126,524	894,157	2.38	0.0181	0.141	365,844	3,887,204

4.4 Results pertaining to Hypothesis 2

Hypothesis 2 assumed that there was no change between 2020 and 2022 in the association between volume of fuel sold at retail sites in South Africa and the average income per adult residing within two kilometres, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric, and site services.

The results for hypothesis 2 include a Fisher z-transformation and a two sample analysis. The regression performed for the statistically significant variables saturation level (S) and site services (SS) showed an R-value of 0.279 and 0.281 for the Q1 2020 and Q1 2022 datasets, respectively. The Fisher z-transformation and two sample analysis was performed using the tool provided by Lowry (2022) as shown in Table 13. Both the one-tailed P-value and two-tailed P value were well above 0.05, therefore the association of saturation level (S) and site services (SS) with fuel sold at a retail site for the Q1 2020 and Q1 2022 datasets were not statistically different.

Table 14: Results of Fisher z-transformation and a two sample analysis

Test	Result
Z	-0.02
P one-tailed	0.492
P two-tailed	0.984

4.5 Summary of results

Data was reviewed before performing regression analysis and Fisher z-transformation analysis to evaluate Hypothesis 1 and Hypothesis 2.

The regression analysis showed that there was no multicollinearity, no non-linearity, no heteroscedasticity, no influential outliers, no autocorrelation, and that

residuals were normal based on the Q1 2020 dataset. Therefore, the linear regression results were valid. The R-square and analysis of variance (ANOVA) test showed that the saturation level (S) and site services (SS) had a statistically significant association with volume of fuel sold at retail sites, while the other variables did not have a statistically significant association.

The regression performed for the statistically significant variables saturation level (S) and site services (SS) was used in the Fisher z-transformation. The comparison showed that the association of saturation level (S) and site services (SS) with fuel sold at a retail site for the Q1 2020 and Q1 2022 datasets were not statistically different.

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

Regression analysis and Fisher transformation were used to evaluate Hypothesis 1 and Hypothesis 2. The resulting associations are discussed first before discussing the changes in the association and concluding on Hypotheses 1 and 2.

5.2 Discussion on the association between the volume of fuel sold and predictor variables

Regression analysis showed that saturation level (S) and site services (SS) had a statistically significant association with the volume of fuel sold at retail sites, while the other variables did not have a statistically significant association.

This was the first known study that analysed the influence of saturation level on sales at a fuel retail site. It was expected that saturation level (S) would be associated with volume of fuel sold at retail sites, as part of the model proposed by Turhan *et al*. (2013); therefore, finding a significant association partially validated Hypothesis 1. The influence of saturation level was also found to be the largest contributor as the standardised association was the largest. Saturation level was meant to indicate the degree to which customer needs could be serviced and it was defined as the adult population divided by the number of fuel retail sites within two kilometres. A higher saturation level would create more opportunity for sales at a fuel retail site and vice versa, as proposed by Turhan *et al*. (2013). However, the internal combustion engine was dominant in South Africa (with electric cars accounting for 0.2 per cent of new car sales (Montmasson-Clair, 2022)) and there is a lack of alternate modes of transport (public transport being one of South Africa's challenges (Department of Transport, 2020)). This allows liquid fuels to be the dominant energy source for transportation in South Africa. It made sense that at a higher saturation level, with a higher population

serviced per fuel retail site, there was less of a need to have other contributing factors to enable sales.

It was expected that the number of competitor sites (O) and adult population (P) residing within two kilometres of a fuel retail site would be associated with the volume of fuel sold at retail sites, as part of the model proposed by Turhan *et al*. (2013); therefore, not finding a significant association partially invalidates hypothesis 1. The lack of an association with adult population (P) residing within two kilometres of the fuel retail site could have been due to the process used to gather data. Adult population (P) residing within two kilometres of the fuel retail site was not directly used in the regression, as the data was not easily available for the 355 fuel retail sites included in the study. Instead, adult population per voting district was used as a substitute. A voting district has a radius of between 7.5 and 10 kilometres (IEC, 2023), which might have been too large to properly determine an association as some retail sites were in the same voting district. There were 317 unique voting districts with 355 fuel retail sites. Adult population per voting district was gathered by forecasting from Statistics South Africa (StatsSA, 2022b) and inferring a population distribution from the Independent Electoral Commission (IEC, 2022a). The forecasting and distribution inference might have created inaccuracies.

