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Online markets as a Tool for Rug Design Future Trend Forecasting Using Linear Regression

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Abstract

The world in the last decade seams to be a changeable world, due to many factors, especially the digital shift. Purchasing behaviors generally become more complex over time. Changes in the business environment require decisions about the product line to be made continuously. These can include adjustments to product specifications, the introduction of new product variations, the selection of the product platform and making use of new technologies and markets by means of completely new product lines. These decisions affect a large group of different players at different levels of product design and corporate management. Decisions must be based on information from market surveys, technical research and development work. In decisions related to product's lines, products and their subsystems, the information about markets and new technology - even if it is accurate and credible, which is not always the case - cannot be easily exploited. It deals with premises, while the decisions concern designs and concrete actions. The ability to predict upcoming trends plays a very important role in designing carpets and textiles. Trend forecasting can be used to anticipate trends for the next season or year. Many carpet companies can use this valuable trend forecasting information to create their own products. The classical way for fashion brands, and agencies to forecast trends is by analyzing runway shows, trade shows, newspapers & magazines' information, and market research . The Internet, and consequently, social media, has accelerated the life cycle of trends and birthed phenomena like fast fashion and global supply chains. Trend directions, time-to-market speed, and consumer behavior has shifted in the last decade as a result of the digital age. There are now fashion forecasting services using new technologies and mostly AI, to predict what's coming next. The aim of this research is to use online stores as a tool to predict future trends in goods design (carpet designs as a model). Where some distinctive electronic markets will be elected, in some geographical areas, which will represent the area of the study (preference is determined according to many factors like: the ability to know the experiences and evaluation of previous customers, covering the largest amount of the products in the study and the degree of prevalence among customers).

Keywords

Forecasting- Online markets - Trend- Linear Regression

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A. Introduction

A-1- What is trend in Carpet and Rug design?

A trend simply reflects what seems to be going around at any given time. According to many like (https://www.etymonline.com and Henrik Bejlgaard) trend (v.) in etymology is "to run or bend in a certain direction" (of rivers, coasts, etc.), from Middle English *trenden* "to roll about, turn, revolve". (According to Amanda Queiroz Campos 2018 p; 34)The English language presents two different words for trend and tendency. The differentiation usually defines trend in relation to the idea of ephemeral novelty and fashion, whereas the noun tendency maintains associations with areas such as Statistics and Psychology, referring to a longstanding inclination and predisposition.

(According to Henrik Bejlgaard 2008, p: 6) the word *trend* and the concept it describes are certainly not new. But for much of the twentieth century, the word was used only in very limited circles, mainly among statisticians and economists. In the last third of the twentieth century, it also became common in the fashion industry. (According to Henrik Bejlgaard 2008, p: 6) in statistics, *trend* means the direction of a curve. Often a statistician will use the word *trend* when the direction of a curve is not all that evident. For instance, if there is only a slight change in the curve, a careful statistician will talk of a positive or negative trend in the curve instead of saying that the curve is going up or going down (either direction can be positive or negative, depending on what the curve is representing). (Fashion) trends appear widely and are considered by readers to be the most interesting content of fashion magazines (BAILEY & SEOCK 2010). The word *trend* and

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the interest in trends have become part of our everyday life when we talk about design and style.
According to (Amanda Queiroz Campos 2018 p; 46) it is possible to state that trends consist of changes. They are transformations that involve different aspects of social, cultural, individual, and aesthetic spheres. Such transformations are accepted as positive due to the logic of ordination, renovation, and normalization of the change. Fashion trends are expressions of trends – which are socio-culturally grounded – in aesthetic spheres, mostly by means of visual characteristics applied to clothing and apparel products and are often considered fads or short-term trends. These momentary trends are of tactical applicability whereas long-term, more enduring, trends are suitable for strategic praxes.
The same thing for rug and carpet, rug and carpet trend is common, widely used and is already have become part of our day life; rug making factories, rug designers, approximately all sites on the internet that dealing with rug and carpet, all internet platforms like Pinterest that are dealing with rug photos, they all are dealing with the word rug and carpet trends.
Beyond categorizing styles, a few initial studies analyze fashion *trends*. A preliminary experiment plots frequency of attributes (floral, pastel, neon) observed over time (S. Vittayakorn 2015).
To start the journey of learning how to predict rug design trends, we can make use of these many researches and ways of predicting fashion trends – it will help us in our first steps- , we should always start with the basics. Trend prediction relies on five elements that work together to produce an overall trend per season: Colour, Themes, Shapes or Patterns, Textures, Key Events or, Social Movements Social Customs or Target Market. Each of these five trends can be predicted as to be alone, but some research is needed. For rug and carpet design forecasting, there are two trends that are too important beside these five trends -for fashion and textile design-; which is the layout and the design direction like to be (modern- transitional- classic), in this research the researcher has adapted (Color themes, pattern, texture and layout) to be the main features of predicted trends in this research.

