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DEMAND FORECAST MODELLING OF VEHICLES AS A DECISION SUPPORT: THE CASE OF TOYOTA GHANA

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ABSTRACT

Purpose: This purpose of this paper is to develop a mathematical demand forecast model as an alternative to expert-intensive methods for decision support in automobile companies using Toyota Ghana as a case. The paper explores the challenges associated with reliance on experts' judgment in demand forecasting.

Design/Methodology/Approach: The methodology involved analysing stock reports, lost sales reports, and financial reports from Toyota Ghana to understand the effect of poor forecasting. Using data from two key managers and six sales staff, the project examines the perspectives of staff regarding the use of expert judgment for demand forecasting. Further data was collected via a questionnaire from five authorized automobile distributors and dealerships.

Findings: The results revealed the adverse effects of expert-opinion forecasting, which include irregular stock quantities leading to lost sales, vehicle quality challenges leading to deterioration, and long-term negative impact on profitability. Yet demand forecasting by reliance on experts was very prevalent in the automobile industry. The developed forecast model relies on Mean Absolute Percentage Error with a smoothing constant of 0.4. was validated using recent historical data revealing a 2% variance with actual demand values, while for expert judgment the variation margin was 14%. This strongly indicated that the model yielded more accurate predictions of demand than expert predictions.

Research Limitation: The case-study nature of the study means a more generalized study was still needed before the findings could be more widely applied across the automobile industry.

Practical implication: The study recommended further development of scientific forecasting models for predicting demand across the automobile industry since they carried positive implications for the smooth running of the industry. This could help mitigate the challenges associated with using expert opinions in demand forecasting. Beyond this, the model could serve to provide valuable information to vehicle manufacturers, thereby yielding efficiencies in their value chains.

Social implication: Accurate demand forecasting and management have positive implications for operational efficiency that minimizes customer disappointment.

Originality / Value: The model offers a better alternative for predicting demand more accurately, promoting correct stock holding quantities, avoiding stock deterioration, and reducing expenditure on quality checks, thus ultimately increasing profitability.

Keywords: *Automobile. forecast. industry. model. prediction. toyota*

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INTRODUCTION

The purpose of this paper is to understand the current system for predicting demand and associated challenges at Toyota Company, Ghana, to develop and validate an automobile demand forecasting model based on historical data to manage stock. A secondary purpose is to link this to recent developments higher up in the automotive value chain relating to the increasing manufacturing of automobiles and automotive components across several countries in Africa.

The global automotive industry has undergone great strides in the last decade in terms of manufacturing processes (Patalas-Maliszewska & Topczak, 2020), sustainability of its manufacturing processes (Giampieri, Ling-Chin, Ma, Smallbone, & Roskilly, 2020), and innovation in the production process and value chain management (Pavlínek, 2021). In places such as Europe, the regional integration drive has delivered a decidedly positive influence on growth patterns in the automotive industry (Pavlínek, 2017; Jacobs, 2017; Jacobs, 2019).

Stuart (2022) examined the potential for regional automotive component value chain development in Africa. The observation is that given the historically low share of GDP of manufacturing in most of the African economies, still defined by natural resource exports (Newman, Page, Rand, Shemeles, Söderbom, & Tarp 2016), many challenges exist that hinder the development of a comprehensive automotive sector (Black, Makundi, & McLennan, 2017) to the extent that, except for exports originating from South Africa to several African countries, expansive automotive value chains did not exist in the continent in sharp contrast to the picture in South East Asia (Kobayashi, Jin, & Schroeder, 2015). Yet it is interesting to observe that in recent years, several African countries such as Kenya, Nigeria and Ghana, and wider Africa have been making strenuous efforts through national policy frameworks, to build credible automotive manufacturing sectors (Wambui, 2016; Black & McLennan, 2016). These upcoming countries could benefit from South Africa's Industrial Development Zones model, which transformed that country into the leading manufacturer and exporter of automobiles and related components.

Development of Automotive Value Chains

The value chain encompasses all processes from the conception of the product to its final delivery into the hands of the customer (Pratap, 2022)and its efficient management could yield cost savings and competitive advantage. Sturgeon, Daly, Frederick, Bamber, and Gereffi (2016) identified six end-to-end automotive value chain activities, the three most downstream of which are: (4) Systems integration and final assembly; (5) Marketing and sales (including promotions, advertising, distribution, sales force and customer relationship management, and making sure the target market is made aware of product features and advantages); and (6) Replacement parts and recycling (including customer support after the sale of the product covering maintenance of the vehicle).