It was expected that car ownership (C) by people residing within two kilometres of a fuel retail site would be associated with the volume of fuel sold at retail sites; however, such data was not found. Therefore, this association could not be explored.

It was expected that site services (SS) would be associated with volume of fuel sold at retail sites, as part of the model proposed by Turhan *et al*. (2013); therefore, finding a significant association partially validates Hypothesis 1. Site services act as a magnet to customers, a differentiator that improves customer convenience. Turhan *et al*. (2013) defined magnets as other non-competing services that draw consumers towards the vicinity of a retail site. Site services act as a magnet drawing people towards the fuel retail site, which increases the

opportunity to sell fuel giving rise to the association with fuel sales. Site services also differentiate a fuel retail site from competitors as explained by Stavrakakis and Chountalas (2015) and has been shown to be a factor in consumers choice of a fuel retail site (Kakunu, 2012; King *et al*., 2018). Non-fuel services improve a fuel site's profit and create a better value position for consumers, which allow consumers the opportunity to minimise inconvenience (Miller, 1979). The effect of site services could be illustrated by a customer choosing a fuel retail site to reduce inconvenience while buying fuel, such as buying daily groceries or fast food while the motor vehicle was being filled with fuel.

It was expected that average income per adult (I) residing within two kilometres of a fuel retail site, as part of demographics in the Turhan *et al*. (2013) model, would be associated with the volume of fuel sold at retail sites, therefore not finding a significant association partially invalidates Hypothesis 1. The lack of association was surprising as income levels dictate buying power and buying power was generally associated with retail sales, according to Turhan *et al*. (2013). The lack of association could be due to data shortcomings and the necessity of fuel. Average income per adult (I) residing within two kilometres of a fuel retail site was not directly used in the regression as the data was not available for the 355 fuel retail sites included in the study. Instead, average income per ward was used as a substitute. Average income per ward was gathered by forecasting based on data from the South African Revenue Services (SARS, 2022) and inferring an income distribution from Statistics South Africa (StatsSA, 2022a). The forecasting and distribution inference might have created inaccuracies. The wards might have been too large to determine an association as many fuel retail sites were in the same ward. There were 177 unique wards with 355 fuel retail sites, giving an average of three fuel retail sites per ward. There might be a significant difference in income levels within a ward as South Africa has a highly unequal distribution of wealth (Chatterjee *et al*., 2020). Fuel is also a necessity to power modern living standards, which can be inferred from its price inelasticity (Akinboade *et al*., 2008). It might be that people, rich and poor alike, are simply required to purchase fuel. In addition, it might be that richer

households use more delivery services, which could be more fuel efficient, thereby offsetting their higher fuel needs.

It was expected that location (L) would be associated with the volume of fuel sold at retail sites, as part of store characteristics in the Turhan *et al*. (2013) model, therefore not finding a significant association partially invalidates Hypothesis 1. Location of fuel retail sites was generally accepted as a key driver of fuel sales (Abrams, 2009; Chan *et al*., 2005; King *et al*., 2018; Mwenda & Oloko, 2017; Sartorius *et al*., 2007; Siddique & Jalil, 2018; Tawia, 2018), therefore it was surprising that no association was found. Each study defines location differently, as shown in Table 14, which might cause differing results. However, this study's definition of location was similar to that of King *et al*. (2018) and Sartorius et al. (2007), so differing definitions do not fully explain differences between this study, and the studies by King et al. (2018) and Sartorius *et al*. (2007).