A-2- The term online store

According to Philip Kotler, "The term Electronic Commerce describes a wide variety of electronic platforms, such as sending of purchase orders to suppliers via Electronic Data Interchange; the use of fax and email to conduct transactions; the use of ATMs, EFTPOS and Smart Cards to facilitate payment and obtain digital cash; and the use of internet and online services."
An online store is an e-commerce website or app where buyers can see a catalog of products or services and electronically purchase them (https://www.optimizely.com). Within the online shopping system or online store, there are three most common ways of doing business: B2C, then B2B, and the B2B2C method developed as a kind of combination these two online trading methods, which is shortened from the English terms business to business to client. It is this third method that is also the most commonly used in modern online stores. However, it should not be forgotten that it is not a direct trade; there are numerous shortcomings (https://www.oxfordwebstudio.com). Another scenario of doing online shopping is drop-shipping.
A-3- Drop-shipping is a Supply chain management (distribution/sale) method in an alternative way to the classic supply chain. The whole process starts with the consumer who orders a specific product through the web-shop (Katarina Mostarac 2020). Many like (Katarina Mostarac 2020 and https://thestrategystory.com) the webshop owner does not keep products in its inventory, according to (Katarina Mostarac 2020) but instead transfers the customers' orders and delivery to the manufacturer or wholesaler is referred to as drop-shipping.
For an online retailer, the warehouse could be located anywhere as it does not have to fulfill a retail store. When a consumer purchases online a product, the information is sent to the warehouse through a data center. The product is individually packaged and shipped to the customer delivery address. According to the delivery option chosen (Dimitri Weideli 2013).
Research Selected Market is U.S. e-commerce, according to (E-commerce Payments Trends Report 2021) this market has up-taken lagged behind other nations for years, but growth is now on a strong upwards trajectory, fueled by e-commerce's convenience and major legacy mall brands pivoting to become Omnichannel retailers. Giant pure-play e-commerce platforms and heritage mall brands dominate sales. In the USA, e-commerce platforms are; Amazon which took 37.6 percent of U.S. e-commerce market share in 2023, Walmart (6.4 percent) and eBay (3 percent) round out the top three (http://statista.com), Wayfair made $13, 7 billion and had an average order value of $265 in 2021. In the last 20 years, Wayfair has systematically built and expanded a unique platform that is changing how people shop for their homes and enabling its supplier partners to reach a massive customer base in North America and Europe. Wayfair, founded in 2002, is an American e-commerce company based in Boston, Massachusetts, that sells furniture and home goods online. Wayfair sells more than 14 million products

across five branded retail websites it operates: the leading Wayfair site, Joss & Main, AllModern, Birch Lane, and Perigold. Historically, Wayfair's primary method of fulfillment was a drop-ship network (https://thestrategystory.com). It also has 80 "house brands," It does not manufacture any of the products it sells, instead using a drop ship model. When customers place an order, Wayfair purchases the item from one of its 11,000 suppliers, which then ships to the customer https://www.vox.com.

Related Work

To come up with accurate results for forecasting trends or to make a quantitative data analysis, a large amount of raw data is needed, so we can get a time series over a given time period. Many researches get this raw data by many ways; for example google team (Google's 2016 Fashion Report) pulled the largest number of search attempts related to the apparel industry in the Fashion Trends 2016 U.S. & U.K. report which, focused on apparel trends from the United States and United Kingdom, to enable a better understanding of how trends spread and behaviors emerge across the two markets, to come up with accurate results for forecasting trends in the fashion industry. (Hongbo Zou et al 2015) used the Primary data on "boards" and "pins" as a raw data, to explore the potential patterns of user behavior on Pinterest. They have studied the use of Pinterest in 10 selected public libraries. An in-depth quantitative data analysis was then conducted on these Pinterest boards. Primary data on "boards" and "pins" were collected by retrieving the web page directly from Pinterest. Data analysis coding was developed based on Pinterest metric filtering. Through a metrics mining of Pinterest. Others considered the number of likes and the image frequency as a raw data (Samit Chakraborty et al 2020); for data collection collected images from single or multiple runways - which truly reflects the trend for upcoming seasons- Setting some criteria, such as the number of likes, image frequency, and image quality, helps screen more useful images for trend forecasting. After the selection, image analysis is performed based on colour, pattern, and output. (Tong Zhou 2023) has built many time series tables. Firstly he collected data, and then the entire dataset is first being split into different categories based on stores, states, product categories etc. Then feature engineering is conducted, including adding more features. There are many researches in this field; (Özlem İpek KALAOGLU 2015) used the simple moving average weighted forecasting and linear trend as models. Other researches (Samit Chakraborty et al 2020) used the Logistic regression as a model; which can be stated as a predictive analysis used to discover the chances of an event to have occurred in near future (Grayson, Gardner, & Stephens 2015). The Logistic regression analysis is a form of machine learning technique that describes a dataset containing single or multilevel independent and dependent variable(s).

Research Methodology:

This research utilized data is a set of product reviews of the selected designs over time, the techniques used to analyze data are as follow:

The First technique has been used by the researcher is descriptive analysis. Descriptive analysis shows minimum, maximum, and mean values of the collected data.

The Second Technique are the quantitative methods, which make forecasts based on mathematical models, where it can be considered as a non-causal model (K. Holden et al 1991), non-causal models are also known as time-series models, which make forecasts, or by extracting systematic patterns by analyzing them to their main components (such as trends and seasonality) from historical time series data (Shouyi Wang et al 2018, p. 5) and (Marcel Dettling 2020).

