CONSULTING REPORT
FOR KIA MOTORS

Group Assignment
Fall 2019

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1.0 Introduction and Scope

1.1 About Us

Infinity Consulting is dedicated on providing intelligent solutions and superior services to organizations. Our goal is to offer guidance to businesses that require any strategy consultation using the latest data analytics and web scraping methods. Our vision is to provide customers with the best possible guidance in order to achieve their strategic goals based on data not mere mythologies.

1.2 Executive Summary

This consulting report has been produced for our client, KIA Motors, hereinafter referred to as KIA. KIA is an automobile company that has been in the market for 74 years. They are seeking to exploit the current opportunities in the car manufacturing industry in the US. In order to achieve this, we have structured a report that includes an analysis of undiscovered car markets for KIA and the main competitors and a predictive model that estimates car's prices based on our recommendations.

Initially the report guides the reader through all the data collection and cleaning steps conducted to produce the final dataset used in our analysis. Then, potential markets are analyzed to highlight the main reasons for our decision to focus only on 3 out of the 4 potential markets. In the main body of the report we provide a thorough analysis of the market characteristics and provide a competitor report to identify potential market positioning for KIA. We then provide model suggestions for each market that are finally imported into a predictive model to estimate their prices. The report concludes with an overview of the analysis and the limitations of our approach.

2.0 Dataset

2.1 Description of the dataset

The dataset that we exploit in this report contains information for produced cars from 1999 to 2018 for 43 car manufacturers and 32316 cars. Figure 1 shows a list with the manufactures and the number of cars they produced. For our analysis we are going to consider car models only from 2014 to 2018 because the automotive market changes significantly across the years. The dataset contains 234 different attributes that describe different aspects of each car which we grouped into three categories:
- Car dimensions
- Fuel economy
- Power performance
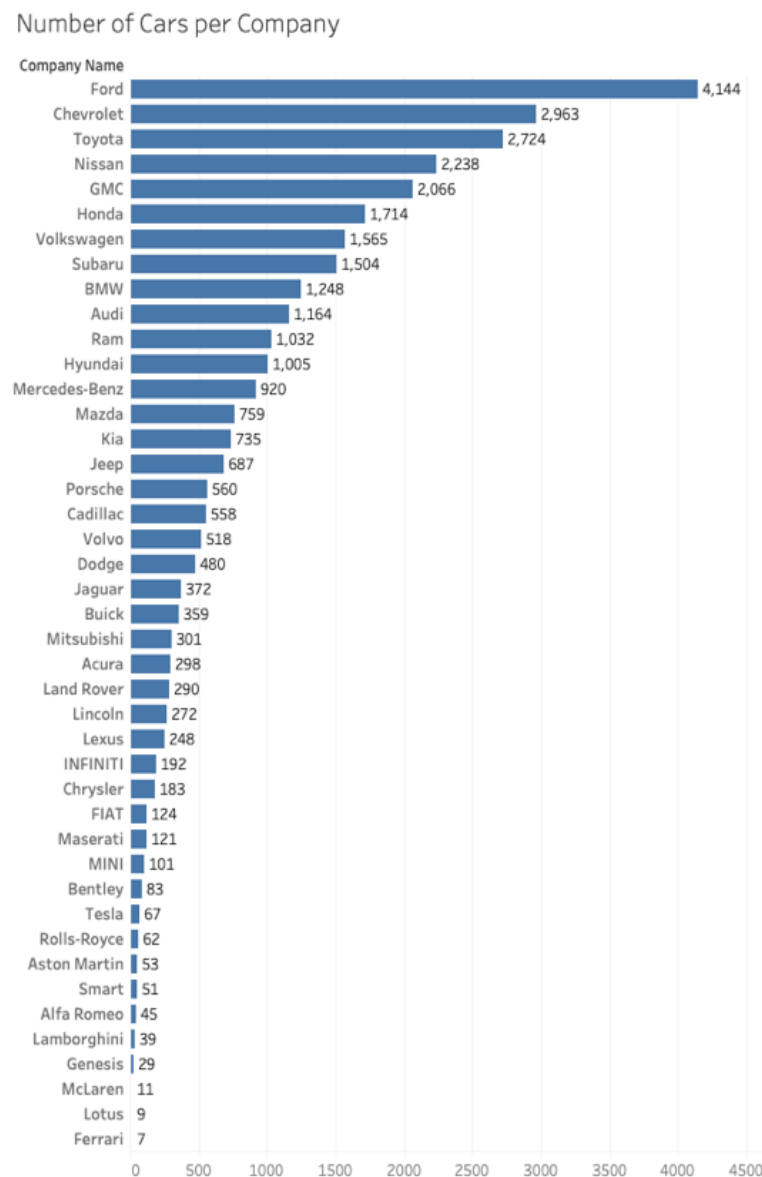
Figure 1: Number of Cars produced by each Manufacturer

2.2 Collection of the Dataset

Our dataset is based on an initial project from Nicolas Gervais. In his GitHub repository[1] he has provided a script which shows how he scraped data from the Car Connection website[2].For our report we have used the same dataset.

2.3 Major data cleaning steps

The data were transformed and cleaned in a useful format for our analysis. Scrapping fetches data in a raw format which makes it difficult to work with. In brief we have performed the following steps:

- Saved the data in a tabular format, declared attributes as numerical, matched different decimal points (points and commas), removed special characters from numerical values, extracted the release year of each car from its commercial name.
- Matched different text labels that are referring to the same values e.g "Front Wheel Drive" with "Front-Wheel Drive".
- Manually imputed cars which had a missing (EPA) Classification e.g compact,SUV etc.
- Created or calculated new attributes based on existing ones. For example, the tire width ratio was created, based on the existing rear tire width and the front tire width.
- Identified which cars are Hybrid or Full Electric based on their commercial name or the engine that they use.
- Identified outliers which were due to mistypes and we turned them into missing values
- Removed attributes with more than 75% of missing values and attributes that carried the same information e.g Displacement in Liters and Displacement in cc. From 234 attributes we ended up with 30 attributes.

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[1] https://github.com/nicolas-gervais/predicting-car-price-from-scraped-data
[2] https://www.thecarconnection.com/aboutus

3.0 Analysis of new markets

We initially identified the four markets that KIA is not present, and we have seen how the production changes throughout the years. Since we do not have sales in our data, we will use production as a proxy for demand and market health. Figure 2 illustrates the markets KIA is not present and the production by years.

Figure 2: Production Volume of each Market that KIA is not present

Our analysis focuses on the Hybrid SUVs, Two-seaters and Pick-up Trucks market because all three show evidence of growth in the recent years. We decided to discard the market of wagons as the conditions look unfavorably. In fact, Honda that is KIA's direct competitor has decided to withdraw from the wagon market in 1998. This phenomenon can be explained by the fact that these cars have been largely replaced by SUVs.

