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**ARTICLES**

<b>Tourism forecasting by search engine data with noise-processing?</b>	<b>114</b>
Li Xiaoxuan, Wu Qi, Peng Geng and Lv Benfu	
<b>An investigation of the marketing performance measurement practices in Hatfield Volkswagen group</b>	<b>131</b>
Chris Beukes and Gerhard van Wyk	

*Full Length Research Paper*

# Tourism forecasting by search engine data with noise-processing

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In many studies, search engine data were efficient to analyze and forecast as an explanatory variable, including the tourism volumes predictions. However, the search data and the tourism volumes were always interfered by the noise. Without noise-processing, the predictive ability of search engine data might be weak, even invalid. As a method of noise-processing, Hilbert-Huang Transform (HHT) could deal with non-linear and non-stationary data. This study proposed a model with denoising and forecasting by search engine data, namely CLSI-HHT. The search queries were composited into an index first, then the noise were extracted from the index and tourism volumes sequences by HHT. The study further forecast the tourism volumes with the effective series. The results demonstrated that CLSI-HHT model outperformed the baselines significantly while the index model without denoising performs nearly same as the time series model. Moreover, wavelet transform and filtering were compared with HHT on denoising and the results implied that HHT had higher signal noise ratio (SNR) and forecast more accurately. The study concluded that noise-processing was necessary for the tourism forecasting with search engine data, and HHT could be an effective method on denoising.

**Key words:** Hilbert-Huang Transform (HHT), search engine data, noise-processing, wavelet transform.

## INTRODUCTION

In the past few decades, the tertiary industry has developed fast with the driving force of macroeconomics. Leisure entertainment demands are increasing while tourism is one of the most important components. However, tourism development could present a significant challenge for the nature, environment and scene management as well as boom the local economy. Tourists exploding and the upsurge of holidays both make it difficult to manage the scene and distribute the limited

resource appropriately. The perishable nature of tourism products make forecasting an important subject for future success (Gunter and Onder, 2015), especially the peak forecasting. Meanwhile, the internet changes the decision process and behavior. The search engines are able to capture and record the online behavior of netizen. Many previous studies have effectively analyzed and forecast the social economics with search engine data, including tourism volumes, stock prices, countries' risks and

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exchange rate (Smith, 2012; Zhang et al., 2013; Fondeur and Karame, 2013). However, despite predicting tourism volumes by web data, not many studies have investigated the noise-processing before predictions. Either the tourism volumes or the search engine data, both of them are easy to be interfered by the noise from outside. This noise will be contained in the statistical sequences, which could impact on the analysis of this study. The actual behavior and decisions may be misunderstood by the jamming of noise, which will further fail the tourism forecasting. All these characteristics of tourism products and web data make noise-processing a necessary issue for both academics and practitioners.

In signal processing and physics, spectral analysis is widely utilized to deal with the noise. Fourier transform combines the signal features of time and frequency, and it respectively analyzes in the time and frequency domain. But Fourier is only defined on the natural domain of the global integration and cannot reflect the signal spectrum characteristics of the local time. Both of them make Fourier transform contradictory between the time domain and the frequency domain in analyzing the signals. Moreover, Fourier transform requires the signals to be stationary and have obvious difference in the spectrum characteristics of the noise.

These preconditions are always dissatisfied for sequences in tourism and other social science objectives. Wavelet transform recovers some restrictions of Fourier transform. It can handle the non-stationary signals and present the distinct features of the effective signals compared with the noise (Huang, 1998). Hilbert-Huang transform (HHT) is new developed time-frequency analysis in recent years and can deal with the non-stationary and non-linear signals freely. HHT absorbs the advantages of multiresolution of Wavelet without choosing the Wavelet basis. All these characteristics make HHT suitable on filtering and denoising. Two main parts complete HHT: Empirical Mode Decomposition proposed by Huang and Hilbert spectral analysis (Huang et al., 1998).

Empirical mode decomposition (EMD) is an adaptive signal decomposition by their own characteristic time scales. Compared to Wavelet transform and Fourier transform, EMD has higher signal noise ratio (SNR) in dealing with non-linear and non-stationary series, and it is widely applied in noise-processing and forecasting. EMD decomposes the original signal into several Intrinsic Mode Functions (IMFs) and a residue. Each IMF contains the local characteristics of the original signal in different time scales (Chen et al., 2012). IMFs, derived from EMD, satisfy the narrow-band requirements of Hilbert transform and can be further calculated to obtain the Hilbert instantaneous frequency and the power spectrum. The study preprocess the noise of tourism volumes and search engine data by HHT, then forecast the tourism volumes and analyze the role of denoising in tourism forecasting with search engine data.

## LITERATURE REVIEW

### Forecasting with search engine data

Search engine data offers a new source for the behavioral analysis. As the antecedent actions of decision-making in real life, online search can reflect users' trends in the future. Search engines have become the main sources for netizen to gather information and are helpful for researchers to find the behavior patterns and decision-making process.

As early as 2009, Ginsberg et al. (2009) successfully predicted flu outbreaks in the United States with Google Search, then the studies with search engine data have sprung up in the next decades. The scholars applied search engine data to predict economics (Vosen and Schmidt, 2011; McLaren and Shanbhogue, 2011; Dzielinski, 2012; Fondeur and Karame, 2013), finance (Bollen et al., 2011; Bordino et al., 2012; Smith, 2012; Zhang et al., 2013), disease control (Rothberg et al., 2014) and so on. In Japan, Takeda and Wakao (2014) collected and recorded search queries of 189 stocks in Google Trends as the online search intensity. They then analyzed the relationship among search data, stock trade volumes and stock returns, finding that Google Trends data had a great positive effect on stock trade volumes, enabling them to predict the trade returns in the next periods.

Unlike the other studies to predict the future with the present search engine data, Varian and Choi (2009) claimed the important role of Google Trends data in predicting the present rather than the future to make up the lagging calculation of the statistical data. They combined the Google search data and time series to predict the volumes in several different industries, including retail sales, automobile sales, home sales and travel.

Meanwhile, Search engines extend the information dissemination channels for tourism industry and altered the way that people gather travel information (Beldona, 2005; Buhalis and Law, 2008). Gawlik et al. (2011) based on the research of Varian and Choi (2009) used query-specific search data to forecast the monthly tourism volumes in Hong Kong between 2005 and 2010. They extracted the features and chose the highest relevant queries of key words, then evaluated the performance of the prediction with k-fold cross validation. It turned out that the forecast result was better than the study of Varian and Choi (2009) in either the training error or forecast error. The research of Bangwayo-Skeete and Skeete (2015) gathered the composite queries of "hotel and flight" and applied Autoregressive Mixed-Data Sampling (AR-MIDAS) model. Contrast with seasonal autoregressive integrated moving average (SARIMA) model and autoregressive (AR) model, AR-MIDAS model performed better in most out-of-sample forecast tests. The result also demonstrated that search data had a

significant benefit in predictions. Song et al. (2013) proposed a web-based tourism demand forecasting system (TDFS), including the data module, the quantitative forecast and forecast evaluation. They also uniquely combined the quantitative prediction and judgmental forecast together in the TDFS.

Most analysts forecast with data from Google Trends. But Baidu owns overwhelming users in comparison to Google search engine in China. There is a growing trend after Google quit the Chinese market. Since 2006, Baidu has opened its search database and published "Baidu Index" online, which enable researchers to forecast the tourism trends and other social issues with Baidu Index. Yang et al. (2015) compared Google and Baidu search data to predict the tourism volumes in Hainan Province of China. The indicators suggested that Baidu Index outperformed the Google Trends and the benchmark ARMA model due to the overwhelming users for Baidu search engine in China. Vaughan and Chen (2015) forecast the quality of Chinese universities and companies by using Google and Baidu search data respectively and obtained similar conclusion. Huang et al. (2013) predicted the tourism flow in the Forbidden City during the "golden week" by using Baidu Index and autoregressive distribution lag (ARDL) model. They claimed that Baidu index data and ARDL model could produce the more accurate forecast results than the traditional ARMA model.

### HHT in the noise processing

The forecast ability of the web search data has been confirmed by many previous studies. However, either web search data or the social society object contains some inevitable noise. The predictions become more difficult because of this noise. Signal science mainly processes the noise by applying spectrum analysis which maps the signals in frequency domain. The most commonly methods include Fourier Transform and Wavelet Transform. As mentioned earlier, Fourier and Wavelet transform have too many restrictive conditions to suit the social science. HHT was firstly proposed by Huang et al. (1998) and consisted of two parts: EMD and Hilbert Transform. Since then, HHT has begun to be widely used in the field of building structure (Roveri and Carcaterra, 2011), mechanical fault (Bin et al., 2011; Wu et al., 2014), medicine (Yan and Lu, 2014) and geophysics (Ni et al., 2013). Song et al. (2012) applied HHT and threshold to denoise the electrocardiogram (ECG) signal. EMD decomposed the ECG signal into the noise layers and the effective signal layers. The noise layers were calculated by the energy spectrum and high frequency average periods. The experiment results implied that several main noise included in ECG signal were effectively identified and extracted by HHT and threshold method.

Recent studies attempted to introduce HHT into business management and have a remarkable effect. Ju et al. (2014) combined HHT and time series analysis to study the impact mechanism between stock prices of Chinese crude oil and macroeconomics. HHT was used to screen the target stocks for each event. The results turned out that HHT was valid as the screen method for event studies. Chen et al. (2012) and Yao et al. (2014) decomposed the tourism volumes signal and extracted features by EMD. They both found that EMD was a reliable method to deal with the non-linear and non-stationary signal, and could improve the predicted accuracy. Chen and Wei (2011) proposed a time variants exploration method that includes EMD and Hilbert spectral analysis (HSA) to extract the frequency features of Taipei short-term passenger flow. Also they compared the results of HHT with that of fast Fourier transform (FFT) and concluded that HHT could obtain the narrower frequency band, accurately capture time-frequency-energy distribution and help to enhance the performance of transportation systems.

Overall, there was one main limitation in the previous studies, related to forecasting with search engine data. Most of these studies have focused on the predicted ability and the relationship between web search data and social society. When the web search data and forecast objects includes a large number of noise signals, the predicted ability and the correlations might be weakened and misled. How to deal with this noise signal before the study analyze and predict by web search data. Can HHT denoise the web data and improve the predicted ability effectively? The study proposes a novel method of denoising the web data and the predicted object to improve the forecast accuracy, especially during the peak periods.

## METHODOLOGY

### Empirical mode decomposition

As the first stage of HHT, EMD is a signal analysis method which can deal with non-linear and non-stationary data. The basic principle of EMD is to decompose the time series into a sum of oscillatory functions, namely intrinsic mode functions (IMFs). Every IMF contains the local features in different time scales. Besides, the IMF must satisfy the following two basic conditions:

1. In the whole function time range, the number of the local extrema (including the maxima and the minima) and the number of zero crossing points must be equal, or differ only by one;
2. At any time, the local average is zero.

The first condition is similar to the traditional narrow band requirements for a stationary Gaussian process (Chen et al., 2012). This condition chooses the local requirement to avoid the unnecessary fluctuation effects. The latter condition is more complicated. The envelope of the maxima forms the upper envelope, and the envelope of the minima forms the lower envelope. The mean of the upper and lower envelopes is set to zero, in order to make sure that the signal wave is a local symmetry.