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Erwin (2016) lists the benefits to be expected from global value chain participation by developing countries including the potential to upgrade – to eventually advance up the value chain to produce higher value-add, more technology-intensive inputs.

Ghana and several other African countries were seeking to create regional automobile manufacturing value chains that would ultimately include the production of their parts. The African Union created the enabling environment by establishing the African Continental Free Trade Area (AfCFTA) in 2021 (headquartered in Ghana) as a mechanism to deepen intra-African trade. Several countries have already been identified as potential participants in a continental automotive value chain based on a country's revealed comparative advantage (GIPC, 2022).

Until recently, the Ghanaian automotive value chain was comprised largely of retailers of imported pre-owned cars with a sprinkling of other dealerships trading in brand-new vehicles. In terms of figures the country imports about 100,000 vehicles per year, 90% of them used. In 2021 the industry was valued at USD 4.60 billion; and was expected to grow to USD 10.64 billion by the year 2027 (MODOR Intelligence, 2022). With the inauguration of the Ghana Automotive Development Policy in 2019 aimed at producing affordable new vehicles in the Ghanaian market and reducing the heavy reliance on used vehicles, it was anticipated that the industry would experience even more rapid growth in the future. Through its Automotive Policy Framework (GIPC, 2022) the government sought to promote the development of the automotive sector with a panoply of measures including a planned reduction of vehicle imports by 50%.

This new policy direction is designed to attract investment from leading global Original Equipment Manufacturers (OEMs) (International Trade Administration, 2022), several of whom started manufacturing operations after 2019. These include Volkswagen, Nissan, and Toyota. For instance, VW Ghana, a full subsidiary of VW South Africa, assembles six models in Ghana: VW Tiguan, Teramont, Amarok, Passat, Polo and Caddy. Even before the government intervention the local company Kantanka Automobile Company Limited was already assembling the Kantanka line of vehicles from knocked-down kits from China since 2016. The Government of Ghana has procured some of these local vehicles for its use (International Trade Administration, 2022). The growth prospects in the Ghanaian automotive industry thus seem bright, given the increasing trend toward local manufacturing of the product. But this in turn has implications for the downstream elements in the value chain, namely marketing and sales processes including accurate demand forecasting, which need to be developed well to support the expanding upstream operations.

Literature on demand forecasting models usually focuses on fast-moving consumer goods (Bzai, Alam, Dhafer, Bojović, Altowaijri, Niazi, & Mehmood, 2022), but studies have shown that customer purchase intentions are dependent on both extrinsic and intrinsic cues, but availability and timely delivery are the main factors influencing customer choice of brand. In meeting the availability and timeliness cue for customer purchase decisions, organizations in

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the value delivery chain must implement accurate planning and control supported by effective decision-making, otherwise, the consequences become more severe.

The main factors that influence Ghanaian buyers in their choice of a vehicle brand are design, colour and glazing, performance, and features (Narteh, Odoom, Braimah, & Buame 2012). However, availability and timely delivery of vehicles is equally important especially when product features happen to have equal weighting in the minds of competing vehicle dealerships. Moreover, a sharp upsurge in the number of companies that deal in the Toyota brands of vehicles in Ghana means that availability and timely delivery have remained key differentiators. The quality of decisions is influenced by the support systems that generate the information.

Concerning customer segments, based on a 2018 sales segment report, 51% of purchases came from private financial institutions, construction firms, health and sanitation companies, and hospitality institutions. Government-related institutions comprised 21%, whilst individuals, mining and non-profits took up 17%, 8% and 2%, respectively.

About vehicle demand categories, the pick-up trucks (the *Hilux*) and the *Landcruiser 70* constituted Toyota Ghana's highest-selling models, with a combined share of 46% in 2018. Sports Utility Vehicles (SUVs) represented by the RAV4, Fortuner, Prado, and Landcruiser were the second highest-selling models with a combined share of 35% in 2018. Saloon cars (*Yaris*, *Corolla*, and *Camry*) accounted for 10% of sales while the buses (*Hiace* and *Coaster*) took 7%. The *Hino* truck, with a share of 2%, constituted the smallest category.

The value chain of the well-known Toyota Production System (Figure 1) is anchored in quality processes, the elimination of waste, and continuous improvement *(Kaizen)* activities.