3.1 Hybrid SUV Market

Given the positive market outlook and the fact that KIA is currently produces hybrid cars in compact and medium segment our suggestion is to expand the company's portfolio by entering the Hybrid SUV market. There are seven companies supplying this market that can be divided into low-cost and high-cost/Luxury brands. Ford, Nissan and Toyota are brands that focus on affordability and high efficiency while Audi, Porsche, BMW and Dodge are more expensive brands that are associated with luxury and high power. Ford is considered the main competitor producing low-cost, high-efficiency cars and has the strongest presence in terms of volume of model production. Figure 3 shows the competitors in this market.
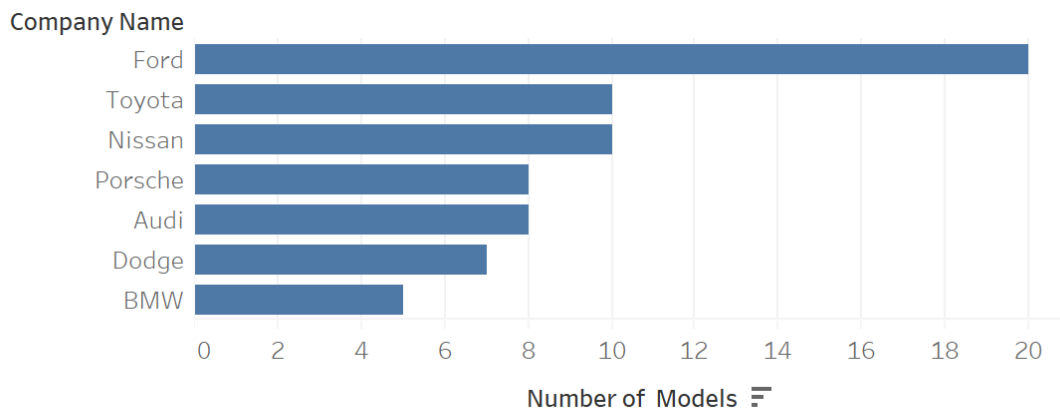
Figure 3:Number of Hybrid SUVs produced by Manufacturers

KIA has experience in both Hybrid and SUVs market (Figure 4). Therefore, they can combine the accumulated experience to expand to the hybrid SUV market with relatively low barriers. Considering the company's focus on affordability we strategically analyze a potential positioning in the market.
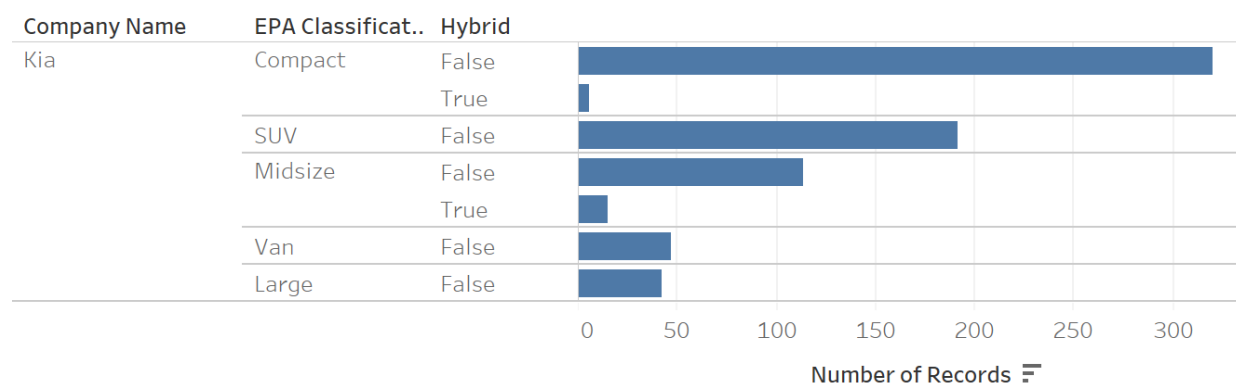
Figure 4: KIA's composition of type of cars manufactured
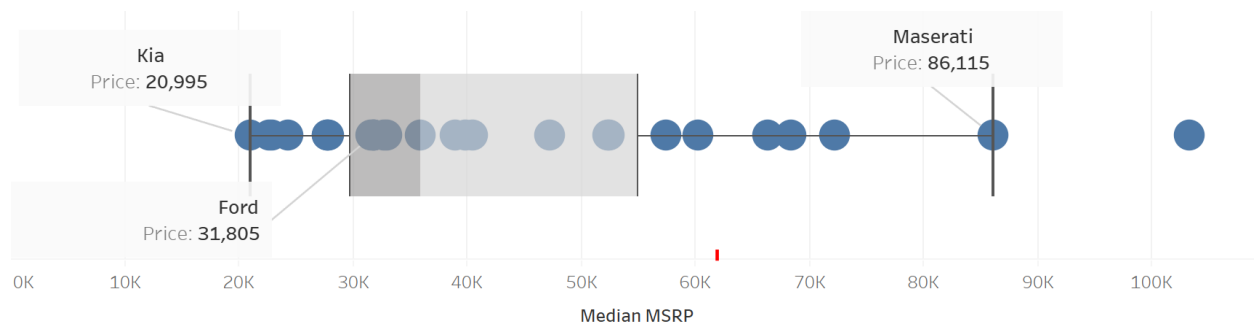
Figure 5: Box Plot of average price distribution of SUV market

Figure 5 illustrates the range of prices in the regular SUV market showing that KIA charges the lowest average price among the competitors.
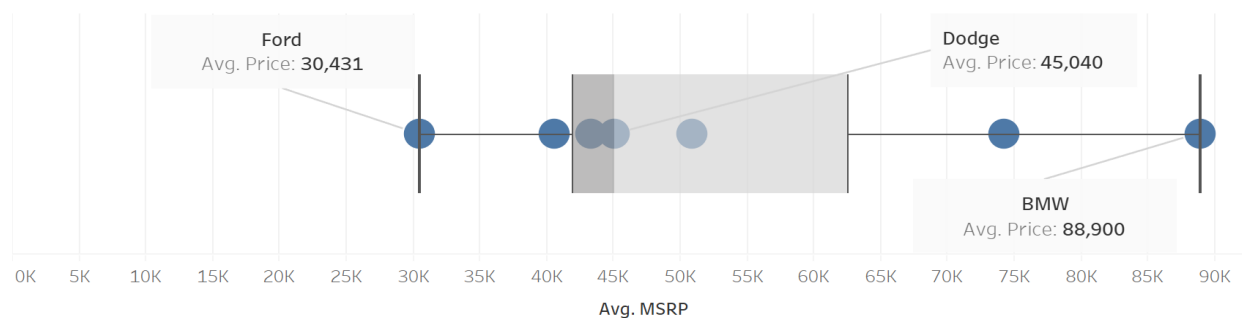
Figure 6:Box plot of average price distribution of Hybrid SUV market

As seen in figure 6, prices range for Hybrid SUVs is $30,430-$88,900 where the former is the average price charged by Ford and the latter is the average price charged by BMW. The median price in the market is charged by Dodge which is at $45,040. Ford charges a similar price for its regular SUVs and Hybrids ($31,805 and $30,570 respectively). We noticed that in the regular SUV market KIA has a competitive advantage against Ford in terms of price. Therefore, If KIA is able to position itself in the Hybrid SUV market with a price similar to what is charged in the regular SUV market ($20,995) it will gain a competitive advantage that may result in capturing some of the market share of the main competitors.