Table 15: Differing location definitions

Study	Location definition
Abrams, 2009	Survey respondent's interpretation
Chan *et al*., 2005	Closeness to airports, highways and towns
King *et al*., 2018	Close to residential, commercial, industry Limited competition Ease of entrance Close to shopping centres
Mwenda & Oloko, 2017	Accessibility
Sartorius *et al*., 2007	Proximity to a major route Accessibility Proximity to rural/urban area Proximity to a shopping centre
Siddique & Jalil, 2018	Urban or highway
Tawia, 2018	Survey respondent's interpretation
This study	Proximity to a major route Number of entrances

Study	Location definition
	Vehicle flow potential Proximity to a work area, school, or mall

The non-significant variables were removed from the regression and the regression analysis was performed with saturation level (S) and site services (SS), which were found to have a statistically significant association with volume of fuel sold at retail sites, though the R-square was low at 0.078. Roughly speaking, 7.8 per cent of the variance of fuel sales was explained by saturation level (S) and site services (SS). There would be many other variables that could explain the remaining 92.2 per cent, perhaps car ownership by people residing within two kilometres (as originally proposed), number of pumping bays (Sartorius *et al*., 2007), service (Kakunu, 2012; Sartorius *et al*., 2007) and image (Kakunu, 2012). Rewards and brand have been shown to influence sales, as found by Hassan and Ahmed (2011) and Mwenda and Oloko (2017), but this would not have been a contributing factor in this study as a single brand was used.

The lack of association between volume of fuel sold at retail sites and variables that were defined by a radius of two kilometres, such as average income, adult population, number of competitor sites, and elements of the location metric, could be due to the radius being too small. The two-kilometre radius was chosen to define the market for a fuel retail site. Distances travelled by motor vehicles drivers could not be measured by Statistics South Africa (2021b) but could be inferred to be at least 20 kilometres for work and education. This large radius of travel and the lack of association between volume of fuel sold at retail and variables that were defined by a radius of two kilometres could mean that the radius of customers and competitors for fuel retail sites was larger than two kilometres.

Following the results of the regression analysis, it was concluded that Hypothesis 1 was partially valid. The volume of fuel sold at retail sites in South Africa was associated with saturation level (S) and site services (SS) but was not associated with the average income per adult residing within two kilometres, adult population

residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, and location metric. No conclusion was made about the association with car ownership by people residing within two kilometres, as it was not studied due to the lack of data.

5.3 Discussion on changes in the association between the volume of fuel sold and predictor variables

The Fisher z-transformation comparison showed that the association of saturation level (S) and site services (SS) with fuel sold at a retail site for the Q1 2020 and Q1 2022 datasets were not statistically different. This was expected as peoples' movements in 2022 had returned to similar levels as 2020, as shown by Our World in Data (2022b). The return to 2020 lifestyles was not conclusively known as Matli (2020) anticipated that working from home would not be permanently adopted on a large scale in South Africa while Young (2020) expected large and far reaching changes to tourism. Perhaps lifestyles have changed, but it was not within the scope of this study to pronounce on lifestyle changes. Even if lifestyles have changed, there has been no known impact on the association of fuel sold at a retail site with saturation level (S) and site services (SS).

Following the regression analysis that showed that only saturation level (S) and site services (SS) were associated with volume of fuel sold at retail sites in Q1 2020 and Q1 2022, and the Fisher z-transformation comparison that showed that the association had not changed. It was concluded that Hypothesis 2 was valid. There was no change between Q1 2020 and Q1 2022 in the association between volume of fuel sold at retail sites in South Africa and the average income per adult residing within two kilometres of a fuel retail site, adult population residing within two kilometres of a fuel retail site, number of competitor sites within two kilometres, saturation level, location metric and site services. No conclusion was made on the association with car ownership by people within two kilometres, as it was not studied due to lack of data.

5.4 Conclusion

The associations found in this study through regression analysis showed that Hypothesis 1 was partially valid. The outcome could have been influenced by the quality of data but barring this, the volume of fuel sold at retail sites of an oil company in South Africa was associated with saturation level (S) and site services (SS) but was not associated with the average income per adult residing within two kilometres, adult population residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, and location metric. The association of saturation level (S) and site services (SS) with volume of fuel sold at retail sites had a low R-square; therefore, there would be many other associated variables. The other variables could be car ownership by people residing within two kilometres (as originally proposed), number of pumping bays, and image. Rewards and brand, which have been shown to influence sales, would not have been a contributing factor in this study as a single brand was used.