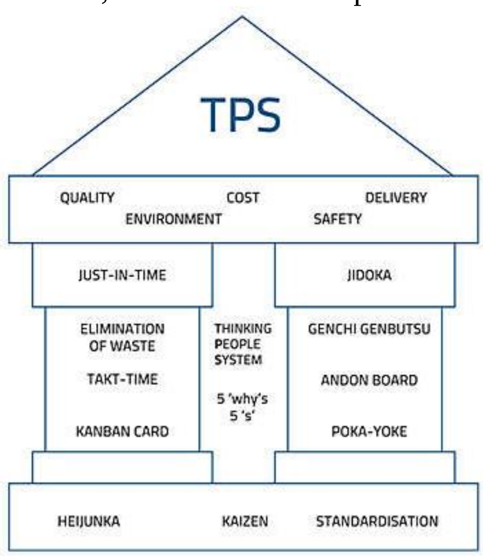

Figure 1. Toyota production system

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Its key pillar is the Just-in-time manufacturing philosophy, which focuses on producing the right items, in the right quantities, and at the right times, so inventory can move fast through the system. Its success depends largely on the quality of the systems in place for demand forecasting and supply delivery. Distributors are required to provide timely and accurate information regarding the demand levels of various models in their respective territories.

Country of Origin of Toyota Ghana Vehicles

Through its adaptation policy, Toyota Global designates specific plants to manufacture and supply specific vehicles to specific countries (Table 1).

Table 1: Country of Origin of Toyota Ghana vehicles

Country	Production Plant	Model
South Africa	Toyota South Africa Motors (TSAM)	Corolla
		Hilux
		Fortuner
Indonesia	Toyota Motor Indonesia (TMIN)	Rush
Thailand	Toyota Motor Thailand (TMT)	Yaris
Japan	Toyota Motor Corporation (TMC)	RAV4
		Prado
		Landcruiser 200
		Landcruiser 70
		Hiace
		Coaster
		Hino 300

The adaptation policy specifies that due to environmental, legal, market dynamics and technological penetration factors, product differentiation is applied throughout the product design, production, and distribution value chain.

Warehousing capacity and stock analysis

Toyota Ghana operates three customs-bonded vehicle warehousing facilities having a total capacity of 983 vehicles with the following breakdown (Toyota Ghana Asset Report (2018)):
Tema bond 1: 540; Tema bond 2: 275; Accra warehouse: 176 vehicles.

Year-end stock analysis over four years showed a steady increase in stock quantities, leading to locked-up capital. Further analysis of the 2018 balance sheet revealed the total stock of inventories as GHC175,615,379 for 2017 and GHC196,581,600 for 2018, representing a 12% increase. This was projected to increase further to GHC 252,350,926 in 2019 (Toyota Ghana Business Report, 2019)

Aged stock analysis

Per Toyota Ghana’s stock holding policy based on the manufacturer’s recommendation, vehicles held at bonded warehouses for below six months are classified as *acceptable stock*,

ISSN: 2408-7920

those held from seven to twelve months are classified as *manageable stock*, while those held for more than twelve months are classified as *over-aged* stock, due to their gradual deterioration over time.

Table 2: vehicle aged stock analysis (Toyota Ghana Business Report, 2019)

		2015		2016		2017		2018	
	stock age	**Qty**	%sh	**Qty**	%sh	**Qty**	%sh	**Qty**	%sh
Challenge	More than 12 months	127	22%	198	35%	307	38%	310	37%
Manageable	7-12 months	157	27%	188	33%	287	36%	198	23%
Acceptable	1-6 months	288	50%	177	31%	213	26%	341	40%
	Total stock	572	100%	563	100%	807	100%	849	100%

The cost associated with a large stock build-up is enormous. Apart from-locked up capital, inventory holding costs in the form of deterioration prevention due to overexposure to harsh weather and environmental conditions, cost of securing the vehicles, cost of replacing damaged parts, forced price-discounted sales to clear stock, etc. all had a negative impact on the company's finances. On the other hand, the risks associated with stock-out in terms of lost sales and customer dissatisfaction are enormous. Yet, stock unavailability had consistently plagued Toyota Ghana year after year, recording 48% in 2015, and rising sharply to 57% in 2018 (Toyota Ghana Business Report, 2019).

Expert knowledge as a decision support

Expert knowledge is substantive information on a topic that is not widely known by others except by the expert. It is, however, susceptible to motivational and cognitive biases.

Importance of demand forecasting

A good forecasting system, usually an associative model such as a regression or trend model, is essential for avoiding problems stemming from inventory shortages or overstocking, missed due dates, plant shutdowns, lost sales, lost customers, expensive expediting, and missed strategic opportunities. A decision support system is a computer-based system intended for use by managers in making decisions. In developing a demand forecast model as a decision support system for Toyota Ghana, the authors first examine the effect of reliance on expert opinion in vehicle stock management.