The main steps of EMD can be broken down into two steps:

**Step1:** Take the experimental data as  $Y(t)$  and calculate all the local extrema. Then connect all the maxima into the upper envelope line  $U(t)$  and all the minima into the lower envelope line  $L(t)$ . All the data will be contained between  $U(t)$  and  $L(t)$  and the mean of these two envelopes are

$$M_1(t) = (U(t) + L(t)) / 2 \quad (1)$$

Eliminate  $M_1(t)$  from the original series  $Y(t)$  and obtain the first line  $Q_1(t)$ , which is the IMF1.

$$Q_1(t) = Y(t) + M_1(t) \quad (2)$$

However, if  $Q_1(t)$  is unsatisfied to the two conditions, it cannot be called as the IMF. Step1 process is to be repeated till the series  $Q_k(t)$  meets the conditions.

$$Q_{1k}(t) = Q_{1(k-1)}(t) + M_{1k}(t) \quad (3)$$

$$IMF_1 = Q_{1k}(t) \quad (4)$$

**Step 2:** Subtract IMF1 from the original series,

$$P_1(t) = Y(t) + IMF_1 \quad (5)$$

Then the study take  $P_1(t)$  as the original time series and iteratively perform the whole step1 to decompose other IMFs. This process ends till the residue becomes a constant or a monotonic function. The residue can be treated as the trends of the original time series.

$$Y(t) = \sum_{i=1}^n IMF_i + R_n \quad (6)$$

$R_n$  is the residue series, and IMFs have different frequencies. Each IMF is on behalf of one signal separated from the original series.

### Hilbert transform and spectrum analysis

Then the second stage of HHT is Hilbert spectral analysis, which is performed to obtain the time-frequency-energy distribution. The IMFs, decomposed by EMD, perfectly satisfy the narrow band requirements of Hilbert transform. Set each IMF as  $c_i$ , and structure the analytic signal for  $c_i$ :

$$z_i(t) = c_i(t) + j\hat{c}_i(t) = a_i(t)e^{j\phi_i(t)} \quad (7)$$

The amplitude function, the phase function and the instantaneous frequency are:

$$a_i(t) = \sqrt{c_i^2(t) + \hat{c}_i^2(t)} \quad (8)$$

$$\phi_i(t) = \arctan(\hat{c}_i(t) / c_i(t)) \quad (9)$$

$$f_i(t) = \frac{1}{2\pi} \omega_i(t) = \frac{1}{2\pi} \frac{d\phi_i(t)}{dt} \quad (10)$$

If the residue  $R_n$  is omitted, the original signal  $Y(t)$  can be presented as:

$$Y(t) = \text{Re} \sum_{i=1}^n a_i(t)e^{j\phi_i(t)} = \text{Re} \sum_{i=1}^n a_i(t)e^{j\int \omega_i(t)dt} \quad (11)$$

$$H(\omega, t) = \text{Re} \sum_{i=1}^n a_i(t)e^{j\int \omega_i(t)dt} \quad (12)$$

$\text{Re}$  represents the real part of the signal.  $H(\omega, t)$  represents the Hilbert spectrum of the signal  $c_i$ . Hilbert spectrum accurately describes the change law of the signal's amplitude with the time and frequency on the whole frequency axis.

### Conceptual framework

Before making travel decisions and traveling, tourists will always gather relevant information, including the travel destination, the transportation, the hotels and the weather. Each search query reveals the tourists' psychology and behavior, and this will reflect the future behavior decisions in advance. Due to the differences among individual behaviors, the search range and target are so large that we need to pre-process the search behavioral data before forecasting. It is wise to reduce the dimension for the web search queries. In this study, composite leading search index (CLSI), proposed by Liu et al. (2015), is employed to screen the large number of related search queries and composite them into one web search index. This synthetic method calculates the lead time and correlations between each search queries and the forecast object by Pearson correlation analysis. Then screen out the search queries with antecedence and strong correlation. The study further aggregate selected search data into one index by shifting and summing method.

When tourists gather information, they are always disturbed by noise. Also the forecast objects fluctuate because of the unexpected factors. Hence, the study should process the noise by HHT before the prediction in order to reduce the noise interference of the sequences. Taking Jiuzhaigou as an example, the conceptual framework is presented in Figure 1.

### Empirical test

#### Data

As one of the famous scenic spots in China, Jiuzhaigou attracts tens of thousands visitors every year, which leads to the potential problems of safety and being stranded for tourists. Particularly, the peak seasonal management is much more difficult for the authorities and policy makers. On October 1st, 2013, the first day of the National Day holiday, four thousands tourists were stuck at the entrance of Jiuzhaigou for five hours due to overcrowding (Qiu, 2013).

This signifies the urgency for accurate prediction for anticipating and managing influxes of tourists during the peak seasons. Moreover, in the network search rankings of Chinese scenic areas, Jiuzhaigou is far ahead and gets the most concern of tourists among the most popular scenic spots. This demonstrates that tourists prefer to collect information and arrange their travel plans with Jiuzhaigou being an attractive site for tourists. As for the search engine, Baidu overwhelms other search engines in China. Lots of studies proved that Baidu search data is much better and appropriate than Google and other search engines in analyzing

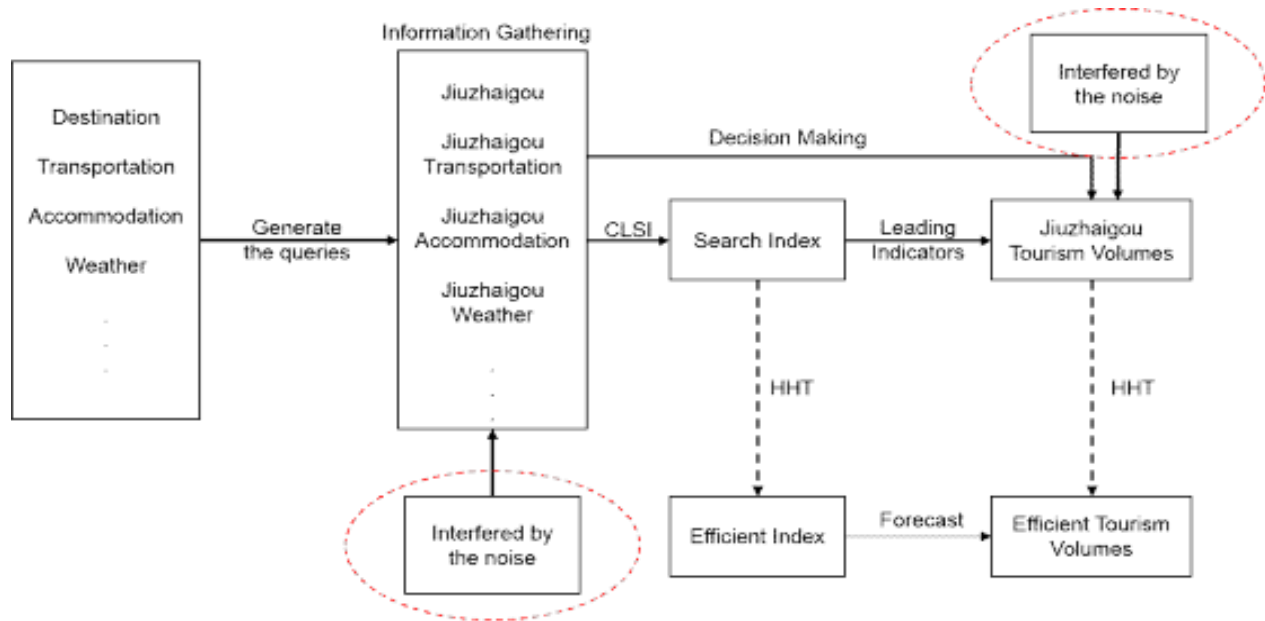


Figure 1. The conceptual framework of forecasting with search engine data and denoising.

Chinese issues. Considering these aspects, the study propose a forecast model with noise-processing, namely CLSI-HHT, to predict the tourism volumes based on search engine data and empirically test the model by taking the case of Jiuzhaigou.

The tourism traffics data of Jiuzhaigou are published by its official website every day. In the empirical study, the time span is from 1 June, 2012 to 31 December, 2014, including 944 data in total. During the empirical test, the series will be divided into two sets: training data and testing data. To achieve more reliable and accurate results, a long period is chosen as the training period (Chen et al., 2012). Based on this, the first 760 data spanning from 1 June, 2012 to 31 June, 2014 (80% of the total sample points) are used as the training sample while the remaining 184 data spanning from 1 July, 2014 to 31 December 2014 (20% of the total sample points) are treated as the testing sample. This testing period covers the peak tourism season (from August to October) and the off season (November and December) in Jiuzhaigou.

### Composite leading search index

Baidu index of each query is in absolute numbers which reflects the search times. CLSI contains four main steps:

1. According to the tourists' information demand, the study initially choose 15 basic search keywords, such as "Jiuzhaigou", "the weather of Jiuzhaigou", "the hotels in Jiuzhaigou", "Jiuzhaigou airport"(in Chinese) and so on. Input these basic keywords to Baidu search engine, then the search engine will recommend more relevant queries based on your search query. This helps to expand the tracking scope of search terms. For example, when we search "Jiuzhaigou", Baidu search engine recommends the queries including "the travel guides of Jiuzhaigou", "travel agents in Jiuzhaigou", "the ticket in Jiuzhaigou" and so on.

2. Taken these 15 basic queries as the seed search queries, the recommended queries are recaptured from Baidu Index. This round is repeated to obtain iteratively the search queries and ends till no new queries are recommended. Delete the queries without query

traffic or without embodied. Only 146 search queries are retained in all.

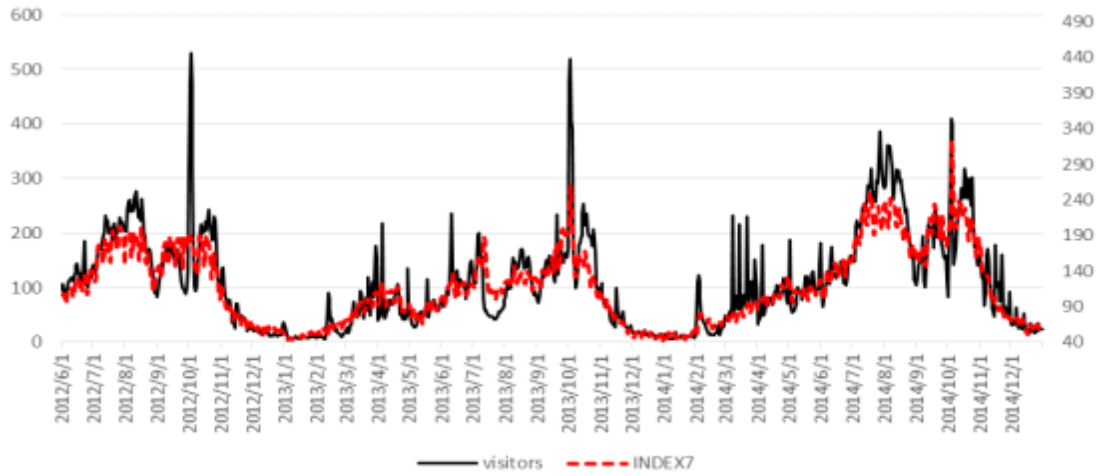
3. Calculate the Pearson correlation coefficient among the search queries and Jiuzhaigou tourist volumes with different lag periods to identify the leading search queries. In total, 32 correlation coefficients are calculated among the search queries and Jiuzhaigou tourist arrivals, 0 to 31 days ahead, respectively. Based on these coefficients, the study further chooses the queries with the maximum correlation values in the modeling process. Confirm the threshold in order to reserve the appropriate number of the leading search queries. Excessive leading search queries contain more noise and useless information, while deficient leading search queries lose too much information. Only 6 search queries is selected if the threshold is 0.8. And if we choose 0.6, more than 60 search queries satisfy the standard. With the threshold of 0.7 and at least one lag period prior to the tourist arrivals, a total of 24 search queries are selected appropriately.

4. The study further combines the search index with moving summation. Each of the leading queries will be shifted according to the lag order of the maximum Pearson correlation value. Then sum up all of the moved queries to obtain the search index, namely INDEX7. Figure 2 presents the correlations between INDEX7 and Jiuzhaigou tourist volumes. Two series have similar change trend, which generally implies the possibility of forecasting the tourism volumes with composite search index.