Comparison of the associations found, together with lack of other associations in both periods, showed that Hypothesis 2 was valid. There was no change between 2020 and 2022 in the association between volume of fuel sold at retail sites in South Africa and the average income per adult residing within two kilometres, adult population residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric, and site services. Similar associations were probably due to return to similar movement levels and similar lifestyles.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The association between the volume of fuel sold at retail sites and predictor variables, in South Africa, was explored before and after COVID-19, with January to March 2020 serving as a pre-COVID period and January to March 2022 as the post-COVID period. Predictor variables were based on categories put forward by Turhan *et al*. (2013) and integrated with predictor variables, put forward by Chan *et al*. (2005), Sartorius *et al*. (2007), Tawia (2018), Siddique and Jalil (2018), and King *et al*. (2018). This resulted in seven variables hypothesised to be associated with the volume of fuel sold at retail sites.

It was first hypothesised that the volume of fuel sold at retail sites in South Africa is associated with the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, car ownership by people residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres of the fuel retail site, saturation level, location metric, and site services. Second, these associations had not changed.

These hypotheses were explored by gathering data on fuel sales at retail sites of an oil company, and using public domain datasets of taxable income data (SARS, 2022), household income data (StatsSA, 2022a), adult population (StatsSA, 2022b), voter registration (IEC, 2022a), and Google Maps to compile competition, location, and site services data. The data sets were reviewed for completeness before performing regression analysis and Fisher z-transformation.

This chapter reflects on the findings for both hypotheses, while integrating them into the main research question. Recommendations are made for stakeholders and for future research.

6.2 Conclusions regarding Hypothesis 1

Following the results of the regression analysis, it was concluded that Hypothesis 1 was partially valid. The volume of fuel sold at retail sites in South Africa was associated with saturation level and site services but was not associated with the average income per adult residing within two kilometres of the fuel retail site, adult population residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, and location metric. No conclusion was made on the association with car ownership by people residing within two kilometres of the fuel retail site; it was not studied due to lack of data. The association between volume of fuel sold at retail sites and saturation level and site services had a low R-square of 0.078; therefore, there would be many other variables associated with the volume of fuel sold at retail sites. The other variables could be car ownership by people residing within two kilometres (as originally proposed), number of pumping bays, and image. Rewards and brand, which have been shown to influence sales, would not have been a contributing factor in this study as a single brand was used.

This study supports the view of Turhan *et al*. (2013) view that competition is likely more linked to price elasticity, as no association was found between competition and volume of fuel sold. Turhan *et al*. (2013) also expected that store characteristics would differentiate competitors and influence consumers' choice on where to spend their money. Perhaps, there was not enough differentiation between fuel retail competitors to influence consumer choice. Fuel could be regarded as a commodity by consumers and their needs were equally served at any retail site.

The lack of association between volume of fuel sold at retail and variables that were defined by a radius of two kilometres, such as average income, adult population, number of competitor sites, and elements of the location metric, could be due to the radius being too small. Distances travelled could be inferred to be at least 20 kilometres for work and education. This large radius of travel and the lack of association between volume of fuel sold at retail and variables that were

defined by a radius of two kilometres could mean that the radius of customers and competitors for fuel retail sites was larger than two kilometres.

6.3 Conclusions regarding Hypothesis 2

Comparison of the associations found, together with the lack of other associations in both periods, showed that Hypothesis 2 was valid. There was no change between Q1 2020 and Q1 2022 in the association between the volume of fuel sold at retail sites in South Africa and the average income per adult residing within two kilometres, adult population residing within two kilometres of the fuel retail site, number of competitor sites within two kilometres, saturation level, location metric, and site services. This could mean that fuel consumers' lifestyles have not been changed by COVID-19. The changes brought about by Governments' restrictions on people movements have not had a lasting effect on behaviour. Behaviour changes could have been in shopping, commute for work, and leisure. Wang *et al*. (2020) expected American consumers to continue to rely more on online shopping but this might not be taking place in South Africa, which could agree with the expectations of Zannat *et al*. (2021) that context and location conditions would influence online shopping. Likewise, South African conditions might be hindering the permanent adoption of working from home (as expected by Matli (2020)), resulting in fuel demand for the work commute being unchanged after COVID-19. Leisure activities were also expected to return to normal; during adjusted Alert Level 1 in Q1 2022 South Africans' visits to retail and recreation facilities was eight per cent above baseline (Our World in Data, 2022b).