METHODOLOGY

Research Design

A case study approach was adopted since it would provide a platform for performing a detailed and contextual examination of forecasting specific to Toyota Ghana.

Data Collection Methods

Primary data came from a survey and personal interviews with staff, and managers of Toyota Ghana while secondary data were extracted from textbooks, articles, and journals. Further

ISSN: 2408-7920

information came from reviews of annual company reports (Toyota Ghana business, financial and sales reports).

Data Collection Instruments

The instrument employed for data collection was the questionnaire. It was designed to unearth the effects of challenges of expert opinion in planning stock quantities. Each question was carefully explained to obtain the right answers from the respondents. In all, two questionnaires to management staff and six to Heads of Sales were administered. Business reports from Toyota Ghana were also analysed for sales and stock trends. In addition, five dealerships were randomly selected and surveyed. As authorized distributors, these firms had direct business relationships with their respective original equipment manufacturers (OEMs) and thus could provide forecast information for production planning purposes. The selected dealerships were Japan Motors: distributors of Nissan and Foton brands; Rana Motors: distributors of Kia, Ford, and Leyland brands; Silver Star Auto Limited: distributors of Mercedes Benz and Suzuki brands, and Mac Ghana; authorized distributors of Isuzu and Chevrolet brands.

Nature of data gathered

In pursuing the objectives of this research, quantitative research approaches involving surveys were used. Qualitative methods were also applied to develop insights into the demand cycles and other factors required for planning stock. This approach is considered appropriate, and is crucial for understanding a situation in depth, as it provides real insights into the nature of practices.

RESULTS AND DISCUSSION

Demographic information

This section presents the demographic information on the respondents involved in the research. Table 3 revealed the demographic features of the respondents. As indicated in the table below, 75% of the respondents are males whereas 25% are females. Also, the respondents are between 31 to 50 years. It is also evident that majority of the respondents had working experience above 15 years which indicated that the respondents were qualified to give an expert view on the information needed.

Table 3: Demographic Profile of respondents

Gender	**Frequency**	**Percentage %**
Male	6	75
Female	2	25
Total	**8**	**100%**
Age	**Frequency**	**Percentage %**
21-30 years	0	0
31-40 years	4	50
41-50 years	4	50

51-60 years	0	0
Total	**8**	**100%**
Profession	**Frequency**	**Percentage %**
Marketing Manager	1	12.5
Finance and Accounts Manager	1	12.5
Sales Executive	5	62.5
Marketer	1	12.5
Total	**8**	**100%**
Work Experience	**Frequency**	**Percentage %**
<5 years	1	12.5
6-10 years	1	12.5
11-15 years	2	25
Above 15 years	4	50
Total	**8**	**100%**

Vehicle Demand Prediction

Respondent 1: National Sales and Marketing Manager

This respondent had accumulated 17 years of experience working in the Service and Spare Parts departments. To understand the degree of the company's reliance on expert opinions, the respondent's views were sought on vehicle ordering schedules and related challenges. Questions asked related to *the schedule of vehicle orders, how the firm does vehicle demand forecasting in planning its stock, what challenges were associated with this method of demand prediction, and how the development of a demand forecasting model could help address these challenges.*

According to this respondent, vehicle order quantities were decided at monthly experts' meetings, but the routine nature of this exercise always held the potential to engender boredom which could adversely affect personal judgments. Uncertainties in the market usually led to overstocking or understocking, aggravated by the lack of a decision support system, such as a demand forecasting tool. Cash flow improvements, limiting ageing stock quantities, and retention of customers was cited as the expected benefits of implementing a scientific demand forecasting system. Such a tool could be a game-changer for the firm's operations.

Respondent 2: Finance and Accounts Manager

Questions asked related to s*tock management, the impact of overstocking/understocking, and stock planning and management lapses on company finances.*

According to this respondent, 60% of company funds were allocated to vehicle ordering and stock management. In his view, both under and over-stocking presented challenges to the company. Overstocking increased the amount of inventory on the company's balance sheets, meaning funds to run the company were tied up. Whenever understocking occurred, the high cost of securing alternative funding to ease the situation posed a challenge as well. Stock

ISSN: 2408-7920

management needed to be coordinated with a good strategy to minimize the negative impacts of irregular stocks on company finances.