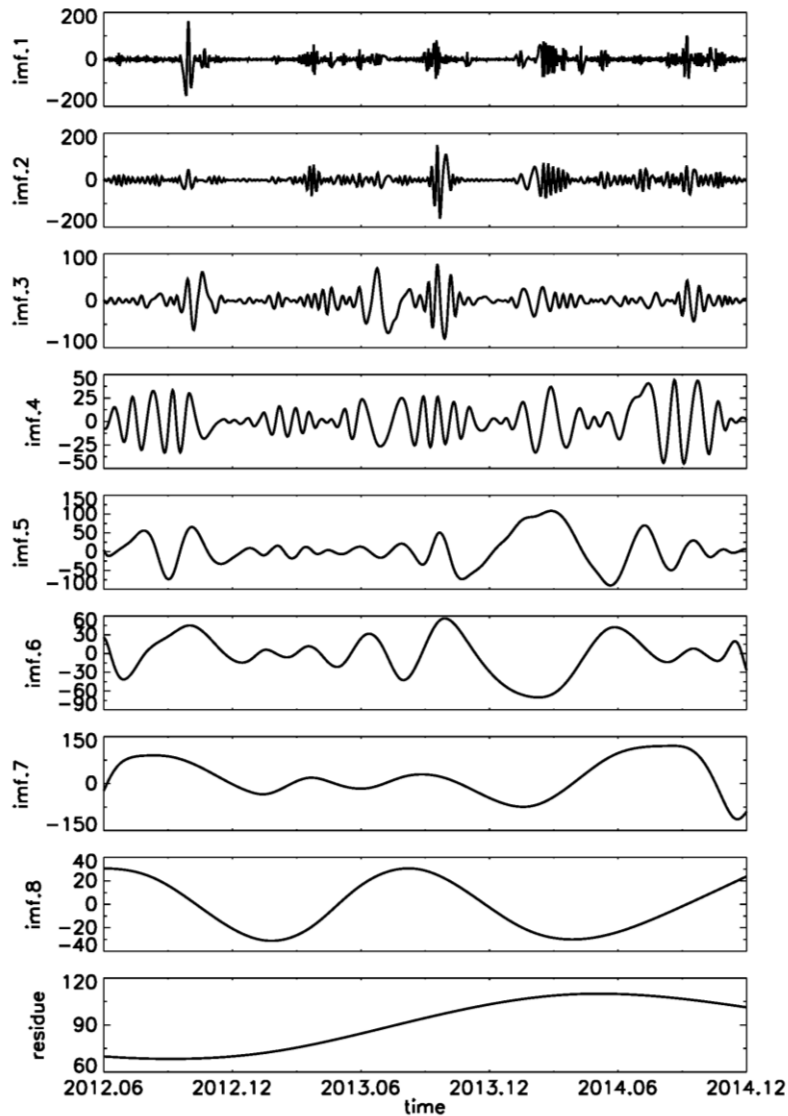
### HHT in noise-processing

On the basis of CLSI, EMD is conducted to the Jiuzhaigou tourism volumes and INDEX7. The decomposition derives out eight IMF functions and a residue of Jiuzhaigou tourist volumes and seven IMF functions and a residue of INDEX7. Figure 3 and Figure 4 respectively presents the series of all the component functions and the residues.

EMD adaptively decomposes the signal into several IMF components and a residue. Each IMF function contains the different characteristics time scales which presents the feature information of



**Figure 2.** The correlations between IDENX7 and Jiuzhaigou tourist volumes.



**Figure 3.** The IMFs and residue of tourist volumes.

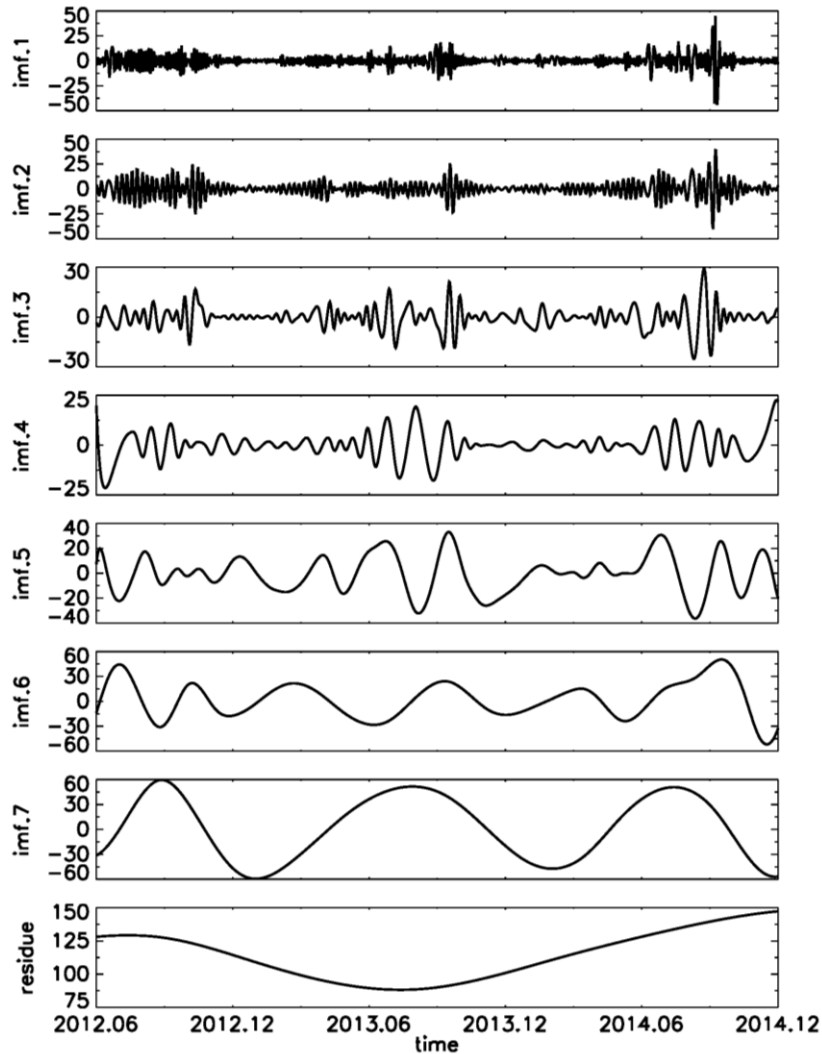


Figure 4. The IMFs and residue of INDEX7.

the signal with multiresolution. Specifically, the resolution size varies with different signals. In Figure 3 and 4, IMF1 has the highest frequency. The frequency of all IMF functions is decreased in turn and non-overlapping while the residue is closed to a monotone function. The horizontal axis represents the time range, and the vertical axis shows the function values of each IMF.

Furthermore, the Hilbert transform is conducted to obtain the instantaneous frequency for IMFs of tourism volumes. The results are illustrated in Figure 5. As discussed earlier, the Hilbert spectrum represents the energy distribution of the time series data in both frequency and time scale. It provides more information about amplitude variants of measured time series data. In Figure 5, the instantaneous frequency of IMF1 has no obvious frequency band. The value distributes uniformly in the high frequency range and IMF1 is identified as the noise layer. The instantaneous frequency gradually reduces and tends to be smooth from IMF2 to IMF8.

The main frequency of IMF2 is located at 0.15 cycles per day (7 days per cycle), which demonstrates that there are 7 days period in the signal's feature of Jiuzhaigou tourism volumes. This is consistent with the weekend effect of Jiuzhaigou. The main frequency of IMF3 appears in 0.07 cycles per day (14 days per cycle) and could be

treated as the harmonic wave of IMF2. IMF4 has the similar main frequency of 0.03 cycles per day (about 30 days per cycle). This IMF reveals the monthly period of the tourism of Jiuzhaigou. The tourist traffic increase or decrease much similarly month to month. The main frequency of IMF5-IMF7 is located at around 0.01 cycles per day (100 days per cycle). This illustrates the seasonal period of the tourist flow.

Particularly, this seasonal characteristic is significant because of the high altitude of Jiuzhaigou (nice and cool in summer and snowed in winter). The lowest main frequency of IMF8 is 0.003 cycles per day (about 360 days per cycle). The residue is almost the monotone function, and also explains the long-term trend of the series. Based on the results of EMD and Hilbert spectrum analysis, IMF1 will be extracted as the high-frequency noise. The rest of IMF components and the residue are aggregated as the effective signal of Jiuzhaigou tourist volumes.

Similarly, Hilbert instantaneous frequency of individual IMF1-IMF7 is illustrated in Figure 6 for INDEX7. The instantaneous frequency of IMF1 has no obvious frequency band and distributes uniformly in the high frequency range. So IMF1 is identified as the noise layer. The rest of IMF components and the residue are

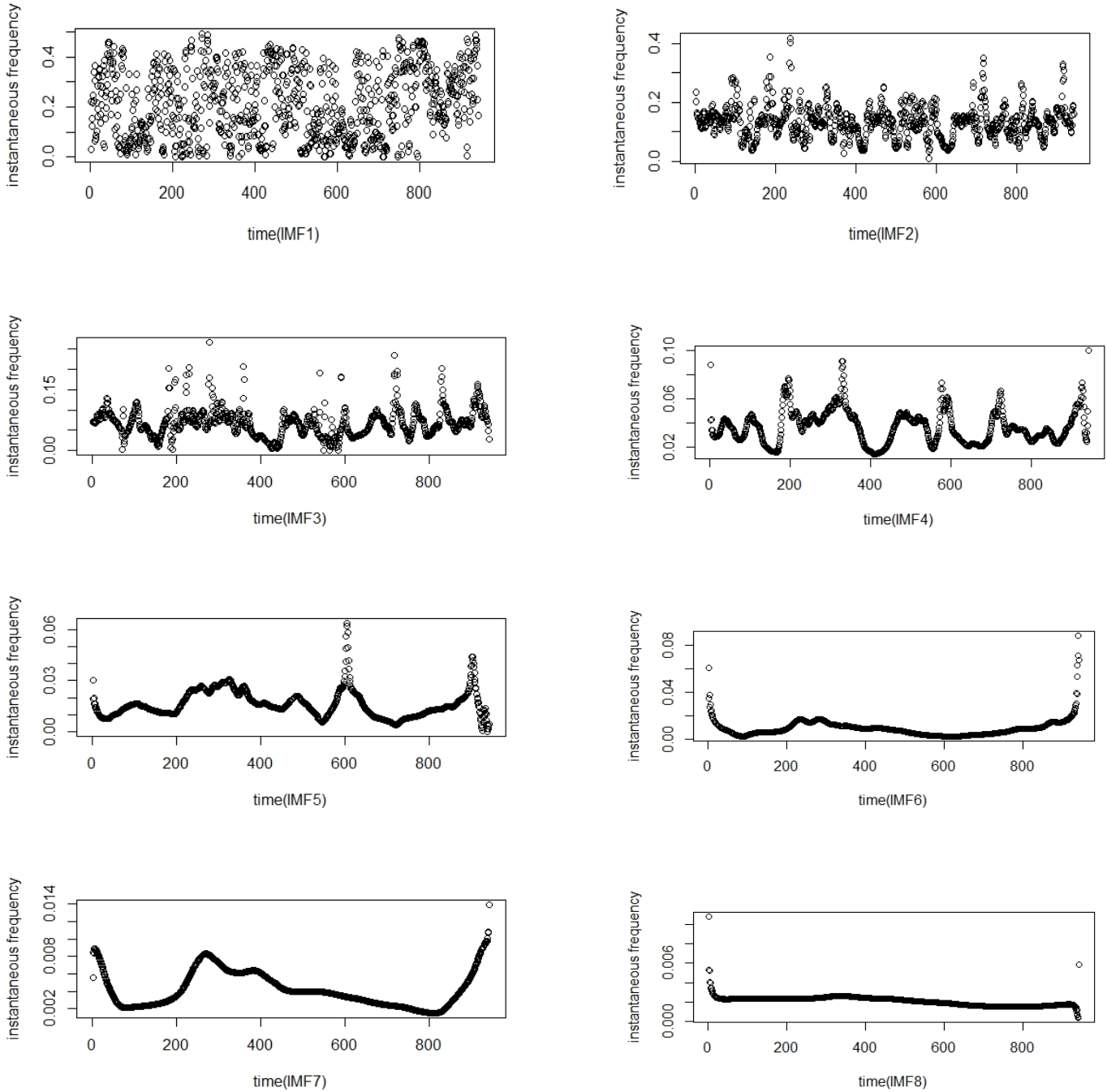


Figure 5. Hilbert instantaneous frequency spectra for IMF1-8 of Jiuzhaigou.