According to (Andreas C. et al 2011) and (Marcel Dettling 2020) a time series can be defined as a collection of random variables, which has indexed over fixed sampling intervals. A time series graph is a line graph that shows data such as measurements, sales, stock prices, population sizes, temperature or frequencies over a given time period. They can be used to show a pattern or trend in the data and are useful for making predictions about the future such as weather forecasting or financial growth.

The main purposes of studying time series are: Explanatory analysis which mainly involves visualization with time series plots, Forecasting, and Modeling the formulation of a stochastic mechanism, by mathematical functions of time, or are estimated using non-parametric smoothing approaches, once a good model is found and fitted to data, the analyst can use that model to forecast future values and produce prediction intervals. Much of the methodology in time series analysis is aimed at explaining this correlation using appropriate statistical models. (Marcel Dettling, 2020). To draw a time series graph, we need a set of axes. The horizontal axis always shows the time period, and the vertical axis represents the variable being recorded against time. The primary objective of time series analysis is to develop mathematical models that provide plausible descriptions for

sample data. In order to provide a statistical setting for describing the character of data that seemingly fluctuates in a random fashion over time (Robert H et al 2011, p. 11).

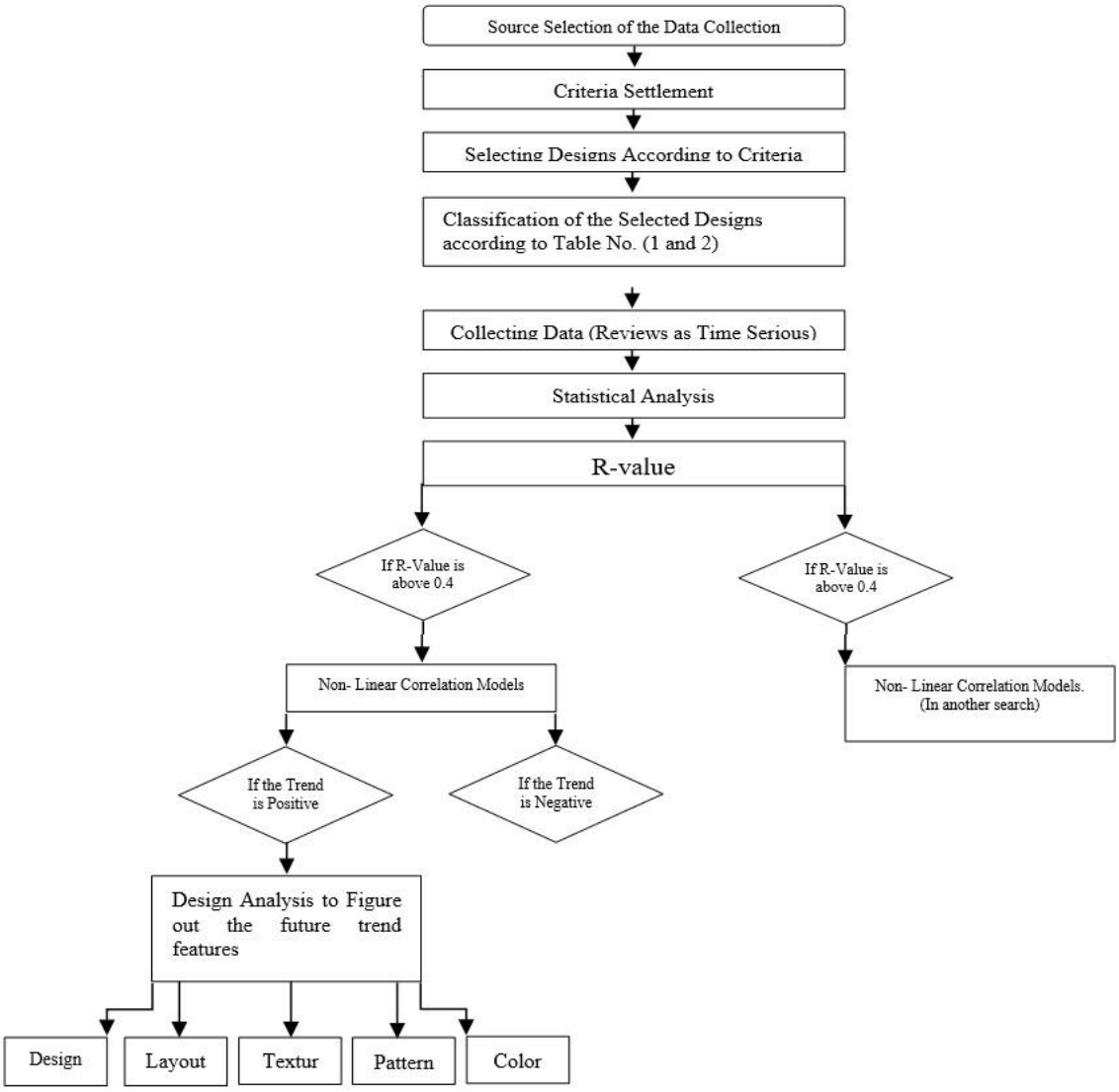


Figure No. 1 The Research Process Flow Chart

The time series is divided into intervals and interval mean values are calculated. Thereafter, r values are calculated from regressions concerning time and interval mean values, r; are calculated to evaluate the strength and direction of the linear relationship between the independent variable x and the dependent variable y (Barbara Illoweky et al 2018, pp 690, 692) ; by looking at the scatter plot, where to check that numerically is to use the correlation coefficient r – which has been developed by Karl Pearson in the early 1900s- which can be calculated as the equation No. 1:

$$\mathbf{r} = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{(n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}}$$

Where the value of r is always between (–1 and +1): $-1 \leq r \leq 1$.