Respondents 3-8: Heads of Sales
Six experienced senior sales staff, including two females, were included in the questionnaire survey. *To determine the level of sales staff's understanding of the problem, their views on the causes of irregular stocking levels were sought. A summary can only be given here.*
From the sales staff's perspective, sharp irregularities in stock quantity hindered smooth prospecting since stock availability was not guaranteed. As well, it may cause customer dissatisfaction and displeasure, disrupt budgets for vehicle purchases, occasion loss of sales and sales commissions, distort promotional activities, divert and marketing budgets to ageing stock clearance campaigns, and delay delivery processes.

Customer demand
In considering inputs to the forecast model, the authors note that private companies constitute the biggest customer segment of Toyota Ghana with a share of 51% of total sales. Such companies are very particular about delivery schedules as most of their purchases are linked to their core operational transportation needs.

Average purchase and replacement cycle of customers
Knowledge of customers' replacement cycles is an essential input for predicting demand and planning stock quantities. The average is four years for most customers. The benefits of knowing the replacement cycles of customers include: As aid in doing sales follow-ups and customer prospecting, stock planning, meeting demand deadlines, customer delight, stock planning, and management, meeting customer demand, enhancing customer relations, planning sales, planning stock replenishment in anticipation of a new purchase. The more accurate information is available for planning and forecasting, the more accurate will be stock orders may be to meet customer demand.

Responses from other distributors (dealerships)
To determine the situation regarding methods of demand forecasting in other automobile companies, the authors sought input from the sales staff of other distributors via a questionnaire (Table 4).
Table 4: Respondents' company profile

No	**Company**	**Years of operation**	**2018 market share**
1	Silver Star Auto Ltd	Over 20 years	3.80%
2	Rana Motors	40 years	7.30%
3	Japan Motors	Over 100 Years	15.80%
4	Mazda Ghana	8 years	1.30%
5	Mac Ghana	6 Years	2.40%

Source: GADA report (2018)

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Vol. 8, No. 2 (2022), pp. 30-47
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With such experiences as indicated above, these distributors could be judged to have adequate knowledge of the automobile market in Ghana and were thus considered a suitable source of information for the research.

Demand forecasting

To ascertain the existing practices of other distributors, the questionnaire sought information on demand forecasting techniques employed. Table 5 displays what was discovered.

Four of the firms: Japan Motors, Silver Star, Rana Motors and, Mac Ghana leaned heavily on management expertise for demand forecasting. This was similar to the practices at Toyota Ghana. However, Mac Ghana exhibited differentiation: they employed the I-CAR software to plan and manage vehicle demand forecasting.

Table 5: Forecast methods by other distributors

Demand forecasting technique	**Frequency**	**Percentage**
Management Expertise	4	80%
Decision Model	1	20%
Market forces		0%
Other		0%
Total	**5**	**100%**

I-CAR could be programmed to prompt management whenever demand issues arise. Poor network infrastructure and inadequate training on the use of the I-CAR software were cited as the main challenges confronting its successful implementation.

Challenges with demand forecasting technique

Table 6: challenges with the current method of demand forecasting

Challenge with demand forecasting technique	Frequency	Percentage
Poor stock management	3	60%
Lost sales	1	20%
Increased cost of sales		0%
Other	1	20%
Total	5	100%

Poor stock management leading to lost sales ranked high among the challenges associated with demand forecasting based on expert opinion.

Demand forecast modelling

To develop a forecast model for demand prediction, time series modelling was employed. Time series models are useful when past data trends of the same variable such as demand, profit, sales

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African Journal of Applied Research
Vol. 8, No. 2 (2022), pp. 30-47
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etc., are collected and analysed to develop a model that describes the underlying relationship that would be used as a basis to extrapolate the series into the future. To smoothen variations in the data, the simple exponential smoothing technique (Equation 1) with smoothing constants α = 0.10 or 0.40 (which fall within the typical range 0.10 to 0.40) was employed:

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \qquad (1)$$

where, F_t = Forecast for period t,
F_{t-1} = Forecast for the previous period,
α = smoothing constant, and
A_{t-1} = Actual demand for the previous period

$$\text{Error } (e) = (A_{t-1} - F_{t-1}) \qquad (2)$$

$$\text{Mean Absolute Deviation (MAD)} = \frac{\sum|e|}{n} \qquad (3)$$

$$\text{Mean Squared Error (MSE)} = \frac{\sum e^2}{n-1} \qquad (4)$$

$$\text{Mean Absolute Percentage Error (MAPE)} = \frac{\sum\left[\frac{|e|}{Actual} x\ 100\right]}{n} \qquad (5)$$

The smaller MAPE is then selected as the forecast. As indicated in table 7, since α=0.4 yielded a MAPE of 11%, compared with MAPE of 16% for α = 0.1, the former is selected, which gives the demand forecast for 2019 as 2,118 units.