**Training models**

In the tourist traffic predictions, most scholars choose to apply time series models and econometric models. The study forecast the tourist volumes of Jiuzhaigou with the search engine data on the basis of considering and extracting the noise. The effective signal layers, obtained from HHT, are used to fit the models and forecast. Meanwhile, the time series model of Jiuzhaigou tourist volumes, the predicted model of web search data without denoising and BP neural network are chosen as the baseline models.

$$visitor_t = c + \alpha_1 visitor_{t-1} + \alpha_2 visitor_{t-7} + \mu_t \tag{13}$$

$$visitor_t = c + \alpha_1 Index7_t + \mu_t \tag{14}$$

$$visitor\_l_t = c + \alpha_1 Index7\_l_t + \mu_t \tag{15}$$

In equation (13) to (15), visitort denotes the Jiuzhaigou tourist volumes. Index7t denotes the index sequence INDEX7. Equation

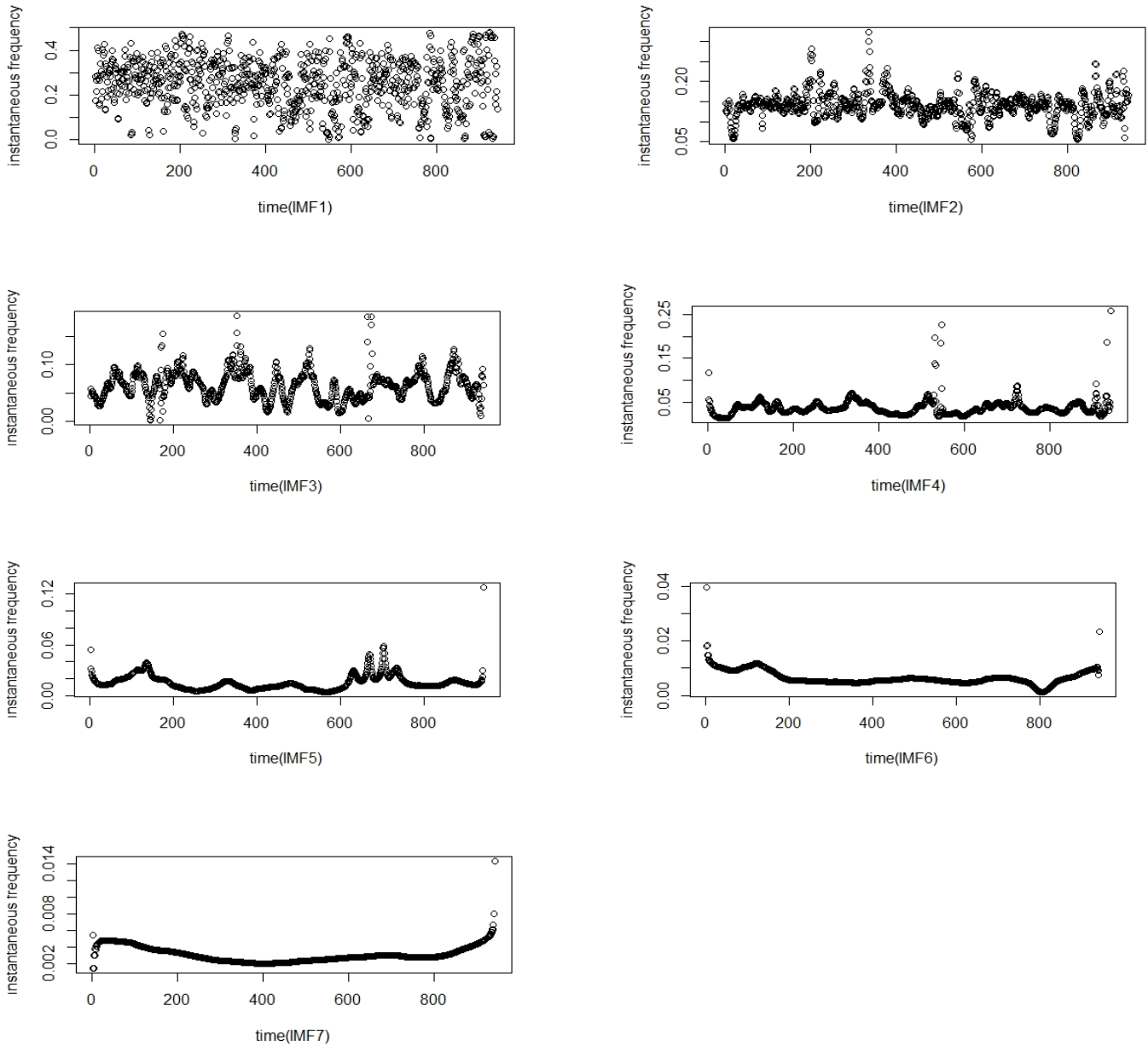


Figure 6. Hilbert instantaneous frequency spectra for IMF1-8 of INDEX7.

13) and (14) are the baseline models, denoted M(1) and M(2). visitor<sub>It</sub> and Index7<sub>It</sub> denotes the effective series of tourist volumes and INDEX7, respectively. Stationary tests (unit root tests) with Augmented Dickey-Fuller test method (ADF) are performed for all four variables. visitor<sub>It</sub> and Index7<sub>It</sub> are stationary sequences. visitor<sub>It</sub> and Index7<sub>It</sub> are non-stable but the first difference are. Two pairs of time series from M(1) and M(2) are co-integration series with the same order. This supported Granger causality analysis and ARMAX (Autoregressive Moving Average with External Variables) models. Equation (15), denoted M(3), is the predicted model after the noise-processing of HHT. Thus, the regression models are constructed based on equation (13) to (15) and illustrated in Table 1.

The coefficients of all explanatory variables are significant at the 5% level. Both Index7<sub>t</sub> and Index7<sub>It</sub> are statistically significant at

the 1% level. The residue test implies that there is sequence correlations. So ARMA adjustment is conducted based on the regression. In Table 1, M(2) with the search engine data performs better than the time series model of M(1). Further, M(3) with noise processing with HHT overwhelms M(1) and M(2). All three models can be expressed as equation (16) to (18) respectively.

$$\begin{cases} visitor_t = 5.193 + 0.785visitor_{t-1} + 0.161visitor_{t-7} + \mu_t \\ \mu_t = \varepsilon_t + 0.103\varepsilon_{t-1} \end{cases} \quad (16)$$

$$\begin{cases} visitor_t = -44.306 + 1.296Index7_t + \mu_t \\ \mu_t = 0.673\mu_{t-1} + \varepsilon_t + 0.185\varepsilon_{t-7} \end{cases} \quad (17)$$

**Table 1.** Regression comparison of Model 1 to 3.

Data type	Historical data		Index7		Noise processing with HHT	
Model	M(1)		M(2)		M(3)	
Independent variables	$visitor_{t-1}$	0.785** (31.216)	$Index7_t$	1.296*** (16.846)	$Index7_{-l_t}$	1.177*** (13.762)
	-		-		-	
	$visitor_{t-7}$	0.161*** (6.996)	$c$	-44.306*** (-4.874)	$c$	-30.461*** (-2.950)
	-		-		-	
	$c$	5.193*** (2.408)	$AR(1)$	0.673*** (24.385)	$AR(1)$	2.011*** (60.585)
	-		-		-	
	$MA(1)$	0.103** (2.359)	$MA(7)$	0.185*** (5.145)	$AR(2)$	-1.707*** (-30.399)
	-		-		-	
	-		-		$AR(3)$	0.627*** (19.409)
	-		-		$MA(1)$	0.571*** (16.479)
$R^2$	0.831		0.847		0.994	
AIC	9.707		9.602		9.503	
SC	9.732		9.626		9.541	
DW	1.99		1.95		1.91	
Residue stationary	-	-11.285***	-	-7.461***	-	-8.421***
	1%	-3.439	-	-3.849	-	-3.495
	5%	-2.865	-	-2.887	-	-2.8897
	10%	-2.569	-	-2.581	-	-2.5819

( ) shows the t-value; \*, \*\*and \*\*\*means that it's remarkable on the level of 10, 5 and 1% respectively.

**Table 2.** Performance of the two forecasting methods.

Metrics	Formula
MAPE	$\frac{1}{n} \times \sum_{i=1}^n \left  \frac{P_i - Y_i}{Y_i} \right  \times 100\%$
RMSE	$\sqrt{\frac{1}{n} \times \sum_{i=1}^n (P_i - Y_i)^2}$

$P_i$  presents the predicted values and  $Y_i$  presents the original values.

$$\begin{cases} visitor_{-l_t} = -30.461 + 1.177 Index7_{-l_t} + \mu_t \\ \mu_t = 2.011\mu_{t-1} - 1.707\mu_{t-2} + 0.627\mu_{t-3} + \varepsilon_t + 0.571\varepsilon_{t-1} \end{cases} \quad (18)$$

The regression results show that the search engine data have a positive impact on Jiuzhaigou tourist volumes. The increase of Index7 will cause more tourists accordingly. The reason is that the increase of search engine data indicates more attention of the destination from the tourists. First, the tourists prepared for the upcoming planned travel and gather information in advance. Second, some potential tourists start to pay attention on Jiuzhaigou

and it is possible to practice in the future. In equation (17), when Index7 doubles, the future tourism volumes will increase 1.296 times. This coefficient is more than 1 because there are package tours and they have no need to search on the internet. In equation (18), the positive impact weakens and the influence coefficient is 1.177. This explains that in M(2) the impacts are overestimated, calling "Big Data Arrogance". By contrast, M(3) pre-processes the noise in the search index and the forecast object and adjusts this overestimation.

**Forecasting with the models**

From the results of the training models, M(2) of forecasting with search engine data performs better than the time series model M(1). Moreover, M(3) of denoising by HHT with search engine data overwhelms the baselines of M(1) and M(2). Based on the training models, the study further forecast the tourist volumes of Jiuzhaigou during the forecast period, including the baselines of M(1), M(2), BP neural network and M(3).

Many different quantitative statistical metrics are applied in evaluating the forecast performance, including Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE). Both assessment criteria have been predominately applied in forecast literature (Song and Li, 2008; Chen, 2011; Bangwayo-Skeete and Skeete, 2015). Table 2 shows the metrics and calculations of MAPE and RMSE.