When the values of r close to –1 or to +1, it indicates a stronger linear relationship between x and y. (Barbara Illoweky et al, 2018, pp 690). In this research the researcher has considered the values of r which they are under 0.4, are going to have non-linear relationship, so according the graph No. (1) of the flow steps of the research; it will be another regression model to evaluate the trend of the relation between the random variable y and the predictor variable x.

The third technique: is Regression analysis which is a technique for estimating the values of the structural coefficients of a model of an economic process (Ashish sen et al, 1990, pp 71). The main characteristics of regression models is that the relationship between the response variable y and the covariates is not a deterministic function $f(x_1, \ldots\ldots, x_k)$ of $x_1, \ldots\ldots, x_k$, but rather shows random errors. This implies that the response y is a random variable, whose distribution depends on the explanatory variables.

One main goal of regression is to analyze the influence of the covariates on the mean value E (y|

$x_1, \ldots\ldots, x_k$) of y depending on the covariates. Hence, the expected value is a function of the covariates:

$$E(y| x_1, \ldots\ldots, x_k) = f(x_1, \ldots\ldots, x_k)$$

it is then possible to decompose the response into:

$$E(y| x_1, \ldots\ldots, x_k) + e = f(x_1, \ldots\ldots, x_k) + e$$

Where e is the random deviation from the expected value. The expected value $E(y| x_1, \ldots\ldots, x_k) = f(x_1, \ldots\ldots, x_k)$ is often denoted as the systematic component of the model. The random deviation e is also called random or stochastic component, disturbance, or error term. (Ludwig Fahrmeir et al 2013, pp 21, 22)

Simple linear regression of time series is standard procedure in many scientific disciplines. If the number of data is large, a trend may be statistically significant even if data are scattered far from the trend line (Andreas C. et al 2011). It is a very straightforward approach for predicting a quantitative response Y on the basis of a single predictor variable X, it assumes that there is approximately a linear relationship between X and Y (just two variables). Mathematically, we can write this linear relationship as (equation No. 2)

$$Y\hat{} \approx B + a\,X$$

Where B and a are two unknown constants that represent the intercept and slope terms in the linear model. Together, B and a are known as the model coefficients or parameters. Once we have used our training data to produce estimates B for the model coefficients, we can predict future trend on the basis of a particular *value* $y\hat{} = B + a\,x$ where $y\hat{}$ indicates a prediction of Y on the basis of $X = x$. Here we use a hat symbol, $\hat{}$, to denote the estimated value for an unknown parameter or coefficient, or to denote the predicted value of the response, where we can find A and B by the next equations (equation No. 3 and 4) (Gareth James et al 2017, p. 61).

$$A = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$B = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2}$$

Data collection

For the data collection, Wayfarer platform is the only source and case study. It is essential to identify the rug images which truly reflect the current trend, so we can count on them and predict the future trends. Researcher inspected the entire rug designs on Wayfair platform, and then selected designs according to some criteria.

This research utilized data is a set of product reviews. Every considerable as a truth ground review must have a rating from 3 stars to above, where one and two stars were not be considered. Time series for every design, are based on these reviews were built.

Criteria for the Selected Designs

The first criteria is the numbers of reviews where the selected designs have the most height review numbers, the second criteria is that the selected designs have to cover all of the variations of the design styles. According to (Ahmed Abdelghany 2025) as shown in the tables No. (1 and 2) which indicate a rug and carpet design classification according to deign, where he has classified rug designs according to taxonomy of data processing methods, into two main basic groups, then these two main groups are classified into (4) subgroups, then these subgroups are classified into sub-subgroups. This hierarchical table has considered to be used in this research to represent most tastes of the selected market. Total number of selected and analyzed designs in the research is (26).

