An empirical study of users' hype cycle based on search traffic: the case study on hybrid cars

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Abstract Many forms of technology cycle models have been developed and utilized to identify new/convergent technologies and forecast social changes, and among these, the technology hype cycle introduced by Gartner has become established as an effective method that is widely utilized in the field. Despite the popularity of this commonly deployed model, however, the currently existing research literature fails to provide sufficient consideration of its theoretical frame or its empirical verification. This paper presents a new method for the empirical measurement of this hype cycle model. In particular, it presents a method for measuring the hype of the users rather than the hype cycle generated by research activities or by the media by means of analyzing the hype cycle using search traffic analysis. The analytical results derived from the case study of hybrid automobiles empirically demonstrated that following the introductory stage and the early growth stage of the life cycle, the positive hype curve and the negative hype curve, the representative figures of the hype cycle, were present in the bell curve for the users' search behavior. Based on this finding, this paper proposes a new method for measuring the users' expectation and suggests a new direction for future research that enables the forecasting of promising technologies and technological opportunities in linkage with the conventional technology life cycle model. In particular, by interpreting the empirical results using the consumer behavior model and the adoption model, this study empirically demonstrates that the characteristics of each user category can be identified through differences in the hype cycle in the process of the diffusion of new technological products discussed in the past.

Keywords Hype cycle model · Search traffic · Hybrid car · Users' hype cycle · Google trends

Mathematics Subject Classification (2000) 91

JEL Classification D91

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Introduction

Various forms of technology cycle models have been developed and utilized for the purpose of the early identification of new and convergent technologies and of forecasting social change, in various academic fields such as management, marketing, technology management, and science and technology policy development, etc. Recently, corresponding to the development of biblimetrics, there have been particularly active attempts to analyze life cycles through a quantitative analytical approach and to utilize the results in forecasting (Makovetskaya and Bernadsky 1994; Daim et al. 2006; Bettencourt et al. 2008; Lecocq and Looy 2009). Among these technology cycle models, the hype cycle model has been most notably spotlighted for its superior explanatory power. The hype cycle model was developed by Jackie Fenn of Gartner to express the level of the technology's maturity and the degree of its adoption and commercialization, and has become an effective method that is widely used not only by Gartner but also in various other fields. However, in spite of the wide popularity of this model, the currently existing research literature has tended to neglect to demonstrate the model's relation to other theoretical frameworks or to provide empirical verification. This paper examines the possibility of building connections in relating this hype cycle model to conventional product life cycle models, and utilizes consumer behavior models, etc. to identify potential methods for a more objective analysis of hype cycles.

Although there have already been efforts to empirically demonstrate technology hype cycles since the early 2000s, the approach of such studies generally focused on stocks or the price index of stocks and therefore failed to sufficiently account for the visibility of the technology, which is one main feature of the hype cycle. Since the mid-2000s, the efforts to empirically verify the hype cycle progressed a step further by beginning to analyze news as an important index for visibility, but it was only in 2008 that Järvenpää increased the possibility of empirical and quantitative analyses of the hype cycle by examining the hype cycles of various technologies through the indices of news reports and specialized technology literature. However, the explanatory power of such studies still remained unimpressive, due to the insufficiency of empirical analyses linked to the theories closely related to the hype cycle, such as those pertaining to product cycles or consumer behavior. This paper seeks to overcome these problems through an analysis that links the hype cycle to a greater variety of theoretical bases, thereby empirically demonstrating the features of the hype cycle and expanding the possibility for future scientometrics approaches (Järvenpää and Mäkinen 2008a, b).