Company Name	Avg.Base Curb Weight (lbs)	Avg.Height, Overall (in)	Avg. Wheelbase (in)
Ford	3,937	69	103
Porsche	4,109	67	114
Nissan	4,175	68	113
Audi	4,431	65	111
Toyota	4,646	68	110
Dodge	5,406	74	119
BMW	5,727	67	116

Table 1: Customer Specification Report (Green rows are the direct competitors)

Company	Avg. Base Curb Weight (lbs)	Avg. Height, Overall (in)	Avg. Wheelbase (in)
Ford	3,937	69	103
Nissan	4,175	68	113
Toyota	4,646	68	110
min	3,937	68	103
max	4,646	69	113
average	4,253	68	109

Table 2: Low-Cost Competitors and summary statistics of their specifications

3.1.1 Car Dimensions

3.1.1.1 Weight

There are many reports that quantify the negative impact of weight on fuel efficiency (MIT-2008; EPA-2012). This is also evident in our dataset were heavier Hybrid SUVs have a negative correlation with MPG (Figures 7&8). In this market the average weight of the cars is between 3,937 lbs and 5,727 lbs with an average of 4,253lbs. If we consider the competitors that have similar characteristics to KIA (low-cost, high-efficiency) then it would be advised to limit the weight of the car close or below the median (4431lbs) to achieve competitive levels of efficiency.
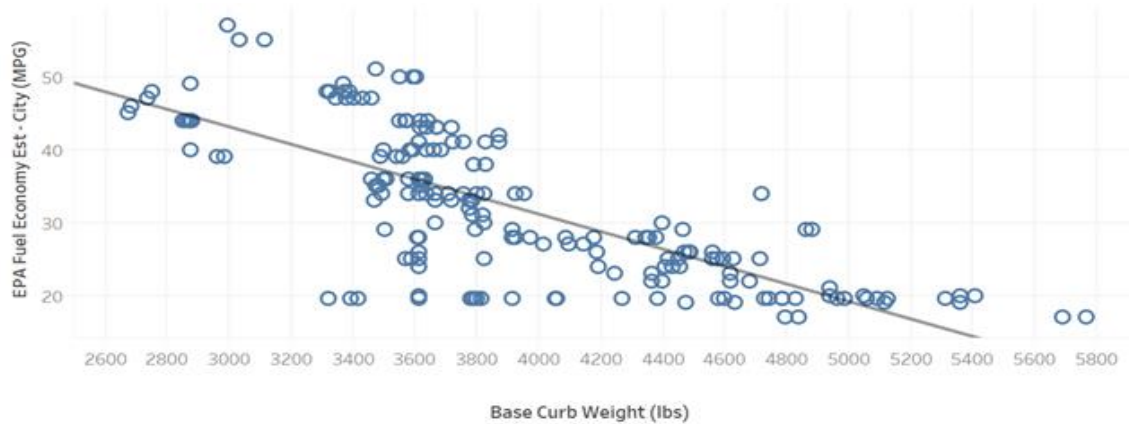
Figure 7: Correlation of City MPG with Base Curb Weight (lbs)
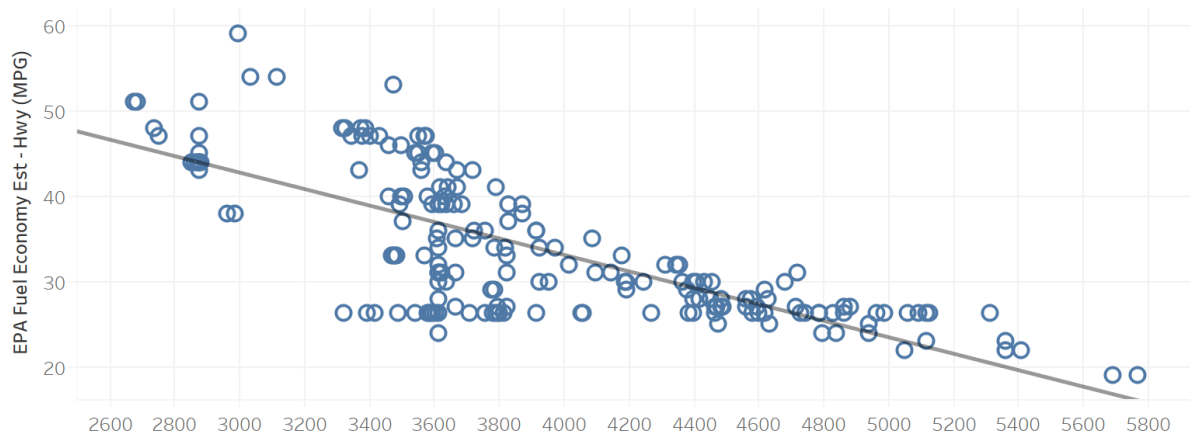
Figure 8: Correlation of Highway MPG with Base Curb Weight (lbs)

3.1.1.2 Height & Wheelbase

In the Hybrid SUV market low-cost companies (Toyota, Nissan, Ford) are very similar in terms of height with an average of 68inc. Luxury hybrids like Porsche and BMW are slightly shorter than the low-cost cars, while SUVs produced by Dodge are on average taller. In contrast, low-cost companies tend to have a lower wheelbase compared to high-cost cars.