Table No. 1 Contemporary Rug Design Classification

Curvilinear								Geometric								
Modern			Transitional					Modern			Transitional					Abstract
Variegated field	Open Field	Repeated Design	The Ideal Oriental	Anatolian	Variegated field	Open Field	Repeated Design	Variegated field	Repeated Design	Open Field	The Ideal Oriental	Anatolian	Variegated field	Open Field	Repeated Design	Color Spray

Table No. 2 Rug Design Classification

Modern									Classic									
Transitional						Contemporary			Oriental Rug Designs						European Rug Designs				
The Ideal Oriental Rug	Anatolian	Open Field	Variegated field	Open Field	Repeated Design	Variegated field	Repeated Design	Open Field	The Ideal Oriental Rug	Anatolian	Open Field	Variegated field	Open Field	Repeated Design	Spainish	French	England	Italian	Finnish

Results and Discussion

- Single variable, continuous time series has been built using pivot tables in excel. Reviews are the only variable, which is measured using real numbers scale over time which has been scaled in months.
- Modeling: a linear relationship between X and Y, in this research; X refers to time in months, Y refers to No. of reviews, our purpose here is to get $Y\hat{}$, systems are modeled as having a number of inputs (or stimuli, covariates) $(x_1, x_2, \ldots..x_r)$, a number of outputs (responses) $(y_1, y_2, \ldots y_s)$, The main characteristics of regression models is that the relationship between the response variable y and the covariates. Since this relation is not a deterministic function $f(x_1, \ldots\ldots, x_k)$ of $x_1, \ldots\ldots, x_k$, but rather shows random errors. This implies that the response y is a random variable, whose distribution depends on the explanatory variables. And a number of system parameters (or conditions) $(e_1, e_2, \ldots.e_t.)$
it is then possible to decompose the response into:

$$E(y| x_1, \ldots\ldots, x_k) + e = f(x_1, \ldots\ldots, x_k) + e$$

- descriptive analysis. Descriptive analysis shows minimum, maximum, and mean values of the collected data, have been made for every designs data with in its time series, and pivot table.
- In the table No. (3) Column No. (2), the researcher has arranged area rug designs of the heights reviews numbers from Wayfare platform, according to a descendent way, where the first design has the maximum numbers of the reviews which is 100622 reviews (in the date of:) its name is Clair Moroccan, according to this research this design has given the number (7) to be used instead of its name, this step may gives us signs about the directions of the current trends.
- Column No.8 shows person correlation coefficient value (r-value) for all the rugs; which were between (0.01- 1). Designs number (1, 2, 4, 7, 14, 16, 18, 19, 22, 24, 25, and 29) showed values less than (0.4) so they seem to have no linear correlation between rug design trends changing during the time, so they did not test using linear regression equation. So the researcher hopes to test them in another research, using non-linear correlation equations.
- According to the test of r value, where designs No. (3, 5-15, 17, 20, 21, 22, 23, 25) showed values between (0.4 and 1) so they seem to have linear correlation between rug design trends changing during the time, which is the predicted numbers of reviews over the given time, so the linear regression equation has been used $Y\hat{} \approx B + a\,X$.
- Results of this linear regression analysis for all the rug designs have been shown in the graphs from (1-18), which showed that; designs No. (11, 13, 14, 15, 22, 25) have a positive trend for the future, where designs number (3, 5-12, 17, 20, 21, 23, 25) have a negative trend for the future.
- Table No. 4 showed the features of the positive trend designs.
- According to this research; according to using of linear regression model for forecasting and using just Wayfair as a source platform for the data, we have here just four rug design trends that represent the positive trends for the future; these trends are

- The First Trend: Which has been represented by the design number 11, the design with curvilinear lines, which is transitional design, and has the ideal oriental layout, its texture seems to be gorgeous mist and their motifs sources are from the Persian Rug designs.
- The Second Trend: Which has been represented by the design number 13, the design with geometric lines, which is modern design, and has the repeated layout, its texture seems to be vintage and their motifs sources are from the Persian Rug designs.
- The Third Trend: Which has been represented by the design number 15, the design is abstract design, which is modern design, and seems to be as color sprays, its texture seems to be smooth, the patterns seems to be curvilinear lines on a spray background.
- The Fourth Trend: Which has been represented by the design number 25, the design is abstract design, which is modern design, and seems to be as color sprays, and its texture seems to be smooth.

Table No. 3

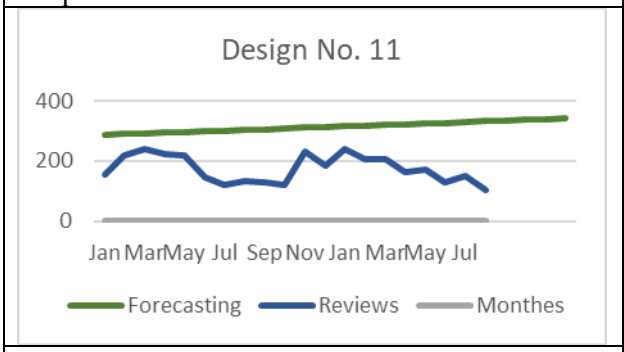
Rug Name	No. of Views	Geo. Or Curvilinear	Sort	Layout	Texture	Pattern Source	Multiple R
7	100622	Geometri	Modern	V. field	Smooth T.	Moroccan	0.27
25	70530	Geometri	Abstract	Color Spray	Smooth T.	Abstract	0.12
11	62580	Curvilier	Transitional	Ideal O.	Gorgeous	Persian Rug	1
18	62507	Curvilinear	Transitional	Ideal O.	Antique Look	Persian Rug	0.04
3	47872	Curvilinear	Transitional	Ideal O.	Traditional	Persian Rug	0.63
2	47794	Curviliar	Transitional	Ideal O.	Traditional	Persian Rug	0.37
1	41848	Curvilinear	Transitional	Ideal Oriental	Vintage	Persian Rug	0.15