Selecting appropriate cases is critically important for proper analysis, and the target selected this analysis must enable the measurement of the bubble stage (excessive increase in expectation) and the disillusionment stage (decline in expectation) which characterize the hype cycle. In other words, to examine the hype cycle, it is imperative to select a technology that requires a relatively long period to reach the growth stage following the initial stage of its introduction, and technologies which have only recently entered into its growth stage are particularly helpful in facilitating measurements. In the case of the US market, the case of hybrid automobiles was determined to satisfy these conditions. This paper analyzes the hype cycles of users in regards to hybrid cars in the United States, and interprets the results in linkage with the conventional product life cycle or consumer adoption models, thereby empirically demonstrating that hype cycles exist in user dimensions. The outcome of this research is expected to make major contributions to the utilization of hype cycles, life cycles and consumer behavior models in various efforts to analyze and forecast markets and technologies hereafter.

## Theoretical background and preceding studies

Theoretical background

To identify or asses emerging research field or trends, the methodologies of scientometircs have been developed and suggested (Lee 2008; Xie et al. 2008; Lv et al. 2011). In addition to the such concepts of quantitative analyses, product life cycles or technology life cycles that are already being widely used in various academic fields including bibliometrics, business management, technology management and science and technology policy development, etc., the concepts of socio-technical systems, consumer behavior models, and consumer adoption models are also employed for the empirical verification of technology hype cycle models and the interpretation of their results.

Unlike conventional life cycles demonstrated by the purchasing behavior of users, the technology hype cycle model is introduced as a model for explaining the expectations of users, and it shall be shown that this latter model can be empirically verified through search traffic patterns. The consumer behavior model is used to explain the difference between consumer purchasing behaviors and search behaviors in the introductory and growth stages within the life cycle and to illuminate the significance of searches in relation to consumers' buying behaviors. In addition, the consumer adoption model is utilized for the mutual comparison and linkage of the position within the life cycle and the position within the hype cycle, and it should be particularly noted that the categorization of consumers provided by the consumer adoption model is also used to distinguish consumer categories for the purpose of explaining the difference between purchasing behavior and searching behavior, a difference that corresponds to the difference between the life cycle and the hype cycle. The major theoretical backgrounds to this study are briefly outlined in the following.

Technology hype cycle model

While the conventional product life cycle (or technology life cycle) constitutes a producer-oriented and outcome-oriented approach in that this cycle seeks to explain indices related to the producer such as sales, sales revenues, and operating profits, etc., by contrast, the hype cycle (or attention cycle) model is an approach that focuses more on the consumers and the procedural aspects.

In general, when a new technology has been introduced, the technology hype cycle model is used to explain the process by which the expectations regarding that technology evolves and the process by which the technology becomes established in the market and utilized by companies. The phase-by-phase technology hype cycle presented in Fig. 1 offers the following observations. The technology trigger phase (i.e., the technology generation phase, or the incipient phase) is when the technology commodity emerges based on the potential of the technology. In this phase, however, though the technology receives attention from the media, it may appear to be deficient in merchandising potential or it may fail to become commercialized. The peak of inflated expectations phase (bubble phase) is the period of heightening interest when numerous initial success stories are publicized but not many companies participate. The media report unrealistic and excessive market forecasts regarding the technological success. The trough of disillusionment (the disillusionment phase) is the phase where the hype rapidly declines due to falling interest in the results of the experiment or the failure of commercialization, and this is the phase in which the technology must be developed into a commodity that can satisfy early adopters if it is
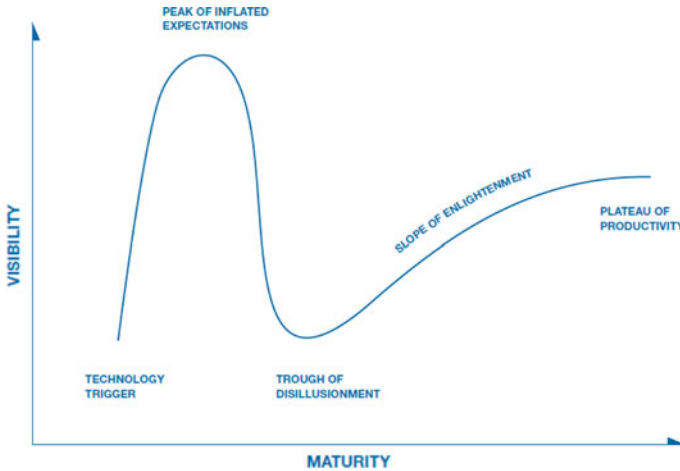
Fig. 1 Gartner technology hype cycle. *Source*: www.gartner.com