ISSN: 2408-7920

Table 7: Total demand forecast

Period (t)	Actual Demand (A)	Forecast (F) α=0.1	Error (e)	| e|	e2	[| e|/A] X 100	Forecast (F) α=0.4	Error (e)	| e|	e2	[| e|/A] X 100
2013	2,421										
2014	1,829	2,421	-592	592	350,464	32%	2421	-592	592	350,464	32%
2015	1,998	2,362	-364	364	132,496	18%	2184	-186	186	34,596	9%
2016	2,016	2,325	-309	309	95,481	15%	2110	-94	94	8,836	5%
2017	2,030	2,294	-264	264	69,696	13%	2072	-42	42	1,764	2%
2018	2,213	2,268	-55	55	3,025	2%	2055	158	158	24,964	7%
2019		2,263	-2263	2,263	5,121,169		2118	-2118	2118	4,485,924	
			Σ	3,847	5,772,331	81%			3190	4,906,548	56%
			MAD	641.1667				MAD	531.6667		
			MSE		1,154,466.20			MSE		981,310	
			MAPE			16%		MAPE			11%

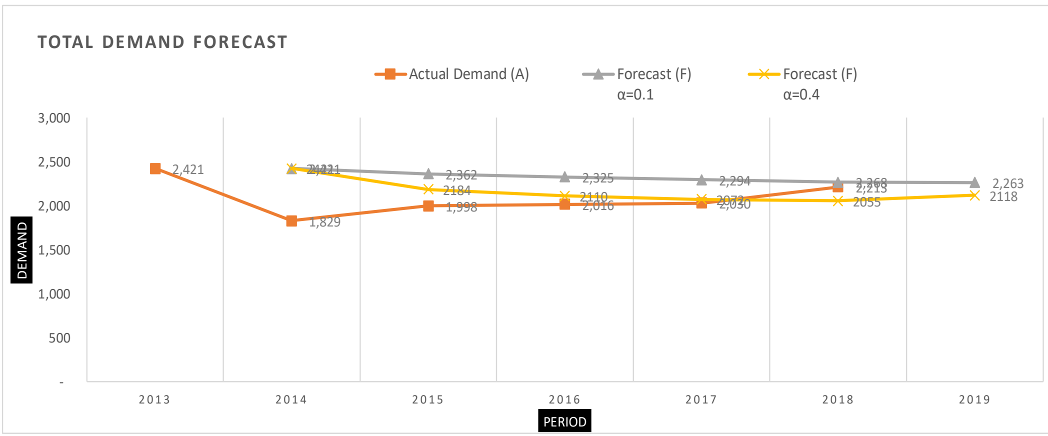

Figure 2: Graph of Total demand forecast

Table 8 and Figure 3 present the model's output demand forecasts for Toyota Yaris.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 8, No. 2 (2022), pp. 30-47
http://www.ajaronline.com
http://doi.org/10.26437/ajar.31.10.2022.03

Table 8: Forecast Model's Demand Predictions for Toyota Yaris

Period (t)	Actual Demand (A)	Forecast (F) α=0.1	Error (e)	| e|	e2	[| e|/A] X 100	Forecast (F) α=0.4	Error (e)	| e|	e2	[| e|/A] X 100
2013	72										
2014	90	72	18	18	324	20%	72	18	18	324	20%
2015	67	74	-7	7	49	10%	79	-12	12	144	18%
2016	75	73	2	2	4	3%	74	1	1	1	1%
2017	65	73	-8	8	64	12%	75	-10	10	100	15%
2018	56	72	-16	16	256	29%	71	-15	15	225	27%
2019		71	-71	71	5,041		65	-65	65	4,225	
			Σ	122	5,738	74%			121	5,019	81%
			MAD	20.33333				MAD	20.16667		
			MSE		1,147.60			MSE		1,004	
			MAPE			15%		MAPE			16%