16	27822	Geometric	Transitional	Anatolianan	Rough	Anatolian	0.11
26	27468	Curvilinear	Transitional	The Ideal O.	Traditional	----	0.42
24	19616	Curvilinear	Transitional	Open Field	Gorgeous	Persian Rug	0.13
19	17347	Geometric	Transitional	Anatolian	Antiqued	Anatolian	0.04
22	16274	Curvilinear	Transitional	Ideal Oriental	Traditional	Persian Rug	0.06
17	15905	Curvilinear	Transitional	Repeated D.	Traditional	Persian Rug	0.72
8	15721	Geometri	Modern	V. field	B.Texture	Abstract	0.92
5	13540	Geometric	Transitional	Anatolian	Vintage	Anatolian	0.62
14	13194	Geometri	Abstract	Color Spray	Vintage	Abstract	0.01
15	13134	Geometri	Abstract	Color Spray	S. Texture	Abstract	1
23	11036	Geometri	Modern	V. field	AntiqLok	Persian Rug	0.56
13	10029	Geometri	Modern	Repeated D.	Vintage	Persian Rug	0.75
20	9838	Geometri	Abstract	Color Spray	Vintage	Abstract	0.8
10	9710	Curvilinear	Modern	Open Field	Traditional	botanical and	0.65
9	9143	Geometric	Transitional	Ideal Oriental	Antique Look	Persian Rug	1
6	8224	Curvilinear	Transitional	Ideal Oriental	Vintage	Persian Rug	0.62
4	7973	Curvilinear	Transitional	Ideal Oriental	Antique Look	Persian Rug	0.01
12	6246	Curvilinear	Transitional	Ideal Oriental	Vintage	Persian Rug	0.64

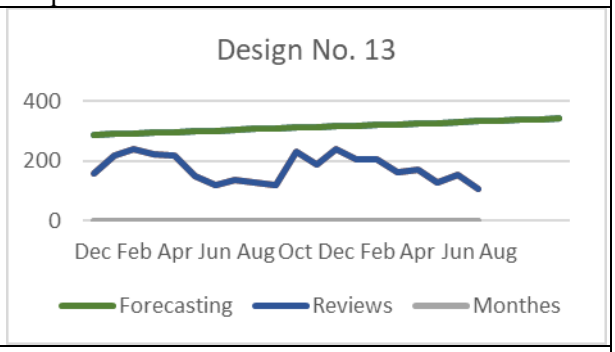
Table No. 4 The Research Rug Design Main Features

Rug Name	Geo. Or Curvilinear	Sort	Layout	Texture	Pattern Source	Color Group	Slope
11	Curvilier	Transitional	Ideal O.	Gorgeous	Persian Rug		2.36
13	Geometri	Modern	Repeated D.	Vintage	Persian Rug		1.7
15	Geometri	Abstract	Color Spray	S. Texture	Abstract		2.48
25	Geometri	Abstract	Color Spray	Smooth T.	Abstract		0.212

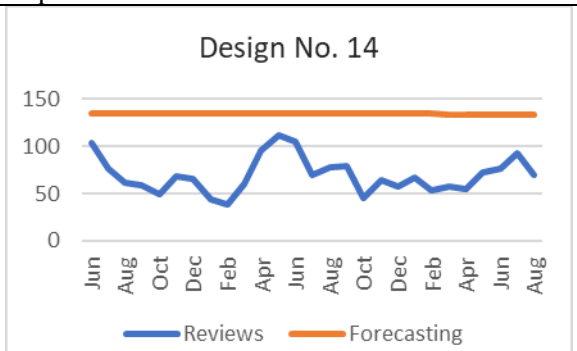
Graph No. 1



Graph No. 2



Graph No. 3



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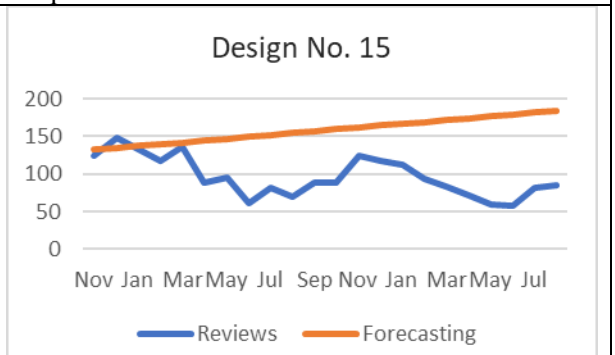

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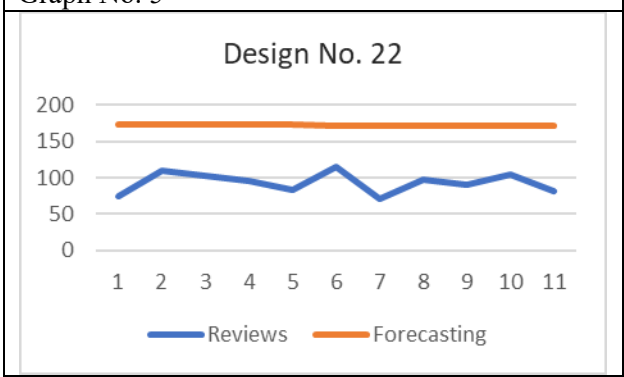