to be able to secure continued investment. This is a period of realistic re-adjustment marked by a rapidly declining curve, and the media lose interest aside from expressing suspicions regarding the technology. The slope of enlightenment (the stabilization phase) is the phase in which a wider understanding can be gained regarding the specific means by which the technology in question will generate profit, and sometimes a second or third generation version that represents an improvement over the initial commodity makes an appearance. This is the phase in which conservative companies remain cautiously attentive to how the technology will proceed. The plateau of productivity (growth phase) is the phase in which the commercial viability is recognized, and advancement into a broad market for the technology in question can take place (www.gartner.com).

One characteristic that distinguishes the hype cycle in comparison to the life cycle is that when a new technology emerges and is evaluated to have potential for applicability (technology trigger), the expectations of the market and the consumers regarding the new technology rapidly rises and reaches a peak (peak of inflated expectation), but as in the case of the majority of new technologies, as the new technology that has reached its peak begins to be disseminated more broadly, there arises a gap between the expectation and the level of actual satisfaction, resulting in the collapse of the bubble (trough of disillusionment). This subsidence of the bubble and the return of the level of expectation almost back to its original point are attributed to technological problems in the new technology itself and the deficiencies in the related infrastructure that is required for the implementation of the new technology. The hype cycle has its origins in the "marketing hype" that explains the negative effects of excessive marketing, or in other words, excessive exposure. Therefore, the visibility in the hype cycle brings about the rapid bubble phase arising from technological vision or from the media, and such visibility becomes hyped according to the contents and the amount of the exposure.

This technology hype cycle model is currently applied to almost all newly emergent informational technologies, and in the case of the Gartner group, this kind of technology hype cycle model is used to explain which phase has been reached by the new informational technologies that have been hitherto introduced, as in the following.

Consumer behavior model

The study of consumer behavior refers to the study of the methods used by individuals, groups and organizations to select, purchase, use and process products, services, ideas or experiences for the purpose of satisfying their primary and secondary needs. Such consumer behavior is impacted by cultural, social and personal factors, and numerous types of consumer behavior models have been proposed to better understand such consumer behavior. According to stimulus–response model of buyer behavior, first, the marketing stimuli and environmental stimuli enter the consciousness of the consumer. The psychological process combines with special consumer characteristics to influence the decision making process and induce the decision to purchase. In other words, the consumer behavior model addresses the process that occurs within the consumer's consciousness in between the input of the external marketing stimuli and the final buying decision.

When the process of the purchase decision making process is examined based on this consumer behavior model, the process can be broadly distinguished into five stages, consisting of (1) problem awareness, (2) information search, (3) evaluation of alternatives, (4) decision to purchase, and (5) actions following purchase. This model emphasizes that the process leading to the purchase is initiated long before the actual act of purchase, and that its results linger long after the purchase. However, consumers do not undergo all five stages in all cases when they purchase a product. In other words, some consumers sometimes simply skip over a certain stage, and some even move through some of the stages in inverse sequence. As in the consumer behavior model, the differences in cultural, social and personal factors inevitably result in the diversity of the forms of adoption exhibited consumers in their consumption of new products in particular (Kotler and Keller 2008).

Consumer adoption model for innovations

Innovations, regardless of the actual length of their particular history, pertain to goods, services or ideas that people perceive to be new. Rogers (2003) defined the innovation diffusion process as the transmission of a new idea that has been generated through invention or creation to the end users or adopters of this new idea. In other words, the focus of the consumer adoption process is on the mental process experienced by the individual throughout the process ranging from first hearing about the innovation up to its final adoption. In this regard, one common characteristic is that this model approaches the adoption process from the perspective of the user (consumer) rather than from the producer-oriented perspective found in conventional product life cycle studies. There has even been a proposal for the study of the use-diffusion process, which expands the user adoption model to encompass the stage of using the new product (Shih and Venkatesh 2004).