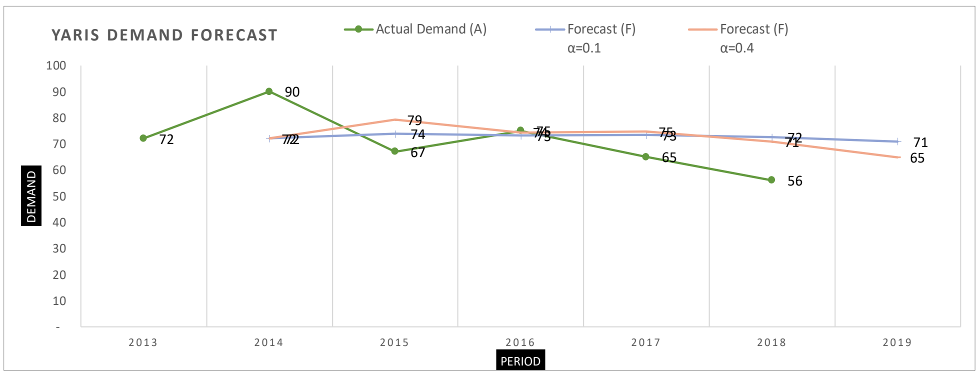

Figure 3: Graph of Yaris demand forecast

Following a similar procedure, the following forecasts were generated for other Toyota models for 2019.

Table 9: Forecasts Figures for other Toyota Models

Vehicle Model	**Demand Forecast for 2019 (Number of units)**
Yaris	71
Toyota Corolla	104
Camry	20
Hilux	847
Rav4	74
Fortuner	265
Prado	228
LC 70	102
LC 200	104
Hiace	136
Coaster	44
Hino	28

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Vol. 8, No. 2 (2022), pp. 30-47
http://www.ajaronline.com
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Model test and validation with 2018 historical demand values

Table 10: Model test and validation

Period (t)	Actual Demand (A)	Forecast (F) α=0.1	Error (e)	| e |	e2	[| e|/A] X 100	Forecast (F) α=0.4	Error (e)	| e |	e2	[| e|/A] X 100
2013	2,421										
2014	1,829	2,421	-592	592	350,464	32%	2421	-592	592	350,464	32%
2015	1,998	2,362	-364	364	132,496	18%	2184	-186	186	34,596	9%
2016	2,016	2,325	-309	309	95,481	15%	2110	-94	94	8,836	5%
2017	2,030	2,294	-264	264	69,696	13%	2072	-42	42	1,764	2%
2018		2,268	-2268	55	3,025		2055	-2055	158	24,964	
					-					-	
			Σ	1,584	651,162	79%			1072	420,624	48%
			MAD	264				MAD	178.6667		
			MSE		130,232.40			MSE		84,125	
			MAPE			16%		MAPE			10%

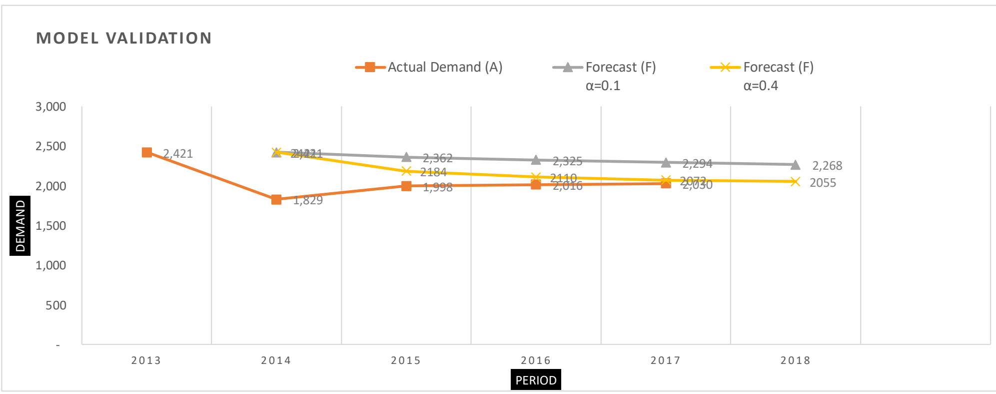

Figure 4: Graph of model validation

Based on the results in tables 9 and 10 the demand forecast for 2018 by the developed model is 2,268 units, which is 2% more than the actual demand value and 14% more than the figure generated via expert opinion.

Table 10: Model validation

Year	2013	2014	2015	2016	2017	2018 (Actual demand)	2018 (OAP) (Expert Judgement forecast)	2018 (Forecast model demand)
Demand	2,421	1,829	1,998	2,016	2,030	2,213	2,515	2,268
						Varience (Actual vs Forecast)	14%	2%

DISCUSSION

The main thrust of this study has been the development of a reliable model for predicting vehicle demand at Toyota Ghana, a process considered to be relatively low-volume and slow-moving. But as was noted earlier, literature on demand forecasting models usually focuses on fast-moving consumer goods (Bzai et al., 2022). This probably explains why there exists such a

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paucity of mathematical, associative forecast models and the resultant tendency to rely on expert opinions in undertaking this activity in the Ghanaian setting.