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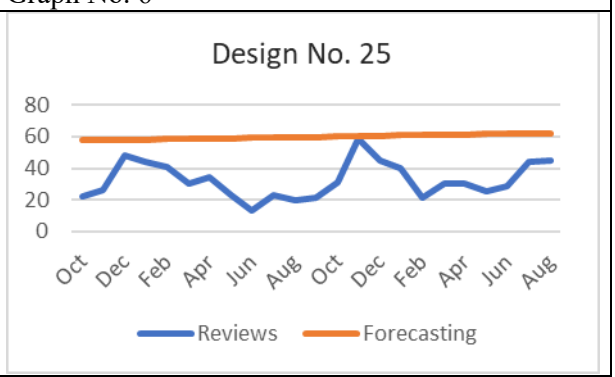
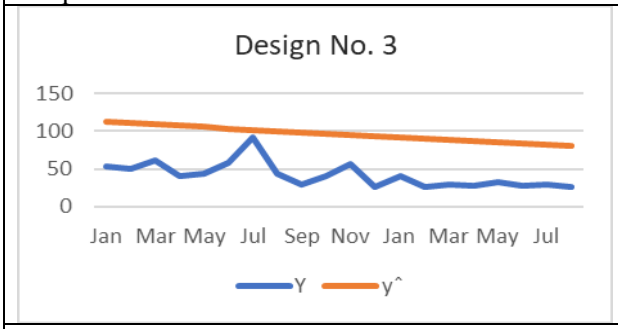
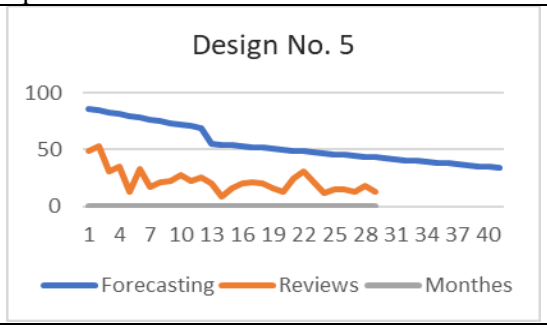