There have been many studies applying the artificial neural networks (ANN) to forecast the tourism demands (Cho, 2003; Palmer et al., 2006; Chen et al., 2012), due to their advantages in

**Table 3.** The predicted performances of the four models in next seven days.

Variable		2014/7/1	2014/7/2	2014/7/3	2014/7/4	2014/7/5	2014/7/6	2014/7/7
Original values		153.19	147.02	148.08	198.2	102.14	212.71	222.65
Predicted values	ARMA	141.52	139.06	139.46	144.91	190.14	199.87	206.41
	Index7	151.07	153.63	165.29	165.45	202.11	207.64	203.31
	BP neural network	215.03	148.13	153.02	146.43	148.09	206.05	203.08
	CLSI-HHT	152.82	143.38	154.59	188.16	213.46	220.18	214.77
MAPE (%)	ARMA	7.62	6.52	6.29	11.44	11.27	11.10	9.86
	Index7	1.38	2.94	5.84	8.51	7.80	7.63	7.10
	BP neural network	3.30	3.69	2.83	8.44	7.38	7.62	6.76
	CLSI-HHT	0.24	1.36	2.37	3.04	2.51	2.27	2.16
RMSE	ARMA	11.67	9.99	9.56	27.90	26.92	26.28	24.41
	Index7	2.12	4.91	10.72	18.82	17.49	17.10	16.14
	BP neural network	20.75	5.06	5.55	4.63	25.37	22.89	22.37
	CLSI-HHT	4.97	0.37	2.59	4.31	6.26	5.61	5.21

**Table 4.** The predicted performances of the four models during the peak periods.

Variable		2014-July	2014-August	2014- September	2014-October	
Original values		-	7913.52	8002.25	5139.94	7429.06
Predicted values	ARMA	7378.071	8059.863	5012.02	7158.815	
	Index7	7525.11	7843.92	5283.43	7228.83	
	BP neural network	6839.11	7509.84	7579.4	5016.31	
	CLSI-HHT	7894.1	7970.34	5198.06	7433.35	
MAPE (%)	ARMA	6.77%	0.72%	2.49%	3.64%	
	Index7	4.91%	1.98%	2.79%	2.70%	
	BP neural network	5.10%	5.28%	2.41%	7.94%	
	CLSI-HHT	0.25%	0.40%	1.13%	0.06%	

capturing subtle functional relationships within the data (Atsalakis and Valavanis, 2009). Unlike traditional statistical models, neural networks are data-driven and non-parametric models which can depict the non-linear functions without a prior assumption about the characteristics of the data (Haykin, 1999). When we fit and forecast with Back-Propagation (BP) neural network, various parameters should be settled, including the number of neurons, the training efficiency and the hidden-layer unit number and may affect the application of BP neural network. After repeated experiments, the study chooses three layers, 15 neurons in the hidden-layer and 0.01 of the training efficiency. The prediction results of CLSI-HHT model and three baselines in the first week of the test period are presented in Table 3. Also the monthly prediction results of the peak periods from July to October are presented in Table 4. The complete predicted values are shown in Appendix A.

In the first week of the test period, MAPE and RMSE of time series model is more than others. ARMA model with historical tourist volumes of Jiuzhaigou has the largest predicted error among all the models. Comparing search engine data model with BP neural network, the study found that M(2) with search engine data performs better than BP neural network in the next days. Yet the further 5 days of the first week, BP neural network predicts

more accurately. This explains that search engine data have stronger predicted ability in the short terms. Tourists always search and confirm information in a few days before departure. From the complete predicted values of 184 days in the test period, BP neural network performs much better than search engine data model. Three reasons could help to explain. First, artificial intelligence methods are more self-adaptive and superiority than traditional statistical models. This result is agreed with most other research conclusions. Second, search engine data have strong timeliness, which make it difficult to forecast in the long run. This is the reason that Baidu Forecasting only reveal the predicted tourist traffic in the next three days. Third, without noise-processing, the noise constantly accumulates and leads to the impossibility of forecasting in the long term.

In Table 4, the monthly predicted values of each model are presented from July to October. These four months are at the peak season for Jiuzhaigou. From the predicted performance, CLSI-HHT obtains the closest predicted values with the original tourism volumes. The predicted error is below to 50 people and the MAPE is quite small. Especially in the forecasting of October, the monthly predicted error is only 0.06%. It implies that CLSI-HHT model could remarkably improve the forecasting error during the peak period of



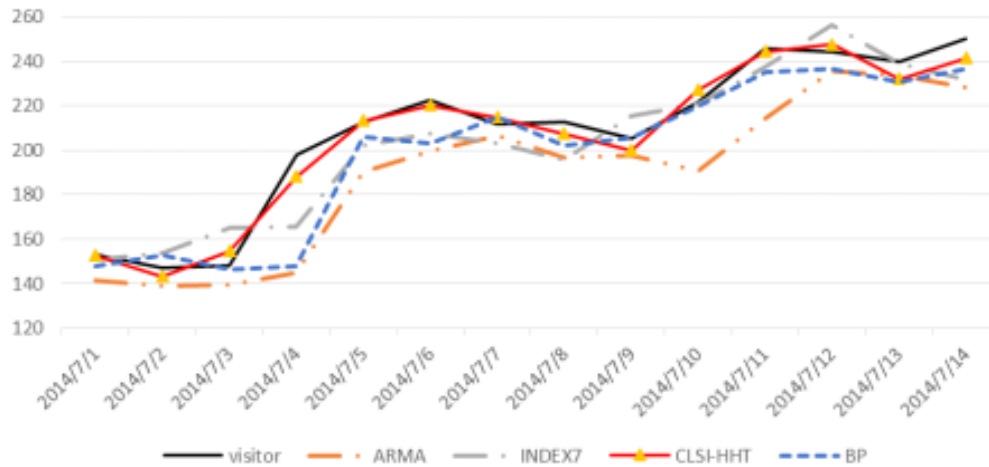


Figure 7. The original and the predicted values of tourist volumes of Jiuzhaigou.

Jiuzhaigou. As to the baselines, the web search data of Index7 almost outperform the other two baselines in the forecasting of the peak months. This proves the predicted ability of the search engine data again. The actual predictions of CLSI-HHT during the peak season could greatly benefit the authorities and the policy makers. This actual forecasting makes better distribution and management in advance.

In all four models, CLSI-HHT model significantly outperforms three baselines. Especially, after the noise-processing, the traditional econometric model with the efficient variables could obtain more accurate forecasting than artificial neural network. Figure 7 shows the original data of Jiuzhaigou and the predicted values of each model.

## COMPARISONS WAVELET TO HHT

### Wavelet transform

In the empirical study, Hilbert-Huang transform is utilized to denoise the series of Index7 and tourist volumes of Jiuzhaigou. CLSI-HHT model outperforms all three baselines. Nevertheless, in the signal science, there are other methods to deal with noise except for HHT. Fourier transform and Wavelet transform are both able to denoise the signals by spectrum analysis. As the multiple limitations of Fourier transform in social economics, Wavelet transform and high-pass filter method will be used to be compared with HHT.

Wavelet transform inherits and develops the ideas of the localization of the short-time Fourier Transform (STFT). Meanwhile, it overcomes the shortcomings that the window size cannot change with frequency. Wavelet can provide a variable “time-frequency” window with frequency and is an ideal tool in identifying the noise signals. The main characteristics is that it can multi-scale refine the signals through telescopic translation operations and self-adaptively satisfy the requirements of the signal analysis.

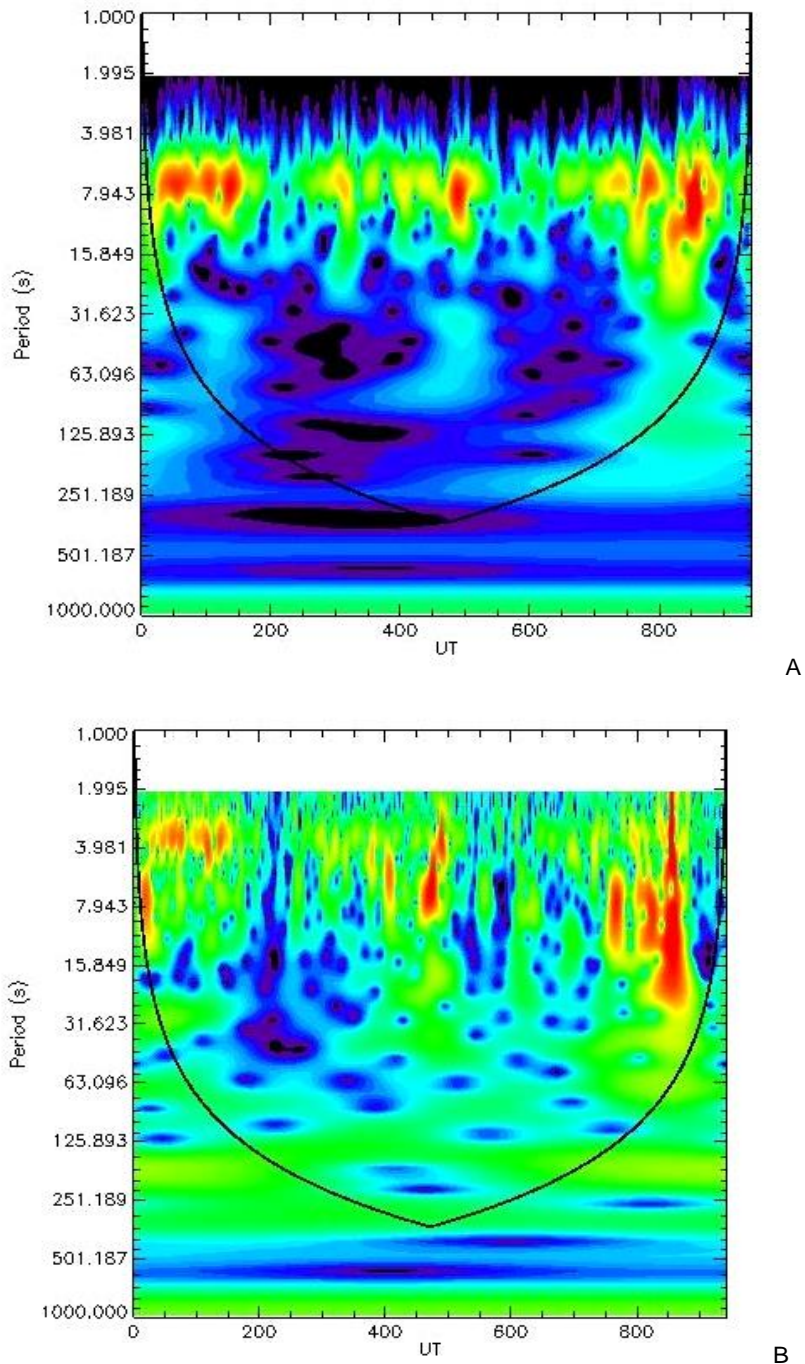
In this section, the study chooses the same data as in the empirical study. The frequency spectrum based on Wavelet transform for tourist volumes and Index7 are shown in Figure 8. The horizontal axis is the time range and the vertical axis is the period values. The inside of the U-shape curve represents 95% confidence interval. In Figure 8, the colors express the strength of the amplitude. The amplitude enhances from blue to red. In the Wavelet frequency spectrum of the original tourist volumes of Jiuzhaigou, the spectral band is significant in the period of seven days. This frequency band implies the 7 days period of tourist volumes. Above this band, there are no more obvious frequency bands, and the lower period is beyond recognition. Based on the frequency spectrum, the periods lower than 7 days are identified as the high-frequency noise. Similarly, the spectral band of 3days cycles is significant and the lower period is unidentified. The periods lower than 3 days are treated as the noise signal.

### High-pass filter to denoise

Based on the results of the Wavelet transform, the high-pass filter is conducted to extract the noise from the tourist volumes and Index7. Filtering extracts or removes some frequency signals from the original series while the high-pass filter decays or removes the low frequency and retains the high frequency and the sharp changes of signals.  $M(x)$  represents the measurement mode and  $H(x)$  is the filter function.

$$R(x) = M(x) * H(x) \tag{20}$$

The output function  $R(x)$  is the convolution of the input functions  $M(x)$  and  $H(x)$ . Some data will be consumed



**Figure 8.** The wavelet spectrum analysis (the wavelet spectrum of Jiuzhaigou tourism volumes (A); The wavelet spectrum). of Index7 (B)).

when we train the high-pass filter for tourist volumes and search index. In this study, the first 30 data and the last 30 data are consumed, and the remaining series span from 1 July, 2012 to 1 December, 2014. The training set starts on 1 July, 2012 and ends on 31 June, 2014 with 730 data (82.6% of the whole sample). The test set is from 1 July, 2014 to 1 December, 2014 with 154 data

(17.4% of the sample).