3.1.2 Fuel Economy

Company Name	Avg. EPA Fuel Economy Est - City (MPG)	Avg. EPA Fuel Economy Est - Hwy (MPG)	Avg. Fuel Tank Capacity, Approx (gal)
BMW	17.00	19.00	22.50
Porsche	19.91	25.27	22.75
Dodge	20.00	22.00	27.00
Audi	24.00	30.00	19.00
Nissan	25.80	28.70	19.30
Toyota	29.25	26.77	17.20
Ford	32.55	29.25	15.04

Table 3: Competitors specifications regarding Fuel Economy

Low-cost Competitors			
Company Name	Avg. EPA Fuel Economy Est - City (MPG)	Avg. EPA Fuel Economy Est - Hwy (MPG)	Avg. Fuel Tank Capacity, Approx (gal)
Nissan	25.80	28.70	19.30
Toyota	29.25	26.77	17.20
Ford	32.55	29.25	15.04
min	25.80	26.77	15.04
max	32.55	29.25	19.30
average	29.20	28.24	17.18

Table 4: Direct Competitors Fuel Economy specifications and their summary statistics

As you can see from table 3 and 4, the most efficient cars for the city are Nissan, Toyota and Ford. Nissan, Toyota and Ford are also the most efficient brands in the highway after Audi that ranks first with 30 MPG. If the decision of the company is to produce a low-cost, highly-efficiency car then it should target City efficiency above 24 MPG and highway MPG above 26.77.

3.1.3 Performance:

Company Name	Avg. Net Torque	Avg. Displacement (L)	Avg. Turning Diameter - Curb to Curb
Ford	131.2	2.4	37.0
Toyota	215.0	3.5	38.7
Nissan	243.0	2.5	38.7
Audi	354.0	2.0	38.1
Dodge	380.0	4.7	37.0
Porsche	411.4	3.0	39.0
BMW	450.0	4.4	40.9

Table 5: Competitors' Specifications regarding performance

Low-cost Competitors			
Company Name	Avg. Net Torque	Avg. Displacement (L)	Avg. Turning Diameter - Curb to Curb
Ford	131.2	2.4	37.0
Toyota	215.0	3.5	38.7
Nissan	243.0	2.5	38.7
min	131.2	2.4	37.0
max	243.0	3.5	38.7
average	196.4	2.8	38.1

Table 6: Direct Competitors specifications and their summary statistics

High power cars are mostly concentrated in the high-cost market with Audi, BMW and Porsche having the highest power among the competitors. We recommend KIA not to focus on the power of the car as this would negatively affect efficiency which is a key element in the low-cost market.

As you can see from able 6, average Displacement for direct competitors ranges from 2.4 to 3.5. There is no clear relationship between the size of the engine and the performance of the car in both efficiency and power, although a larger engine can increase the weight of the car which can negatively affect efficiency. Therefore, it is recommended to avoid large engines.

3.2 Pickup Trucks

KIA is not currently present in the pickup trucks market which makes it another potential sector for portfolio expansion. In order to evaluate said market, it is essential to explore its recent trends. Pickup trucks show an upward trend from 2014 through more models being

produced. There are no signs of a negative trend in the market which could indicate that the market is healthy and there is potential to enter. Main competitors in the pickup market are Toyota, Nissan, Ford, Chevrolet, GMC and Honda. Out of these 6, Ford, Chevrolet and GMC have the most models, which can be seen from figure 9.
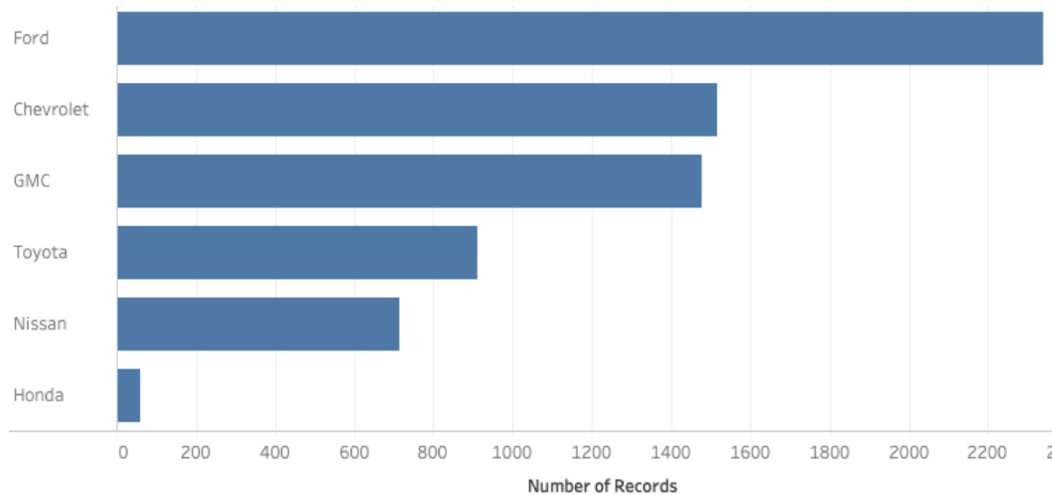
Figure 9: Number of Pickup truck models produced by each manufacturer

Pickups have an average price of $30,792. The lowest average median price comes of $26,168 comes from Toyota, while $33,390 achieved by Honda is the highest average median. In that category, Ford is the strongest competitor with average price of 30,532 (below the overall average). At the same time, Ford has the most efficient trucks with 17 and 23 miles per gallon in the city and on the highway respectively. Additionally, in terms of average torque Ford is above average.
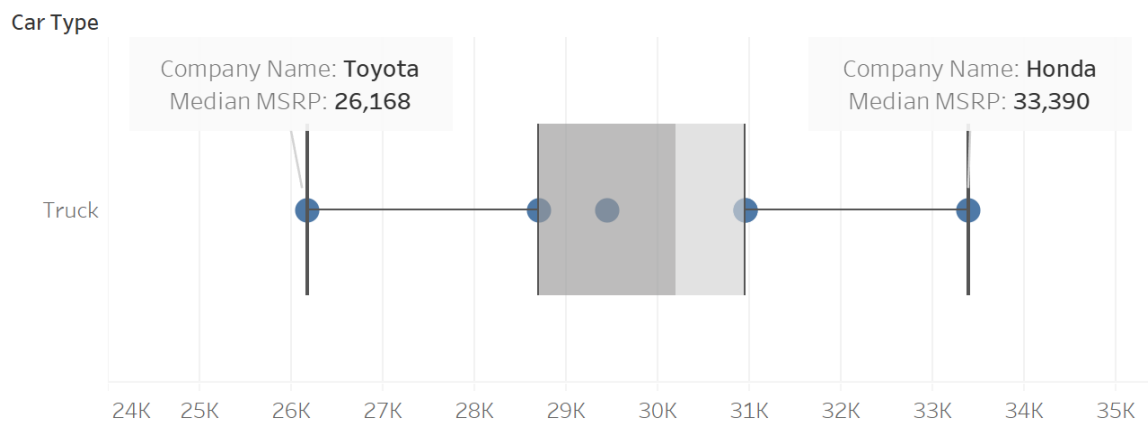
Figure 10: Boxplot of Prices in the Trucks Market

Before releasing a new truck, KIA has to analyse the specifications of close competitor's trucks. In this market, KIA's main competitors are Nissan, Toyota, Chevrolet and Ford. Cars

that these companies offer have been analysed in terms of their dimensions, fuel economy and performance to obtain possible metrics for KIA's truck.