However, the findings of the study have shown that a lot more depends on the underlying patterns of demand rather than the volumes and turnover thereof. This is corroborated by studies that have shown that customer purchase intentions are dependent on both extrinsic and intrinsic cues (Narteh et al., 2012) and that the factors that influence Ghanaian buyers in their choice of a vehicle brand include availability and timely delivery.

Moreover, looking to the future, noting the potential for regional automotive value chain development across Africa cited by Stuart (2022) and the observed trends towards intensifying vehicle manufacturing in several African countries including Ghana (MODOR Intelligence, 2022), firms could only expect the volumes of trade among African countries to increase since producers in one country may receive reduced or duty-free access to a wide range of other Africa countries via the African Continental Free Trade Agreement framework (GIPC, 2022).

The challenges identified by Newman et al. (2016) and Black et al. (2017) would need to be addressed, though. However, what is clear is that scientific demand forecasting models would play an even greater role in such a regime in line with the other benefits noted by Erwin (2016) expected from participation in an expanded value chain when more and more countries move up the chain to produce more vehicles. At such a stage, efficient management of the chains, especially at the downstream levels, which encompasses marketing and sales (Sturgeon *et al.*, 2016) could deliver such further benefits as cost savings and competitive advantage, as noted by Pratap (2022).

One major finding of the study is that the use of expert opinions as a basis for demand prediction was not confined to Toyota Ghana; it has been an industry-wide practice. This came out from the survey and interviews conducted with key stakeholders among several dealerships, including Toyota Ghana, to which we now turn.

Expert 1 – National sales and marketing manager, Toyota Ghana
It was very significant that he admitted the absence of a demand forecasting tool and that possible errors of judgment may have occurred from boredom stemming from the routine nature of the process. The assessment that an accurate demand forecasting model could prove a game-changer for operations indicated openness to new ideas including the introduction of an associative forecasting model.

Expert 2 – Finance and accounts manager
By citing what fraction (a high 60%) of company funds went into supporting vehicle trade and operations, the expert implied that this area of the company's operations was critical to its survival, giving the reader a sense of what was at stake. Additionally, the observation that stock

management needed coordination with a good strategy to minimize the negative effects of irregular stocks on company finances reinforced the above point.

Respondents 3-8: Heads of Sales

The range of issues addressed by this group was a testament to the depth of their understanding of the challenges confronting their firms, especially as they relate to stock availability, the impacts of exchange rate fluctuations, and the costs associated with stock obsolescence as well as the measures needed to be put in place to address them.

Customer demand, other dealerships

The report that private companies constituted the biggest customer segment of Toyota Ghana (with a share of 51% of total sales) increased the pressure to get delivery schedules right these were directly linked to their core operational needs. Lost sales analysis and overaged stock reports from Toyota Ghana seemed to suggest that the current system of demand forecasting posed risks to the company - an over-reliance on expert opinions for predicting demand.

Put together, input from the other dealerships namely, Japan Motors, Rana Motors, Silver Star Auto, and Mac Ghana, showed that demand forecasting via experts was a prevalent practice in the automobile industry, despite being risk prone. The developed forecast model, based on the single exponential smoothing technique with a smoothing constant of 0.4, delivered much higher accuracy in the prediction of demand levels than expert opinions.

CONCLUSION

The automobile industry in Ghana has seen significant developments over the last several decades, with both authorized and grey distributors competing for market share. The practice of relying on "expert" opinions to determine product demand levels is widespread in the industry, but it presents a setback to achieving strategic ideals in the sector. The project sought to achieve the key objective of developing an associative vehicle demand prediction model to provide decision support to facilitate the smooth operations of Toyota Ghana. It takes into account the practices of other vehicle distributors. The results of the research are now evaluated to the set objectives.

In pursuing the objectives, an attempt was made to understand the current systems of forecasting demand and any challenges associated with them. This entailed eliciting the views of experts; and to understand the challenges from an operational point of view, the impressions of the sales staff were also collected. The accuracy or otherwise of a forecast is dependent on the method of forecasting selected. This research has shown that reliance on expert opinions in forecasting demand is not reliable as a source of accurate information for vehicle manufacturers and dealerships. Scientific methods employing associative models have been shown to yield better results. Such systems for predicting vehicle demand carry positive implications for the smooth running of Toyota Ghana and other players in the automobile industry. This work has produced evidence to show that scientific associative forecast models could predict demand much more reliably and accurately than using an expert's judgement and help mitigate the challenges associated with the former methods. Beyond Toyota Ghana, the developed model could equally be useful to other vehicle manufacturers and dealerships in terms of delivering higher value in their supply chains.

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