6.4 Recommendations

The lack of other associations and a low R-square value for the association between fuel sold at retail sites and saturation level (S) and site services (SS) could be a result of liquid fuels being the dominant energy source for transportation in South Africa. The dominant nature of liquid fuels means that a careful balance, that ensures enough fuel supply for consumers and appropriate

profit for fuel retailers, should be found. Saturation level and site services can be used to guide this balance between consumers' needs and business profits.

This study was the first known study to apply the retail performance model put forward by Turhan *et al*. (2013) to fuel retail in South Africa and the first study in South Africa that uses sales data of 355 fuel retail sites. In doing so, it illustrated that the model proposed by Turhan *et al*. (2013) has very little applicability to fuel retail sites in South Africa.

COVID-19 was an exogenous economic and societal shock; however, no change was found in the association of volume of fuel sold at retail sites in South Africa and predictor variables studied. This could point to a resilient and predictable fuel retail sector.

6.5 Suggestions for further research

There would be value in exploring the influence of car ownership by people residing within two kilometres of fuel retail sites on fuel sales at these retail sites, as it was not studied due to lack of data.

Brand and price, together with loyalty programmes, was not included as a predictor variables and may have limited the application of this study. Further research into the association of brand and price with fuel sales may be beneficial.

Study of consumers' perceptions of fuel retail site differentiation would help explore whether the lack of differentiation of retail sites could have resulted in no association between competition and volume of fuel sold.

In South Africa, there is a large variation in demographics and spatial distribution between townships, urban areas, rural areas and central business districts. Understanding the association of predictor variables with fuel sales in each of these location categories may be useful to help develop service offering tailored to the population in the area.

As consumers have a large radius of travel; hence, the lack of association between volume of fuel sold at retail sites and variables that were defined by a radius of two kilometres could mean that the radius of customers and competitors for fuel retail sites was larger than two kilometres. Understanding the potential market and competitors of fuel retail sites would be valuable, especially if price deregulation is implemented and fuel retail sites price for sales.

Further application of the retail performance model, conceptualised by Turhan *et al*. (2013), in other retail sectors would help illustrate the applicability and limitations of the model.

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APPENDIX A: Profiles of G Turhan, C Zehir, and M Alkalin

G. Turhan is an associate professor in the Department of Textile Management and Marketing at Faculty of Technology, Marmara University. She holds a bachelor's degree (2001), master's degree (2005), doctorate (2009) and a postdoctoral degree (2016). G. Turhan is credited with 25 publications.

C. Zehir is a professor at the Department of Administration, Faculty of Economic and Administrative Sciences, Yildiz Technical University. He holds a bachelor's degree (1993), postgraduate qualifications (1995 and 1996) and doctorate (1999). C Zehir is credited with 118 publications.

M. Alkalin is at the Department of Textile Engineering, Marmara University. M. Alkalin is credited with 66 publications.

APPENDIX B: Data sample

Site number	2020 sales unit / month (V)	2022 sales unit / month (V)	2020 Average Taxable Income per ward (I)	2022 Average Taxable Income per ward (I)	2020 Adult Population per Voting District (P)	2022 Adult Population per Voting District (P)	Site services (SS)	Competitor sites (O)	Location metric (L)
Source	Oil company data	Oil company data	Developed during this study	Developed during this study	Developed during this study	Developed during this study	Google Maps	Google Maps	Google Maps
2	20,138,382	18,818,223	214,554	243,822	419	435	2	0	4
3	15,449,356	12,649,701	214,554	243,822	419	435	2	0	4
4	25,158,192	20,358,819	959,460	1,052,896	7,134	7,408	1	1	7
5	25,465,586	20,668,266	959,460	1,052,896	7,134	7,408	2	1	7
6	16,094,210	13,824,079	619,098	679,388	5,838	6,062	2	5	8
7	18,870,039	24,628,261	1,289,717	1,415,314	7,347	7,629	1	1	5
8	12,354,608	11,470,679	1,322,603	1,429,039	914	949	2	5	9
9	1,975,170	1,815,074	515,696	571,095	1,971	2,022	1	5	5
10	23,871,460	19,309,054	1,020,609	1,119,999	4,906	5,094	2	2	9
11	10,776,569	8,864,906	399,165	438,038	3,590	3,728	1	0	4
12	15,773,385	21,093,586	619,098	679,388	9,723	10,095	2	8	8