3.2.1 Truck Dimensions

Company Name	Avg. Base Curb Weight (lbs)	Avg. Front Leg Room (in)	Avg. Height, Overall (in)	Avg. Wheelbase (in)
Audi	3,324	41	56	107
Chevrolet	3,612	42	74	142
Ford	3,557	42	73	139
GMC	3,612	42	73	141
Honda	4,164	41	71	123
Nissan	3,612	42	73	137
Porsche	4,950	42	67	112
Toyota	3,612	42	71	132

Table 7: Truck Dimensions of other manufacturers

Chevrolet	3,612	42	74	142
Ford	3,557	42	73	139
Nissan	3,612	42	73	137
Toyota	3,612	42	71	132
min	3,557	42	71	132
max	3,612	42	74	142
average	3598.111482	42	72.82170523	137.5843215

Table 8: Truck Dimensions of Competitors and the summary statistics

There are 4 investigated measures in the dimensions category for direct competitors:

a) Average Car Weight – there is no substantial variability between competitors when it comes to this measure with the average ranging from 3557 to 3612 lbs. Therefore, KIA should aim to obtain a weight towards the lower end (3560lbs) as reduced weight means better fuel economy.

b) Average Front Leg Room – 42 inches of leg room is a standard across the whole category so KIA should apply the same dimension, providing equal seating comfort as competition.

c) Average Height – vehicle height ranges from 71 to 74 inches among competitors. This variable is of great substance as pickup trucks are often used to move cargo, hence KIA should aim for the higher limit of 74 inches.

d) Average Wheelbase – this measure is key when it comes to car's steering and balance. As the wheelbase of competitors is roughly the same size (between 132 and 142 inches), KIA should aim for the average of 137.6 to be on a par with competition and provide impeccable performance.

3.2.2 Fuel Economy

Company Name	Avg. EPA Fuel Economy Est - City (MPG)	Avg. EPA Fuel Economy Est - Hwy (MPG)	Avg. Fuel Tank Capacity, Approx (gal)
Audi	26.50	34.50	14.25
Chevrolet	17.41	23.15	28.07
Ford	18.10	24.04	27.02
GMC	17.48	23.30	27.84
Honda	16.18	22.99	21.26
Nissan	15.06	20.97	25.13
Porsche	14.00	18.00	26.40
Toyota	16.28	20.42	23.47

Table 9: Fuel Economy specifications of other manufacturers

Nissan	15.06	20.97	25.13
Toyota	16.28	20.42	23.47
Chevrolet	17.41	23.15	28.07
Ford	18.10	24.04	27.02
min	15.06	20.42	23.47
max	18.10	24.04	28.07
average	16.71342627	22.14377981	25.91985273

Table 10: Competitors' Fuel Efficiency specifications and summary statistics

Three main measures were looked at in the fuel economy section:

a) Average EPA Fuel Economy (City) – The average for KIA's competitors is roughly 16.7 miles per gallon in the city, so KIA should aim for at least 17 as efficiency is key in the budget pickup truck category.

b) Average EPA Fuel Economy (Highway) – this measure is more important than city fuel economy as pickup trucks tend to be used to cover much more ground, so their highway fuel economy is key. To set itself apart from competition, KIA needs to achieve a value of 24 miles per gallon as competitor's average is 22.14.

c) Average Fuel Tank Capacity – the tank capacity ranges from 23.5 to just above 28 gallons which, combined with fuel economy, gives all models a range of over 350 miles in the city and an impressive 450+ miles on a highway. KIA should aim for similar results which can be achieved with a 27-gallon tank.

3.2.3 Performance

Company Name	Avg. Net Torque	Avg. Displacement (L)	Avg. Turning Diameter - Curb to Curb
Audi	228.5	2.0	37.1
Chevrolet	314.0	4.9	47.0
Ford	311.3	4.4	46.5
GMC	314.0	4.9	46.7
Honda	251.5	3.5	43.1
Nissan	340.2	4.7	43.9
Porsche	310.0	4.5	39.7
Toyota	285.0	4.1	42.3

Table 11: Performance Specifications of other Manufacturers

Chevrolet	314.0	4.9	47.0
Ford	311.3	4.4	46.5
Nissan	340.2	4.7	43.9
Toyota	285.0	4.1	42.3
Min	285.0	4.1	42.3
Max	340.2	4.9	47.0
Average	312.6419416	4.549819887	44.92363306

Table 12: Performance specifications of competitors and summary

Regarding performance, 3 measures play a key role:

a) Average Net Torque – this measure shows relatively large variability between competitors with the lowest value being 285 and the highest at 340.2. Pickup trucks are often used for heavy-duty tasks so a higher torque is sought after. Therefore, KIA should aim to achieve a torque of 320 to be above the competition's average.

b) Average Displacement – it is directly linked with torque, meaning that an increase in displacement will give a vehicle higher net torque, however a rise in displacement also causes fuel consumption to increase. Accordingly, to provide satisfactory performance without reducing fuel economy, KIA should aim for a displacement value of 4.5 litres which is the competitors' average.

c) Average Turning Diameter – this is where trucks perform much worse than other categories because of their size. The turning diameter ranges from 42.3 to 47 feet, so to fit within the industry standard, KIA's truck needs to achieve a value of 45 feet.