After the high-pass filter, the study obtains the effective signals of tourist volumes and Index7 and their noise signal, respectively (Figure 9). In the sequence charts, the series with denoising maintain consistency with the original series while they are smoother. The black lines are the original series. The red lines are the effective

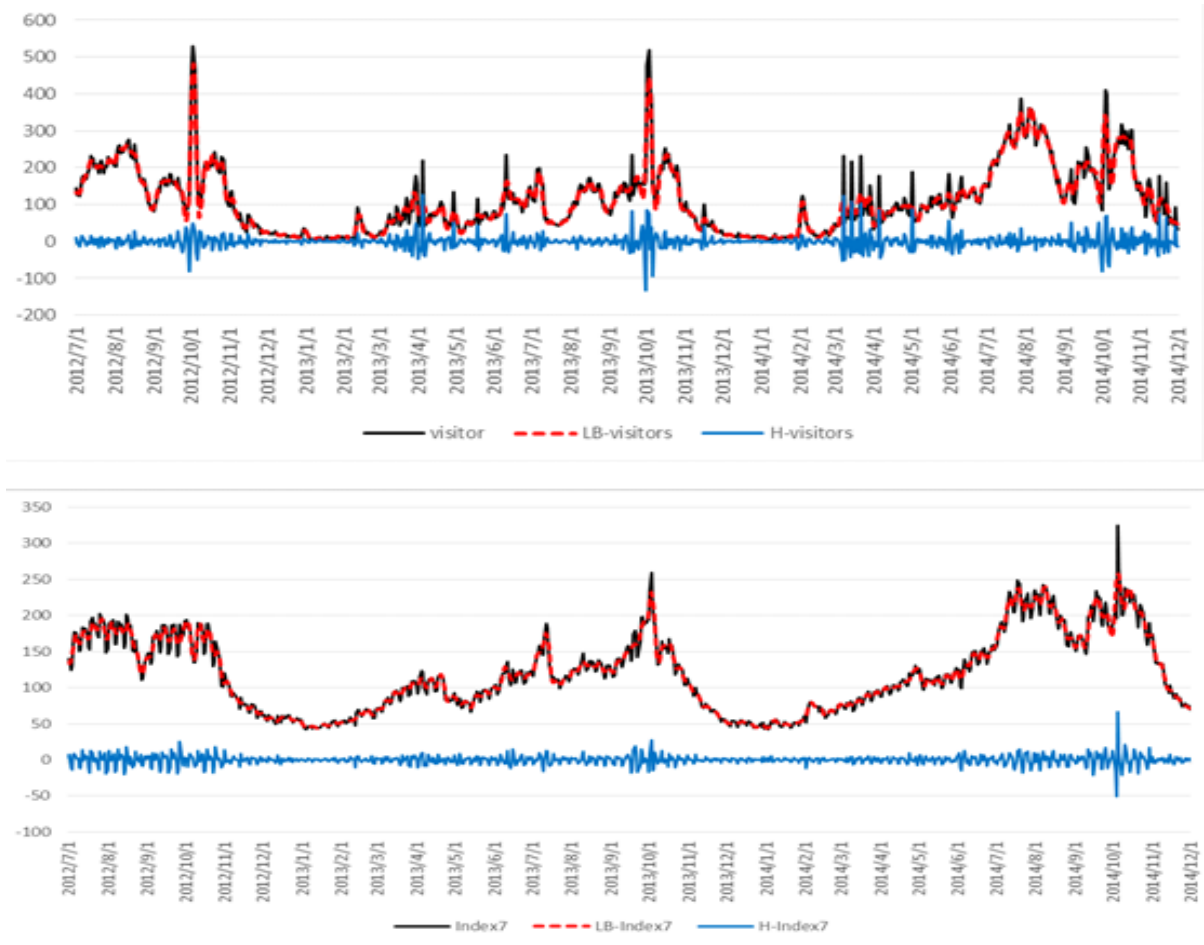


Figure 9. The series of Jiuzhaigou and Index7 with High-pass Filter.

series after high-pass filter. The blue lines distribute around the vertical axis show the high-frequency noise.

**Predictions and comparisons**

$M(1)-(3)$  are trained with the effective signals based on the high-pass filter.  $Index7_t$  denotes the composite searchindex,  $Index7\_hht_t$  denotes the effective series of Index7 with HHT and  $Index7\_wf_t$  denotes the effective series of Index7 with Wavelet transform and high-pass filter. Stationary test with ADF are performed for all variables.  $Index7_t$ ,  $visitor_t$ ,  $Index7\_wf_t$  and  $visitor\_wf_t$  are stationary.  $Index7\_hht_t$  and  $visitor\_hht_t$  are non-stationary.. The pair of these series are co-integration series with the same order. The regression results of CLSI-HHT model and Wavelet-filtering model are presented in Table 5. All the variables are significant and the residual of all three models are significant on the 0.01 level. CLSI-HHT model fits better than Wavelet-filtering model and the search engine model without denoising.

Furthermore, the next 154 days tourist volumes are

forecast based on these models to compare the performance of Wavelet-filtering model with CLSI-HHT model. The values of MAPE for the test set are illustrated in Figure 10. It is obvious that CLSI-HHT model outperforms Wavelet-filtering model in the predicted set except for the last week of November. Compared with Wavelet denoising, HHT has higher signal to noise ratio (SNR) for non-linear and non-stationary signals. Specially, Wavelet-filtering model performs worse than search engine model without denoising in the short term. This proves the strong timeliness of search engine data and ability of short-term prediction. Furthermore, during the peak period from July to October, CLSI-HHT has the smallest predicted error among three models. This implies that HHT is more effective than Wavelet in the peak season of the tourism volumes in denoising.

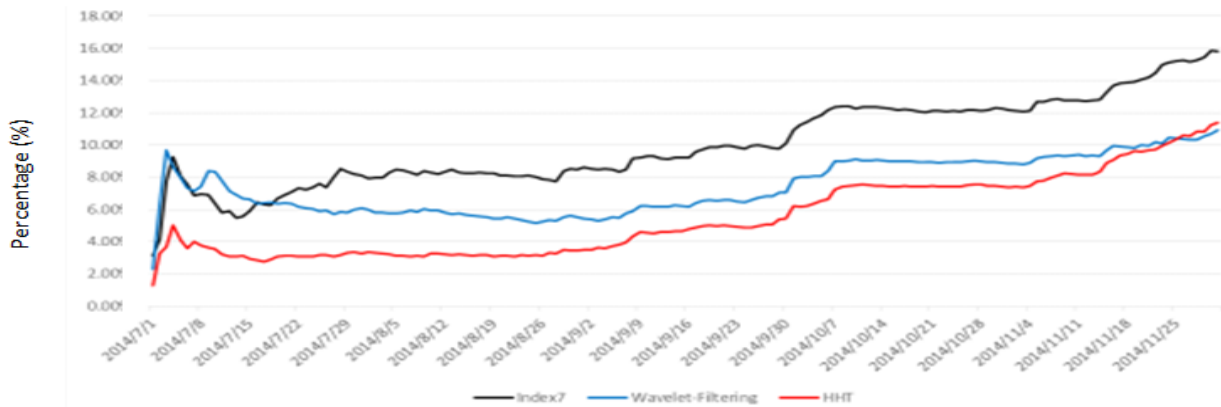
**CONCLUSION**

Since big data has boomed, many studies focus on the correlation analysis and prediction with web search

**Table 5.** Regression comparison of three models.

Data type	Index7		CLSI-HHT		Wavelet-filtering	
Independent variables	$Index7_t$	1.300*** (16.526)	$Index7\_hht_t$	1.229*** (14.372)	$Index7\_wft_t$	1.555*** (21.410)
	$c$	-45.198*** (-4.868)	$c$	-35.867*** (-3.521)	$c$	-72.479*** (-7.331)
	$AR(1)$	0.674*** (24.028)	$AR(1)$	2.003*** (58.606)	$AR(1)$	2534*** (152.744)
	$MA(7)$	0.183*** (4.998)	$AR(2)$	-1.696*** (-29.426)	$AR(2)$	-2.446*** (-82.227)
		-	$AR(3)$	0.621*** (18.673)	$AR(3)$	0.895*** (53.932)
		-	$MA(1)$	0.571*** (16.044)		-
		-				
		-				
		-				
		-				
$R^2$	0.848	-	0.994	-	0.983	-
AIC	9.629	-	6.326	-	6.514	-
SC	9.655	-	6.364	-	6.535	-
DW	1.95	-	1.90	-	1.87	-
Residue stationary		-6.671***		-8.272***		-4.397***
	1%	-3.439		-3.849		-3.495
	5%	-2.865		-2.887		-2.889
	10%	-2.569		-2.581		-2.582

( ) shows the t-value; \*, \*\*and \*\*\*means that it's remarkable on the level of 10, 5 and 1% respectively.



**Figure 10.** The MAPE of each predicted models.

data. The methods of how to composite the search data and how to capture the web data were constantly proposed. The web data reflects human behavior and intention which could be used to forecast the future behavior and decision-making. However, these data always contains much noise which may mislead the forecast and the data further analysts, the policy makers and the managers. It is necessary to pre-process the

noise before data mining. There are many methods of denoising, and HHT has its own improved algorithm and covers the lacks of Fourier and Wavelet transform. Taking Jiuzhaigou as an example, this study analyzed the predicted performance of Baidu search engine data with denoising by HHT, particularly during the peak period. We further compared Wavelet-filtering with HHT on the predicted performance of tourist volumes.

Compared to previous studies on using search engine data to forecast tourist volumes, this study makes two main contributions in theory and application. First, HHT is widely utilized in physics, engineering and geophysics. For social science, especially for tourism management, this study enriched the application. Second, this study analyzed the methods of denoising for web search data and tourist volumes, including HHT and Wavelet-filtering. If we ignore the noise-processing, the results of data mining may mislead the decisions and analysis. Especially, during the peak seasons there are higher risk of congestions for the tourism destinations. The deflection prediction may mislead the policy makers to distribute the resources of the scenic spot incorrectly. The managers may implement the inappropriate marketing. Noise-processing with HHT improves the efficiency of policy makers and managers when they use the web search data. This is particularly crucial in the peak seasons. In this study, CLSI-HHT forecasting model was able to improve the predicted accuracy and controlled the number of prediction error below one hundred people.

The study composited the search engine data by CLSI to omit the irrelevant queries and noise preliminarily. Then the noise was extracted from the composite index and tourist volumes by HHT. The forecast results demonstrated that the search engine model of noise-processing with HHT improved the predicted accuracy remarkably. Besides, the search engine data without denoising performs almost the same compared with time series model. BP neural network performed better than the untreated search engine model but much worse than CLSI-HHT model. The study then applied Wavelet transform and high-pass filter to denoise the series and compared with HHT. The results turned out that HHT performed better than Wavelet transform in dealing with non-linear and non-stationary signals.

However, this study had a number of limitations. In the empirical test, the study only takes Jiuzhaigou as the example. Whether CLSI-HHT method could be efficient in other forecast objects needs further researches. Besides, HHT could deal with the noise in forecasting the tourist volumes with search engine data. The micro blog and online news are the web data, either. They have the different features and data structure compared to search engine data. Apply HHT to deal with these data source would also be a useful research direction.

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## Conflicts of interests

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# An investigation of the marketing performance measurement practices in Hatfield Volkswagen group

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The measurement of marketing function is vitally important to establish the performance of the brand. The aim of this study is to investigate the marketing performance measurement practices in the Hatfield Volkswagen group with reference to the following elements: the awareness of the importance of effectively measuring the marketing activity, the satisfaction with the current marketing performance measurement, the marketing performance measures considered by the company's top management, the timeframes of gathering of the marketing performance measures, the significance that top management attaches to the marketing performance measures, the different kinds of benchmarks used to extract meaning from the marketing performance measurements, the measurement and timing thereof of the marketing asset and the challenges if any faced by the managers. The data represents the extent and status of the marketing measurement and evaluation in the Hatfield Group, by examining each departmental manager's understanding, perception and challenges towards measurement and evaluation of marketing performance. Findings indicate that departmental managers are unsure about the measurement methods needed to determine the performance value of their marketing efforts. Top management measures the success of marketing with "financial measures" and place very little significance on non-financial measurements.