APPENDIX C: Sample of income data determination

	Average taxable income (R)							Average taxable income (R)	
Tax year	2015	2016	2019	2020	slope	intercept	r squared	2021	2022
Eastern cape	224,624	246,811	294,181	289,114	13,449	-26,870,286	0.92	309,144	322,593
Free state	203,487	226,764	278,438	282,932	16,025	-32,086,587	0.94	300,113	316,138
Gauteng	325,634	358,088	409,463	408,537	16,583	-33,082,510	0.94	431,739	448,322
KZN	245,091	270,154	311,394	306,323	12,567	-25,072,198	0.92	326,662	339,230
Limpopo	232,750	257,846	325,197	316,991	18,017	-36,070,067	0.90	342,215	360,232
North West	217,009	245,448	277,907	298,472	14,709	-29,417,434	0.96	309,418	324,127
Mpumalanga	248,925	274,633	298,296	302,354	9,967	-19,826,947	0.92	316,719	326,686
Northern Cape	223,764	246,979	305,732	308,501	17,336	-34,709,923	0.91	326,691	344,027
Western Cape	270,582	304,799	343,460	341,943	13,761	-27,447,316	0.91	364,066	377,827

(SARS, 2022)

Mpumalanga				
Average taxable income (R)			302,354	326,686
Ward	Annual household income	% of province average	2020 income	2022 income
83001001	32,029	46.6%	141,082	152,436
83001002	25,937	37.7%	114,247	123,441
83001003	30,194	43.9%	133,001	143,705
83001004	48,229	70.2%	212,443	229,539
83001005	57,248	83.4%	252,169	272,462
83001006	34,283	49.9%	151,010	163,163

APPENDIX D: Sample of population data determination

Province	2002 population	2003 population	2004 population	2020 population	2021 population	slope	intercept	r squared	2022 population
Western Cape	3,063,024	3,140,277	3,222,595	4,789,743	4,866,227	97,332	-191,841,106	1.00	4,964,513
Northern Cape	598,127	608,024	617,919	808,695	814,909	11,811	-23,052,309	1.00	829,333
Eastern Cape	3,394,200	3,428,447	3,453,275	3,903,075	3,871,315	29,995	-56,646,113	0.96	4,003,063
Free State	1,598,236	1,606,832	1,614,252	1,841,055	1,842,856	14,004	-26,455,962	0.99	1,861,105
KwaZulu-Natal	5,132,345	5,204,044	5,273,142	6,828,688	6,874,090	97,797	-190,737,388	1.00	7,007,150
Mpumalanga	1,858,155	1,910,330	1,961,775	2,916,321	2,954,076	59,584	-117,449,038	1.00	3,029,327
Limpopo	2,459,949	2,507,581	2,546,260	3,342,201	3,346,798	51,110	-99,879,240	0.99	3,464,352
North West	1,794,128	1,826,822	1,859,446	2,576,227	2,607,343	44,437	-87,202,997	1.00	2,648,707
Gauteng	6,476,399	6,644,447	6,834,417	10,777,584	11,012,148	244,141	-482,462,953	1.00	11,190,753

(StatsSA, 2022b)

Mpumalanga					
Population estimate			2,916,321	2,954,076	3,029,327
Voting district	Sum of Registered Population	% of population in voting district	2020 population	2021 population	2022 population
54100011	1,652	0.085%	2,475	2,507	2,571
54100022	1,582	0.081%	2,370	2,401	2,462
54100033	1,997	0.103%	2,992	3,031	3,108
54100044	791	0.041%	1,185	1,200	1,231
54100055	98	0.005%	147	149	153
54110012	1,518	0.078%	2,274	2,304	2,363

(IEC, 2022a)