3.3 Two-Seaters

The third car segment that KIA is currently not operating in is Two Seaters. It is a segment consisting of cars with inclined roofline, two-doors, and generally two seats in one row. After analyzing the market, we have identified that there is a division between product offering among different brands (see figure 11). On one hand, there are brands such as McLaren or Lamborghini that produce cars that are expensive with very high performance, which is delivered by compromising on other specifications. On the other hand, brands such as Mazda, Honda or FIAT with similar brand image to KIA, have decided to focus on cars that are more convenient, easy for urban navigation and more economical. This positioning is highly visible in terms of pricing (see figure 12) – with prices varying between $20413 for an average Honda and $365305 for average Lamborghini.
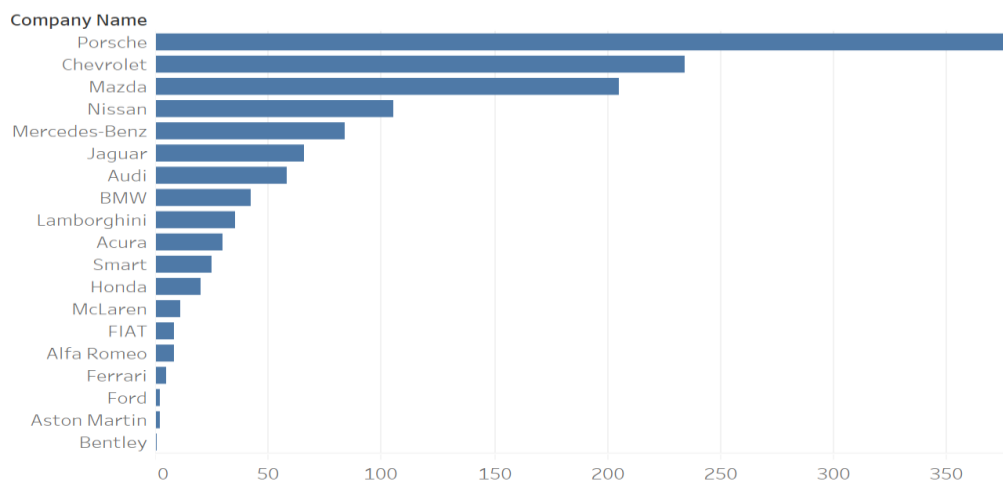
Figure 11: Number of two-seater models produced by other manufacturers

Box Plot of Price Distribution of Two Seaters

KIA's Direct Competitors
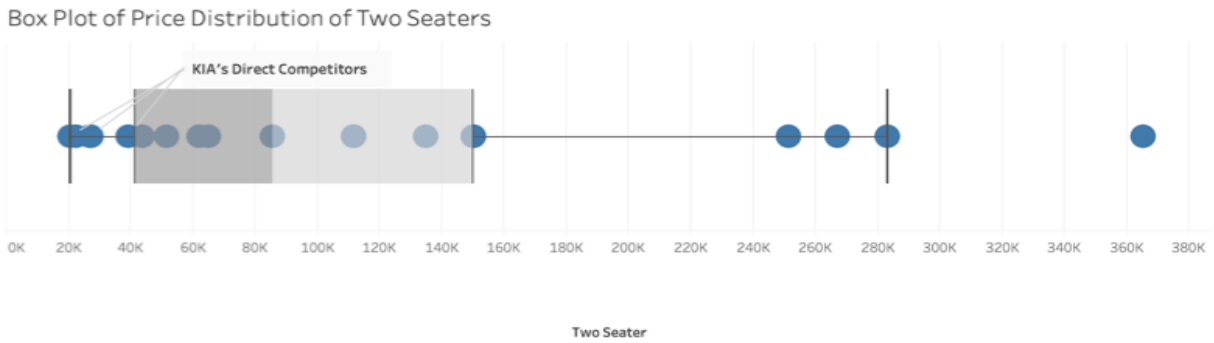
Two Seater

Figure 12: Box Plot for Prices of Two Seaters

3.3.1 Two-Seater Dimensions

Company Name	Avg. Base Curb Weight (lbs)	Avg. Front Leg Room (in)	Avg. Height, Overall (in)	Avg. Wheelbase (in)
Acura	3,193	44	46	100
Alfa Romeo	2,476	43	47	94
Aston Martin	3,612	42	50	107
Audi	3,381	41	53	97
BMW	3,252	42	51	99
Bentley	4,94	42	54	108
Chevrolet	3,323	43	49	106
FIAT	2,451	43	49	91
Ferrari	3,386	42	48	105
Ford	3,35	45	44	107
Honda	1,898	43	53	95
Jaguar	3,593	43	52	103
Lamborghini	3,772	42	45	105
Mazda	2,494	43	49	91
McLaren	3,18	42	47	105
Mercedes-Benz	4,096	43	51	101
Nissan	3,385	43	52	100
Porsche	3,318	42	54	98
Smart	2,126	42	61	74

Table 13: Dimension Specifications of other manufacturers for two-seaters

FIAT	2451	43	49	91
Honda	1898	43	53	95
Mazda	2494	43	49	91
Nissan	3385	43	52	100
Smart	2126	42	61	74

min	1898,0	42,0	49,0	74,0
max	3385,0	43,0	53,0	95,0
average	2470,8	42,8	52,8	90,2

Table 14: Competitors specifications of dimensions for two seaters

Average Weight of a Car

In terms of average weight, there is no large variability between KIA's direct competition. Indeed, only Nissan is an outlier with an average weight almost 900lbs more. Hereby, as the weight of the cars significantly affects its performance and fuel efficiency, it can be said that KIA should aim to produce a car that weights in the lower range of 1898 and 2494 lbs.

Average Front Leg Room:

When looking at the average front legroom, it is visible that the almost no variability. Therefore, when entering the market KIA should aim to produce a car with the front legroom of between 42 and 43 inches.

Average Height

In terms of the overall height, the cars are relatively diverse. Namely, the range of the height ranges between 49 (for Fiat) and 61 (for Smart). In order to maximise space inside the car, it is suggested for KIA to create a car that is closer to 61.

Average Wheelbase

The average wheelbase is substantially varied between direct KIA's competitors (between 74 and 100 inches). Therefore, KIA should aim to maximise the amount of space available for passengers in the cars and produce a car with average wheelbase close to 100 inches.

3.3.2 Fuel Economy

Company Name	Avg. EPA Fuel Economy Est - City (MPG)	Avg. EPA Fuel Economy Est - Hwy (MPG)	Avg. Fuel Tank Capacity, Approx (gal)
Acura	17.47	23.87	18.31
Alfa Romeo	24.00	32.07	10.50
Aston Martin	18.79	25.64	19.30
Audi	20.84	28.29	15.08
Bentley	12.00	19.00	23.80
BMW	18.89	27.34	14.40
Chevrolet	16.11	25.45	18.29
Ferrari	14.40	20.80	21.34
FIAT	25.88	35.13	11.90
Ford	13.00	23.64	17.50
Honda	59.60	64.00	10.60
Jaguar	18.29	26.00	18.42
Lamborghini	12.22	20.47	22.38
Mazda	22.63	28.98	12.58
McLaren	17.03	25.69	19.00
Mercedes-Benz	15.02	22.09	20.29
Nissan	18.16	25.57	19.00
Porsche	17.69	25.06	17.79
Smart	25.02	31.13	15.77

Table 15: Fuel Economy Specifications of two-seater cars of other manufacturers

FIAT	25,88	35,13	11,9
Honda	59,6	64	10,6
Mazda	22,63	28,98	12,58
Nissan	18,16	25,57	19
Smart	25,02	31,13	15,77

min	18,2	25,6	10,6
max	59,6	64,0	19,0
average	30,3	37,0	14,0

Table 16: Summary Statistics of Competitors Fuel Efficiency Specifications

Average EPA – City & Highway

Amongst direct competitors, Honda produces the most efficient cars with regards to fuel efficiency in both city and highway. Fiat and Nissan, however, are the least efficient. Considering this it would be recommended for KIA to produce cars that are above the average of EPA.