**Key words:** Marketing performance measurement, measurement practices, methods and time frames of measurement, brand performance, sustainable demand, and marketing asset terminology.

## INTRODUCTION

In order for any business, including a motor dealership, to be effective in marketing it has to advertise, promote and sell products and services, as well as interact through public relations, for these activities to be successful an investment is required to stimulate the demand for these products and services. Furthermore, the business requires a return on the funds that were invested. All companies have a primary goal of achieving maximum profits to increase shareholders' wealth by generating the

optimum return from their capital initially invested in the business (Shim and Siegel, 2007). Dealerships meticulously examine ways to increase income and decrease expenses and measure all the pertinent performance indicators to develop strategies to increase the return on investment. In relation, marketing practices should be measured with the same vigour. Papageorge (2005) states the importance of marketing, explaining that historically, the measurement of the marketing activities

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in South African companies has not been adequate and therefore marketing remains largely unmeasured. If the marketing function is better analysed and measured, this should assist in increasing the reach and success of advertising, promotion, selling and public relations, which should in turn, increase the return on the marketing expense.

The aim of the paper is to assist dealers in the Hatfield Volkswagen group to evaluate the marketing performance through exploration of management and the understanding of the marketing performance measures, the ability of management to measure marketing performance, the current measurements in place and the challenges in the adoption and implementation of marketing performance measurement and evaluation.

## **BUSINESS MANAGEMENT IN PERSPECTIVE**

Business management involves the detailed analysis and understanding of enterprise with the objective of establishing the most efficient way to manage the enterprise (Le Roux et al., 1998). Business management is a science that examines and analyses the internal and external processes and procedures of a business enterprise. Nieuwenhuizen and Rossouw (2008) define management as the process of integrating and combining the precise measures of each factor of production available to them in a way that these achieve the objectives and goals of an organisation. This includes realising a profit and satisfying the needs of the society.

Marketing is fundamental to business as it establishes what the customers' desires are and then directs the resources towards fulfilling these needs. Cant (2010) states that marketing has transformed from being a 'making a sale' practice to having the objective of satisfying the customer needs. Cant (2010) continues by arguing that in the marketing process, the act of exchange wherein people surrender something in order to receive something that they desire is of central importance. Boone and Kurtz (2009) emphasise that marketing embraces a broad spectrum of activities and is therefore not easy to define. The concept of marketing therefore encompasses all the activities that are entered into with the sole purpose to satisfy the customers' needs and to obtain a return on the investment out of the activity (McPheat, 2010). Marketing according to MCPheat (2010) has a direct influence over advertising, promotions, public relations and sales. When a company engages in marketing, time and money is spent, and as with any other expense in a company, there should be fair returns.

Woodburn (2005) states that marketing has traditionally been seen by companies as a function that is not accountable, and that it is an expensive way of communicating with customers. Marketers have traditionally avoided measurement of the marketing activities. However, in recent times this has changed with companies dissecting each function in the business with

the sole purpose of extracting and maximising shareholders' value. Senior management expect that management and marketers deliver a return on marketing activity as an intangible asset in order to increase shareholder value (Walker et al., 2004). Performance measurement needs to be broadened by not only measuring the financial outcome, but by encompassing a measurement of resources, processes, products and services and finally, financial deliverables. As motor dealerships and companies are under more pressure to deliver improved shareholder returns, management is expected to measure and contain all expenses and to increase income streams. In order to achieve this, management is required to measure and evaluate the performance of all areas of the business. Performance measurement is not a new business tool but rather a term and science that found relevant prior, with Kelvin who described the importance of measurement when he states (Shane, 2007):

“... I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind...”

## **THE IMPORTANCE OF MEASUREMENT IN AN ORGANISATION**

Measuring all activities of organisations has been an accepted and much debated practise for a long period of time. Kennerly and Neely (2003) state that terms such as “[w]hat gets measured gets done” and “[y]ou get what you measure” have indicated that companies should measure activities and implement the results into their objectives and strategies. In order to remain relevant, measurement systems should be updated and reviewed on an ongoing basis, but yet it seems that few companies have processes in place to ensure the applicability of performance management methods and systems aligned to the objectives of companies. Previous studies have exposed the positive link between a company's ability to measure marketing activity and the performance of the company (O'Sullivan and Abela 2009).

Accenture (2001) conducted a study that exposed that three quarters of marketing managers in the USA and the UK are unable to calculate and indicate the ROI on a specific marketing campaign that they ran. The study emphasises that some of the reasons behind this is the inability of companies to integrate their sales, marketing and customer services tools. The analysis of data was emphasised further by the fact that 65% of the marketing managers find it difficult to integrate customer data throughout the company to establish a single view of a customer. Porter (2008) indicates that the competitive advantages of a company cannot be established by holistically analysing the company, but rather by dividing



and measuring each activity of the company. The results can then be evaluated to establish the performance of each activity and the interrelationships between each activity.

## **MARKETING AND FINANCIAL PERFORMANCE**

Financial analysis assists in measuring and identifying the strengths and weaknesses of a business and ultimately the sustainability of the organisation over time. The financial analysis consists of financial ratios that indicate and determine the relationship between the company's activities such as current assets in relation to sales (Kretlow et al., 2006). The main reasons Sexton (2009) found for the slow progress made with the measurement of marketing return are the following:

1. Absence of understanding what marketing return constitutes. In many companies the managers reported that their company does not define the marketing return or ROI.
2. Shortage of time and resources dedicated to the marketing return. Many companies have not yet developed systems to measure the marketing return and therefore are not allocated time to the advancement of internal evaluation and measurement techniques.
3. Little motivation for staff to contribute to the marketing return measurement. The remuneration systems in companies do not encourage work on marketing measurement and return.
4. Shortage of skills and resources. Companies do not have the skills and resources internally to allocate to the research of marketing return and measurement or are reluctant to apportion it to the research.
5. Absence of collaboration between the marketing and finance departments. The marketing and finance functions seem to operate in separate silos and therefore there is no impetus to advance the understanding and improvement of marketing measurement.
6. Inertia. The managers in companies do not feel the need to change their current method of operation, neither have they the time to change.

The measurement of the marketing function continues to become more and more challenging because several factors, such as the highly competitive nature of markets and competitors, well-informed and educated customers, rapid advancement of technologies, development of new industries and new industry leaders.

## **BUSINESS PERFORMANCE MEASUREMENT**

In order for companies to be successful and to gain competitive and sustainable advantages, it is necessary to design and implement performance measurement systems and structures. Therefore, it is important to

measure and evaluate every function in the business with the objective to increase efficiency and ultimately profitability and business success (Taticchi, 2010). Eusibio et al. (2006) state that, notwithstanding the importance of business performance and the pressure on companies to measure the inputs, there has been little research done on the measures implemented to ensure marketing effectiveness.

### **Marketing performance measurement**

Ambler and Robert (2008) define marketing as the actions the company as a whole engage in with the intent to create shareholder value. Therefore, it is not the performance of the department or a specific marketing activity but the company's overall performance and achievement with regard to marketing that makes the enterprise successful. In order to evaluate the performance of marketing, it is necessary to adhere to three criteria namely a comparison to internal benchmarks, external benchmarks and adjustments for any variation in brand equity (Ambler et al., 2001; Mills, 2010).

#### ***Internal benchmarks***

Measurement of performance has become essential to senior management in companies that are responsible for strategic and operational decisions. This has brought about the use of benchmarks to compare best performance in business (Jin et al., 2013). Marketing or business plans are generally considered as an internal benchmark for performance (Mills, 2010).

#### ***External benchmarks***

The external benchmarking process compares the company's performance against that of successful companies or competitors. No matter how good the performance of a company's internal process and performance, it should always benchmark outside its environment against competitive forces and companies in order to ensure continued improvement (Stapenhurst, 2009).

An exploratory research was completed by Kokkinaki and Ambler (1999) regarding the current practices of marketing performance assessment as part of the Marketing Metrics project.

The research revealed that marketing performance measurement should be done in accordance with the following classifications:

1. Financial measures such as sales volume and turnover, profit, returns of capital.
2. Competitive market measures such as market share,

share of voice, relative price and share of promotions.

3. Consumer (end user) behaviour measures such as penetration and number of users and consumers, user and consumer loyalty and user gains and losses.
4. Consumer (end user) intermediate measures such as awareness, attitudes, satisfaction, commitment, buying intentions and perceived quality.
5. Direct customer (trade) measures such as distribution or availability, customer profitability, satisfaction and service quality.

No research was found on the marketing performance measurement of South African motor dealerships. Moerdyk (2010) does however state that in South Africa companies', effective measure of the performance of the marketing function is scarce and as a result, company executives are becoming more aware of the importance thereof. Moerdyk (2013) emphasises the fact that research has shown that 20% of all advertising fails in South Africa and that the only way of establishing the success of marketing performance is to measure it.

## OBJECTIVES OF THE STUDY

The objective of this study, from a managerial perspective, is to examine the extent to which marketing is evaluated and measured in the Hatfield Volkswagen Group, and to discover the dimensions utilised in the current process. In the larger study objectives were group under the following categories:

1. Demographics
2. The extent of management awareness
3. Satisfaction of management
4. The current marketing performance measurement practice
5. Importance attached by top management
6. Benchmarks used
7. Marketing performance measurement practices
8. Challenges that the managers confront.

For the purpose of this study, selected variables from all categories are dealt with.

## METHODOLOGY

Zikmund and Brabin (2013) define marketing research as the application of a certain scientific method in order to discover the factual truths about marketing phenomena. They continue by stating that effective marketing research decreases uncertainty, and assists in achieving the marketing decision making process. The main objective of this study, from a managerial perspective, is to examine the extent to which marketing is evaluated and measured in the Hatfield Volkswagen Group and to discover the dimensions utilised in the current process. The research objectives of the study are:

1. To analyse the extent of management awareness of departmental management with regards to marketing performance measurement.

2. To measure the satisfaction of management with existing marketing performance measurements.
3. To assess the current marketing performance measurement practice with regard to measure collection.
4. To consider the importance that top management attaches to marketing performance measures.
5. To assess the benchmarks used in marketing performance measurement,
6. To gauge the marketing performance measurement practice with regard to the organisations "marketing assets".
7. To explore the challenges that the managers confront in measuring marketing performance in the motor industry and specifically inside the Hatfield Volkswagen Group dealerships.

## Research hypotheses

Weathington et al. (2012) define the hypothesis of research as a particular expectation about the relationship between two or more variables based on theory or earlier research. The expectations are made with the purpose of achieving the research objectives. The six categories identified to measure marketing performance are financial measures, competitive market measures, consumer behaviour measures, consumer intermediate measures, direct customer measures and innovativeness measures. With regards to the objectives the following hypotheses were formulated in Table 1.

## The sample framework

The population of study consists of all the managers of retail franchised motor dealerships. A purpose sampling strategy was used. A sample of 22 managers that are perceived to be experts were interviewed. Given the nature of this study, a sample size of between five and twenty was considered adequate (Zikmund, 2003). The researcher selected the respondents. The population in the research consisted of the departmental managers in motor dealerships within the Hatfield Volkswagen Group (Table 2). In the study, the departmental managers of the dealerships were selected through the purposive expert sampling method.

An online survey engine, 'Survey Monkey' was utilised and the respondents received an email with information on the study as well as a link to the survey. The answers of the study were downloaded in a Microsoft Excel spreadsheet. Web-based surveys are infinitely more time efficient than email or telephonic surveys, when the respondents are initially contacted through email (Schonlau et al., 2002). In order to ensure a high response rate, the managing director of Hatfield Holdings sent the email directly through to the respondents and requested their co-operation. The response rate was 100%. The research needs to be reliable in such a way that it is understandable to the reader, and that further research can be done using the same method and can confidently produce the same results; or that the reader is confident in the results (Greener, 2010).