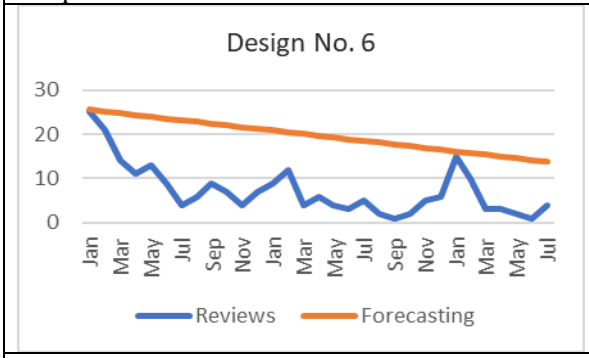
Graph No. 7



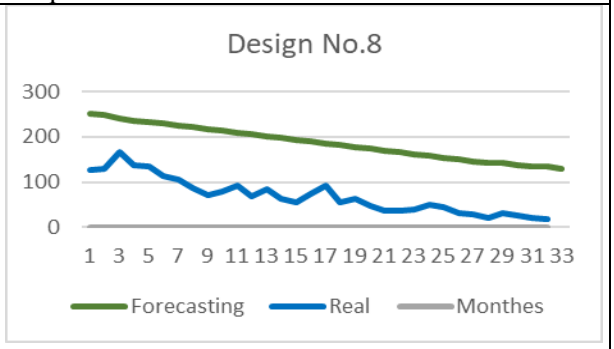
Graph No. 8



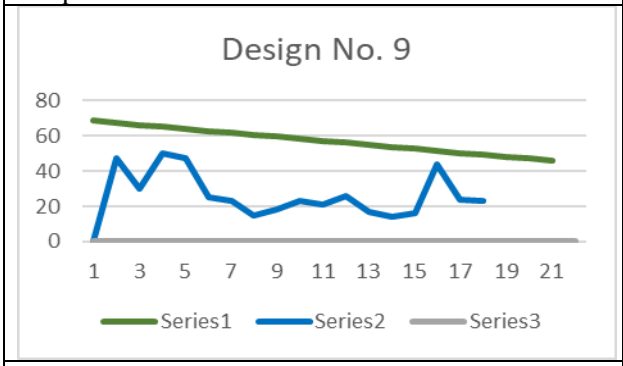
Graph No. 9



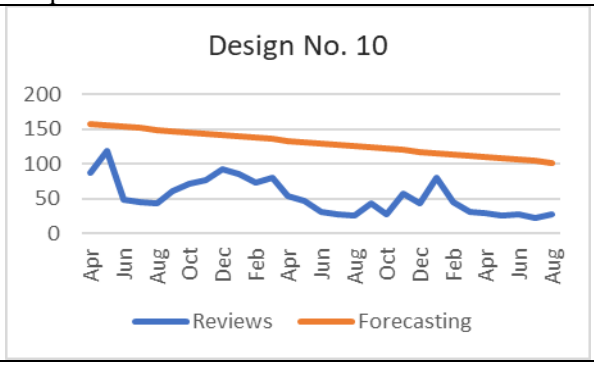
Graph No. 10



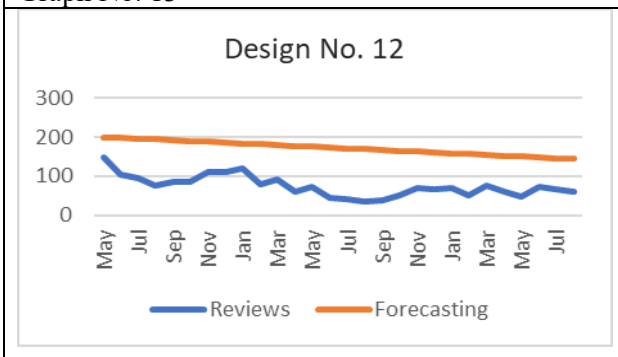
Graph No. 11



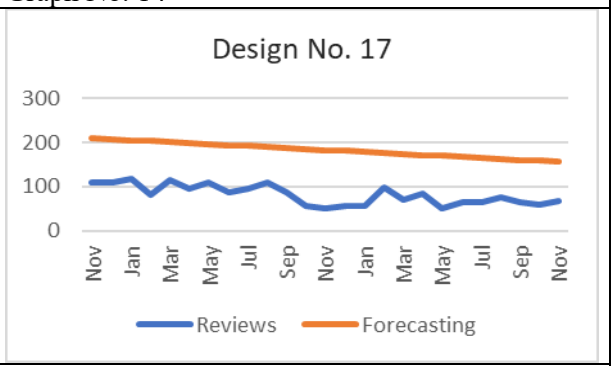
Graph No. 12



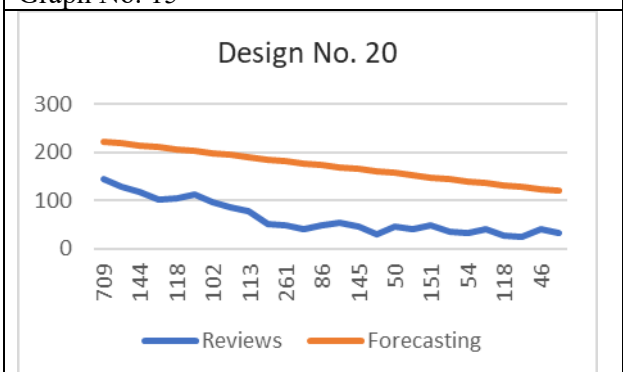
Graph No. 13



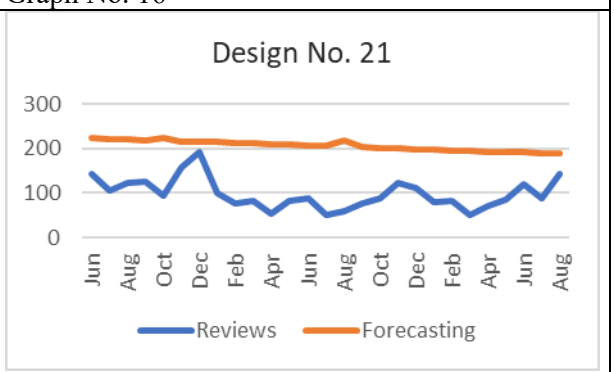
Graph No. 14

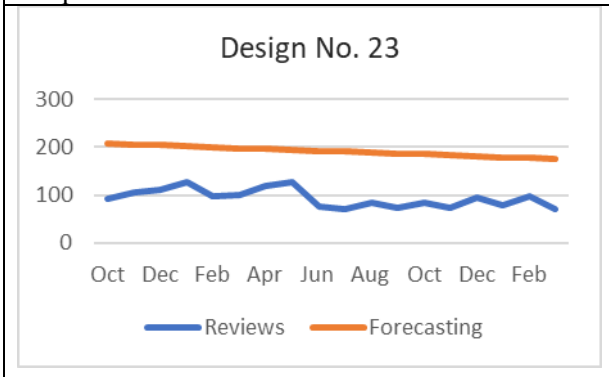
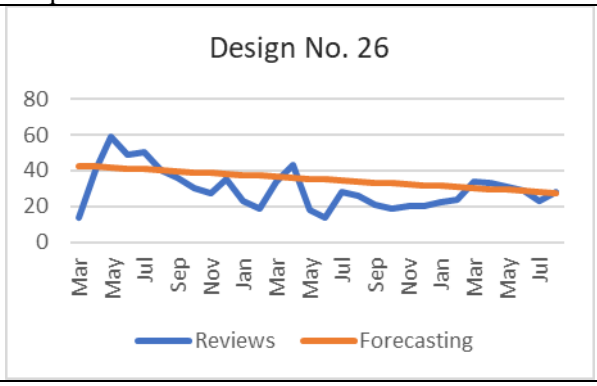


Graph No. 15



Graph No. 16



Graph No. 17	Graph No. 18
	

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