Average Fuel Tank

With regards to the average size of the fuel tank, there is a visible difference between the approaches that car manufacturers take. It can be due to the fact that there is a trade-off between car efficiency if the fuel tank is larger and the convenience for consumers not refueling often. Therefore, if KIA was to introduce a new car in this category, it could aim to create a fuel tank of 14 gallons (the average of competitors).

3.3.3 Performance

Company Name	Avg. Net Torque	Avg. Displacement (L)	Avg. Turning Diameter - Curb to Curb
Acura	234.3	3.1	38.2
Alfa Romeo	258,0	1.7	40.5
Aston Martin	505,0	4,0	39.7
Audi	227.1	2.2	35.5
Bentley	590,0	6,0	39.7
BMW	256.9	2.8	34.1
Chevrolet	468.9	6.2	38.8
Ferrari	553.8	4.4	39.7
FIAT	184,0	1.4	30.8
Ford	500,0	5.4	40,0
Honda	65.9	1,0	31.4
Jaguar	368.9	3.4	35.9
Lamborghini	466.3	5.9	40.2
Mazda	136.3	1.9	28,0
McLaren	511.2	3.9	40.2
Mercedes-Benz	498.9	5,0	36.3
Nissan	271,0	3.7	33,0
Porsche	318.5	3.6	37.3
Smart	98.7	2.5	25.4

Table 17:Performance Specifications of other manufacturers

FIAT	184,0	1,4	30,8
Honda	65,9	1,0	31,4
Mazda	136,3	1,9	28,0
Nissan	271,0	3,7	33,0
Smart	98,7	2,5	25,4

min	65,9	1,0	25,4
max	271,0	3,7	31,4
average	151,2	2,1	29,7

Table 18: Performance specifications of competitors and statistics

Average Net Torque

While comparing Net Torque of the cars produced by KIA's direct competitors, it can be seen that competitors have different strategies in this car segment. Indeed, some car companies such as FIAT and Nissan decided to create powerful cars while Smart or Honda have targeted more leisure drivers. Given that producing a more powerful engine is more costly, it can be suggested for KIA to introduce the car with a torque that is below average.

Average Displacement

With regards to average displacement, similar strategies can be denoted. In fact, Nissan which has the most powerful cars fits its cars with the biggest engines (3.7 litres on average). In the same way, Honda's and Mazda's relatively smaller engines produce less power. In light of this and the previous recommendation on power, it can be advised for KIA to produce cars with below the average engine displacement.

Average Turning Diameter

As the average turning diameter is highly correlated with wheelbase, it is not surprising that cars with the shortest wheelbase have the smallest average turning diameter. Indeed, Smart has a turning diameter that is 15% lower than the average. The other car manufacturers, however, produce cars that on average have a turning diameter of around 30. Therefore, it is recommended for KIA to produce a car that has a turning diameter within industry standard of 30.

4.0 Prediction Model

4.1 Scope

In this section we are going to create a predictive model which estimates the price for the suggested cars based on our recommendations. This model will be provided to KIA as a pricing strategy tool for further exploration.

4.2 Selection of Predictive Algorithm for our model

In order to achieve the prespecified scope we had to construct a model that will take as an input certain variables that will be the car specifications and give us an estimate of the price. Since the dataset is complex, including a lot of variables that might not have a linear relationship we have decided to use the Gradient Boosting Tree Algorithm, otherwise called as XGBoost. When it comes to small-to-medium tabular data, decision tree-based algorithms are considered best-in-class right now with XGBoost being one of the top-performing.

4.3 Model Construction and Evaluation Metrics

To construct the appropriate model, we have included the 10 features that were analyzed in the previous section, and we included variables that declare each car's type and if it the car is a hybrid or not (dummy variables). After training and running the model we have got a Root Mean Squared Error of $2601.76. This means that the algorithm makes predictions which they differ from their true value by an average of 2600$. Furthermore, figure 13 shows how important was each variable for predicting the price.
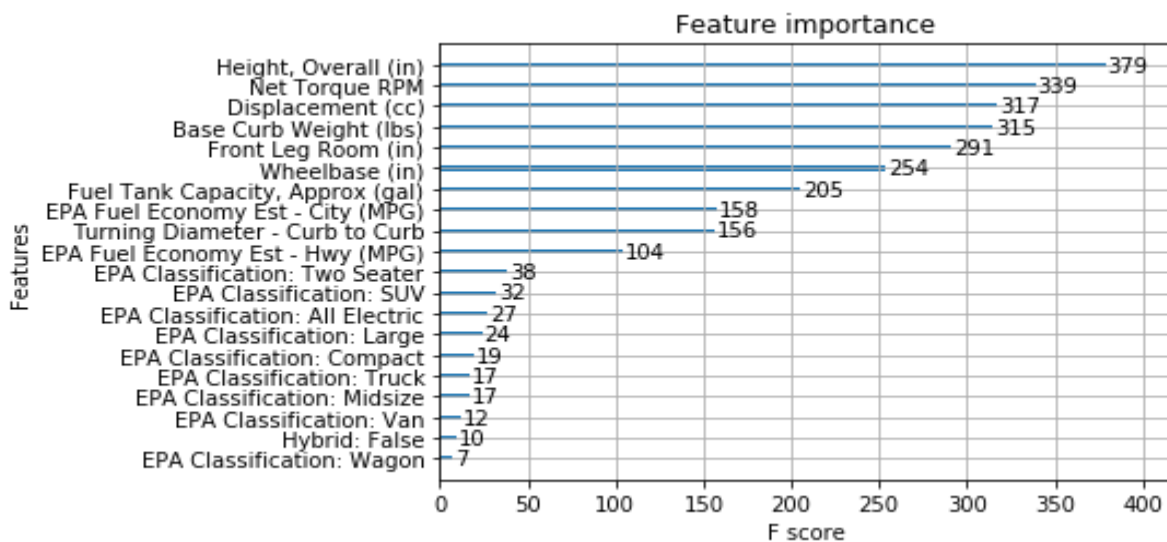

Figure 13: Feature importance of XGBoost model

4.4 Model Application for Predictions

4.4.1 Hybrid SUV

Our aim is to suggest a model that is more efficient than the competition and predict how would that model be priced on average by KIA's competitors. Following, table 19 shows the suggested specifications based on the Hybrid SUV market of the competitors and the predicted price for this suggested model.