**Table 1.** Research hypotheses.

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**Does the size of the dealership influence the respondents' satisfaction with the current marketing performance measurement?**


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*H*<sub>1</sub>: The size of the dealership effects the respondents' satisfaction with existing marketing performance measures

**Does the top management consider and analyse the "financial measures" of the marketing performance measurement more frequently than the other available measures?**

*H*<sub>2(A)</sub>: "Financial measures" are more frequently considered and analysed by the top management than "competitive market measures"

*H*<sub>2(B)</sub>: "Financial measures" are more frequently considered and analysed by the top management than "consumer behaviour measures"

*H*<sub>2(C)</sub>: "Financial measures" are more frequently considered and analysed by the top management than "consumer intermediate measures"

*H*<sub>2(D)</sub>: "Financial measures" are more frequently considered and analysed by the top management than "direct customer (trade) measures"

*H*<sub>2(E)</sub>: "Financial measures" are more frequently considered and analysed by the top management than "innovativeness measures"

**Are "financial measures" of marketing performance more frequently collected than other measures of marketing performance?**

*H*<sub>3(A)</sub>: "Financial measures" are more frequently collected than "competitive market measures"

*H*<sub>3(B)</sub>: "Financial measures" are more frequently collected than "consumer behaviour measures"

*H*<sub>3(C)</sub>: "Financial measures" are more frequently collected than "consumer intermediate measures"

*H*<sub>3(D)</sub>: "Financial measures" are more frequently collected than "direct customer (trade) measures"

*H*<sub>3(E)</sub>: "Financial measures" are more frequently collected than "innovativeness measures"

**Does the size of the dealership influence the frequency with which the marketing performance measures are collected?**

*H*<sub>4(A)</sub>: The size of a dealership influences the frequency with which "financial measures" are collected

*H*<sub>4(B)</sub>: The size of a dealership influences the frequency with which "competitive market measures" are collected

*H*<sub>4(C)</sub>: The size of a dealership influences the frequency with which "consumer behaviour measures" are collected

*H*<sub>4(D)</sub>: The size of a dealership influences the frequency with which "consumer intermediate measures" are collected

*H*<sub>4(E)</sub>: The size of a dealership influences the frequency with which "direct customer (trade) measures" are collected

*H*<sub>4(F)</sub>: The size of a dealership influences the frequency with which "innovativeness measures" are collected

**Does top management rank "financial measures" higher in value to the organisation than the other measures available for marketing performance measurement?**

*H*<sub>5(A)</sub>: Top management ranks "Financial measures" higher in value to the organisation than "competitive market measures"

*H*<sub>5(B)</sub>: Top management ranks "Financial measures" higher in value to the organisation than "consumer behaviour measures"

*H*<sub>5(C)</sub>: Top management ranks "Financial measures" higher in value to the organisation than "consumer intermediate measures"

*H*<sub>5(D)</sub>: Top management ranks "Financial measures" higher in value to the organisation than "direct customer (trade) measures"

*H*<sub>5(E)</sub>: Top management ranks "Financial measures" higher in value to the organisation than "innovativeness measures"

Table 1. Contd.

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**Does the size of the dealership influence the importance that top management assigns to marketing performance measurement?**

- $H_{6(A)}$ : The size of a dealership influences the importance top management assigns to “financial measures”
- $H_{6(B)}$ : The size of a dealership influences the importance top management assigns to “competitive market measures”
- $H_{6(C)}$ : The size of a dealership influences the importance top management assigns to “consumer behaviour measures”
- $H_{6(D)}$ : The size of a dealership influences the importance top management assigns to “consumer intermediate measures”
- $H_{6(E)}$ : The size of a dealership influences the importance top management assigns to “direct customer (trade) measures”
- $H_{6(F)}$ : The size of a dealership influences the importance top management assigns to “innovativeness measures”

**Do the benchmarks utilised for “financial measures” of marketing performance differ from the benchmarks utilised for the other measures available concerning marketing performance?**

- $H_{7(A)}$ : The benchmarks utilised for “financial measures” contrasts the benchmarks utilised for “competitive market measures”
- $H_{7(B)}$ : The benchmarks utilised for “financial measures” contrasts the benchmarks utilised for “consumer behaviour measures”
- $H_{7(C)}$ : The benchmarks utilised for “financial measures” contrasts the benchmarks utilised for “consumer intermediate measures”
- $H_{7(D)}$ : The benchmarks utilised for “financial measures” contrasts the benchmarks utilised for “direct customer (trade) measures”
- $H_{7(E)}$ : The benchmarks utilised for “financial measures” contrasts the benchmarks utilised for “innovativeness measures”

**Does the size of the dealership influence the frequency with which the marketing asset is measured?**

- $H_{8(A)}$ : The size of the dealership influences the frequency with which the marketing asset is measured with “financial measures”
- $H_{8(B)}$ : The size of the dealership influences the frequency with which the marketing asset is measured with “other measures”
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The data collected throughout the research is trustworthy, reliable and valid if the information answers the research questions, describes the sample and population and it can be related to individuals outside the study. Every step of the research process influences the trustworthiness and validity of the survey. In this study care was taken to be honest and thoughtful throughout the research study. In this partially replicated study, the same descriptive statistics were used as in Kokkinaki and Ambler (1999) and Mills (2010) study (skewness and kurtosis, frequency distribution, cross-tabulation and mean. The results of the survey conducted amongst the departmental managers in motor dealerships within the Hatfield Volkswagen Group were discussed.

### Demographics

The respondents in the study were not requested to provide race, age or gender. 91% of the respondents represented dealerships of medium (less than a 100 employees) or large (more than 100 employees) sizes.

The remaining 9% were from small (less than 50 employee) dealerships. A summary of the research findings revealed the following:

**1. Comparison to the criteria for appropriate marketing performance measurement:** The majority of respondents (77.3%) were aware of the importance of measurement of the marketing activity (aware, 45.5%; very aware 31.8%). Only 13.6% were completely unaware and 9.1% “neither unaware nor aware. A quarter of the departmental managers therefore conducted formal marketing performance measurement practices which consist of comparing the marketing performance measurement against internal and external benchmarks, and included the marketing asset and brand equity into their measurement process.

**2. Dealership departmental managers’ satisfaction with the current marketing performance measurements and effectiveness thereof:** Majority of respondents (54.5%) were satisfied with the current marketing performance measurements to some degree

**Table 2.** Managers dealership.

Variable	Hatfield VW Pretoria	Hatfield VW Bryanston	Hatfield VW Braamfontein	Hatfield Audi Hatfield	Hatfield Audi Rivonia	Hatfield commercial	Total
New vehicle managers	1	1	1	1	1	1	6
Used vehicle managers	1	1	1	1	1	0	5
Service managers	1	1	1	1	1	0	5
Parts managers	1	1	1	1	1	1	6
Total	4	4	4	4	4	2	22

(fairly satisfied 27.3%, satisfied 22.7% and very satisfied 4.5%). In comparison, many respondents (36.4%) were neither dissatisfied nor satisfied with the current marketing performance measurements, and only 9.1% were fairly dissatisfied. The study results revealed that the size of the dealership had no effect on the level of satisfaction displayed by the departmental managers.

**3. Marketing performance measurements reviewed by top management:** Financial measures are the marketing performance measurement most considered by top management. Competitive market measures (77%), consumer (end user) behaviour measures (73%), consumer (end user) intermediate measures (73%), direct customer (trade) measures (82%) and innovativeness measures (64%) were considered regularly or more. Only 5% indicated that financial measures were never considered. Financial measures was collected by nearly 65% of the managers on a monthly or more frequent period, while only 9% never collected financial measures. The results confirmed that top management reviewed financial measures most often and therefore attaches most value to financial measures of marketing performance measurement (that is, sales volume, turnover, profit and return on capital) and less to non-financial measures (that is, distribution, commitment, penetration and market share).

**4. Significance that top management assigns to marketing performance measures:** The managers perceived top management to rate financial measures (91%) as the most important of the marketing performance measurements. Competitive market measures is rated the second most important (82%). The lowest measurement rated is innovativeness measures (68%) but is it still rated relatively highly. The earlier results reflect that financial measures are most reviewed by top management, most collected by departmental managers and perceived most important by top management in comparison with the other available non-financial measures.

**5. Marketing performance benchmarks utilised by the managers:** Financial measures (45%) and direct customer measures (36%) were mostly compared to the

marketing plan/budget. Competitive market measures (41%), consumer (end user) behaviour measures (36%), consumer (end user) intermediate measures (41%), direct customer (trade) measures (36%) and innovativeness measures (32%) were all relatively high in the comparison to the total industry/category. The results indicated that the departmental managers compared most of the measures other than the financial measures against the total industry. Other than the total industry, the measurements indicated were mostly internal benchmarks such as previous year, marketing plan/budget and other units /departments in the group.

**6. Measurement of the marketing asset:** Majority of the managers (70% of the total sample) measured the marketing asset monthly by either financial valuation or other measures. 64% of the managers experienced some challenges regarding financial measures. These conclude that most of the respondents' acknowledges that there is a marketing asset and has a term for it. It was established that the size of the dealership had no influence on the frequency with which the marketing asset was measured.

**7. Marketing performance measurements collected:** The study showed that the departmental managers collected financial measures the most, at 60% on a monthly or more bases. It is noted that it is significantly higher than the other measures which range between 41% for the direct customer (trade) measures, the second most and least which is innovativeness measures at 27%. The results revealed that departmental managers focus more on the collection of financial measures. In light of the fact that top management reviewed financial measures the most and as a result, the focus of departmental managers is on the collection of financial measures rather than the other available non-financial measures.

## Conclusions

The aim of this paper is to investigate the marketing performance measurement practices in the Hatfield Volkswagen Group. In the light of the results of the

research, it was concluded that financial measures were the foremost marketing performance measurement instrument used to assess the state of marketing performance in relation to non-financial measures such as competitive market measures, consumer (end user) behaviour measures, consumer (end user) intermediate measures, direct customer (trade) measures and innovativeness measures. It was also concluded that only a quarter of the departmental managers has a formal marketing performance measurement framework that would include internal benchmarks, external benchmarks and the measurement and adjustment of strategy to the brand equity.

## RECOMMENDATIONS

Implementing the following recommendations derived from the research could assist in creating awareness of the importance of the measurement of marketing performance utilising the financial and non-financial measures, and the marketing asset as leverage to improve departmental and dealership performance.

1. Certain non-financial key performance indicators need to be embodied in financial statements and management accounts. The non-financial key indicators would include measures of customer satisfaction, marketing asset description and measurement, market share and comparison against best practise.
2. The analysis framework of marketing performance measurement necessitates the alignment to a balanced scorecard method that dissects the non-financial and financial areas of marketing performance measurement.
3. The strategy and objectives should be reviewed on a quarterly basis and amended to align for improvement and changes to the economical and group environment.
4. More external benchmarks need to be incorporated with which to measure performance. The danger of not incorporating a wider range of external benchmarks is that the departmental managers would have a false impression of their success in terms of measuring marketing performance measurement.
5. Guidelines need to be put in place to assist the departmental managers with the definition, importance and measurement of the marketing asset as well as the importance to align the measurement to the other formal marketing performance measurements such as internal and external benchmarks. These guidelines and assistance could consist out of specific training, implementation of marketing performance measurement tools and inclusion of the marketing performance measurement results in the management accounts. Quarterly review should be implemented to scrutinise the status of the marketing asset(s) with the definite actions for improvement measured and targeted.

This study offers a new perspective on the need for an increase in the focus on all the formal marketing

performance measurement tools available in order to elevate marketing performance results more frequently and ultimately add value through increased profitability and sustainability of the group.

## Conflicts of interest

The authors have none to declare.

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