Car Specifications	Competitors Average	Test Model	Final Suggestion
Net Torque	200	200	200
Displacement	2.8	2.8	2.8
Turning Diameter Curb to Curb (ft)	38	38	38
EPA Fuel Economy City (mpg)	29	**31**	**31**
EPA Fuel Economy Highway (mpg):	28	28	**31**
Fuel Tank Capacity (gal):	28	28	28
Base Curb Weight (lbs):	4431	4100	4100
Front Legroom (in):	42	42	42
Height Overall (in):	68	68	68
Wheelbase (in):	107	107	107
Estimated Price ($):	35221.33	36221.41	39948.637

Table 19: Price Estimations for different Specifications for Hybrid SUVs

The predicted price of a model with average specifications in the low-cost Hybrid SUV market is $35221.33. Our advice is to produce a car that is lighter than the average and more efficient. The first suggested model is a model that focuses on city fuel efficiency and a lighter structure. The estimated price for model 1 is $1000 higher compared to the average. If we improve efficiency both in city and highway (Model 2) the price rises to around $40,000. The estimated price reflects what would have been the price of these models if it was produced by the existing competitors. This provides information for KIA to construct a cost benefit analysis and decide if it is feasible to enter the market and position itself in the market with a competitive price

4.4.2 Two-Seater Cars

Now we are going to predict an estimation of the price for the suggested model in the two-seater market with the aim of having a small and less powerful engine. Figure XX shows the details of test models and the final suggestion.

Car Specifications	Competitors Average	Test Model 1	Test Model 2	Final Suggestion
Net Torque	135	135	**122**	**130**
Displacement	2	2	2	**1.8**
Turning Diameter Curb to Curb (ft)	30	30	30	30
EPA Fuel Economy City (mpg)	26	26	26	**29**
EPA Fuel Economy Highway (mpg)	37	**40**	37	**40**
Fuel Tank Capacity (gal):	15	15	15	15
Base Curb Weight (lbs):	2241	2241	2241	**2150**
Front Legroom (in):	42	42	42	42
Height Overall (in):	60	60	60	60
Wheelbase (in):	100	100	100	**102**
Estimated Price ($):	28550.49	28311.85	26871.43	29764.89

Table 20: Price Estimations for different Specifications for Two-Seater Cars

For the scenario of the first suggested car model we have improved the average mpg by 3 in order to get a price estimation of a more efficient car. Our model predicted that the price of the new model will decrease by roughly $240. This information can be leveraged from KIA. If they manage to manufacture a model that can have a fuel economy on the highway at 40 mpg, they will have a two-seater model that is more efficient than the competitors in this market, and they can also charge it at a lower price. In the scenario of the net torque, we can see that decreasing the performance of the engine has led a decreased predicted price. This is reasonable and it's a good possible action for KIA since we are aiming to produce two-seater cars that are low on performance and low on cost.

The final model suggestion comes out from the analysis that we did in section 3 of the report. Our model estimated that if manufacturers were to build this model, they would have charged it $29764.89. If KIA manages to produce a two-seater car with these specifications they are

going to be in a great competitive advantage as they will have the best specifications for a budget two-seater car, at a price lower than the competitors.

4.4.3 Pick-up Truck

The aim is to provide a model that has sufficient power to deal with difficult conditions and heavy cargo without consume excessive amounts of fuel, in order to attract the more budget-conscious customers.

Car Specifications	Competitors Average	Test Model 1	Test Model 2	Final Suggestion
Net Torque	312.6	**320**	312.6	320
Displacement	4.5	4.5	4.5	4.5
Turning Diameter Curb to Curb (ft)	45	45	45	45
EPA Fuel Economy City (mpg)	16.7	16.7	16.7	17
EPA Fuel Economy Highway (mpg):	22.14	22.14	22.14	24
Fuel Tank Capacity (gal):	26	26	26	27
Base Curb Weight (lbs):	3598	3598	3598	3560
Front Legroom (in):	42	42	42	42
Height Overall (in):	72.8	72.8	**74**	74
Wheelbase (in):	137.6	137.6	137.6	137.6
Estimated Price ($):	30792.14	31241.53	30963.60	34260.57

Table 21: Price Estimations for different Specifications for Pick-up Trucks

The average vehicle price in the budget pickup truck category is $30,792. Performance and capacity are key measurements when it comes to this market so 2 test scenarios were used to estimate the price of a KIA truck with those characteristics altered.

First suggested scenario focuses on a truck with increased net torque to 320 (from an industry average of 312.6). The obtained result is $31,241.53 which is $449.30 more than the average price which makes sense, as a car with higher torque is more powerful and can move a heavier load or pass through a difficult terrain.

Second scenario shows the price after setting vehicle height to 74 inches (from an industry average of 72.8). Price for such a vehicle was found to be $30963.60 which is slightly higher than the average pickup truck price. The $171.46 difference is logical as increased height is associated with bigger vehicle capacity. This is crucial for pickup trucks as customers use them to transport goods, thus a vehicle with more storage space is of higher value on the market.

The final suggestion combines the model with market analysis conducted in previous section of the report to provide a complete picture of a possible model for KIA's pickup truck with specifications changed according to the market standards. This pickup is designed to fill the niche spotted, providing sufficient power and great fuel economy. According to the model and what competitors charge for their specifications, it should be priced at $34,260.57. Therefore, if KIA constructs such a vehicle for a price lower than the model predicted, it should have a big advantage in the pickup truck market.

5.0 Conclusion

5.1 Summary and Synthesis of all results

From our dataset we extracted information about the competitors in each of the three potential markets and proposed a car model that could be competitive upon entry. A prediction model has been constructed that will be provided to KIA as a tool to structure their pricing strategy. We believe that the predictive model is an important asset for KIA to assist their entry decision as it provides an estimate on how the competition would have priced any car model. This information is vital to assess potential positioning.

5.2 Limitations & Data requirements

We are missing important information to understand the market conditions. Sales data are not present in the dataset which limits our understanding of how successful models are in the market. In addition, we have no information about entry costs which may limit the potential of entry in the suggested markets. In addition, some additional attribute could offer additional value to the project. For example, awards for different aspects of cars (safety, performance), reviews from drivers and automobile experts, marketing metrics. In addition, the dataset that we use has information until 2018. KIA on 2019 released a Hybrid SUV car (2019 Kia Niro) with specifications similar to our suggestion (high mpg with competitive price). Also, we assumed that the production of suggested models is technically feasible. Lastly, the model prediction is not exactly accurate and could be optimized further.

5.3 Actions that can be taken based on analysis

We provided information of the competitors in each of the potential markets and constructed a predictive model to assist KIA in making an entry decision. KIA can use the model and the information to conduct a cost benefit analysis of entry.

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