Rogers (2003), while explaining the differences in the preparation taken for the usage of new products and the impact of individual factors, defined the innovativeness of an individual as the relative speed of particular individual in adopting new ideas compared to other members of the social system. In each product field, there are innovators and early adopters, et al. who can be categorized as shown in Fig. 2.

After the gradual take off, the number of those who adopt the innovation increases and reaches its peak, and thereafter the number decreases since there is a smaller pool of remaining non-adopters. The five adopter groups differ in their value orientations and in their movements toward selecting or refusing the product in question. The innovator is passionate and adventurous toward technology, and enjoys repairing new products and
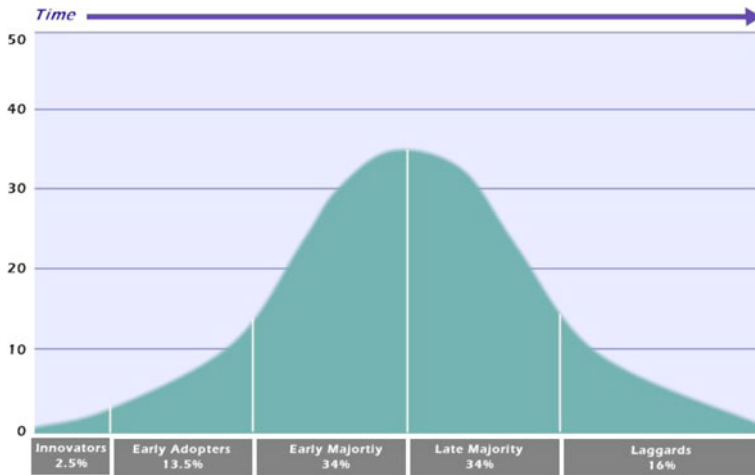
Fig. 2 Categorization of adopters based on the relative time required for innovation adoption. *Source*: Rogers (2003)

becoming familiarized with complexities. The early adopter is an opinion leader who carefully researches new technologies that provide dramatic competitive superiority. They are not price-conscious and have the willingness to select a product if it provides personal solutions and good service support. The early majority consists of prudent pragmatists who adopt a new technology once its benefits have been demonstrated and it has already been adopted by a large number of people. The late majority are suspicious, conservative individuals who are averse to risk and are cautious toward technology while also being sensitive to price. The laggards are those who are bound to tradition, and only adopt innovations when the innovations themselves have come to be accepted and established as tradition.

Review of preceding studies on the empirical verification of the hype cycle and points of differentiation

Dahlberg and Hørlück (2001) and Osterwalder (2004) respectively utilized the equity value graph and the NASDAQ index to empirically define the technology hype cycle, and thereby identified patterns that were similar to the hype cycle. However, the relationship between equity values and visibility remained unclear. In particular, while it is possible to conduct an analysis of the equity values and index for a specific company or a specific industry, there are significant limitations to the analysis of specific technologies or products. In addition, though Romiszowski (2004) has analyzed the adoption patterns for education and TV, since his analysis pertained not to the visibility of technologies but rather to their adoption (market share), his work should be considered to be rather an analysis of one type among the conventional product life cycles. In regards to the aspect of visibility, Lind (2004) was able to clearly illustrate the hype cycle pattern involving the usage of the word "convergence" in IT-related articles using databases of news reports. Though this cannot be considered an empirical study of the hype cycle since it did not consist of an analysis of technology, Lind's work has presented the possibility for using the visibility measurement indices provided by news reports.

Table 1 Technology life cycle indices

Factor	Indicator
R&D profile	
Basic research	Items in e.g. science citation index
Applied research	Items in e.g. engineering index
Development	Items in e.g. US patents
Application	Items in e.g. newspapers abstracts daily
Societal impacts	Issues in business/popular press abstracts
Growth rate	Trends over time in number of items

Source: Watts and Porter (1997)
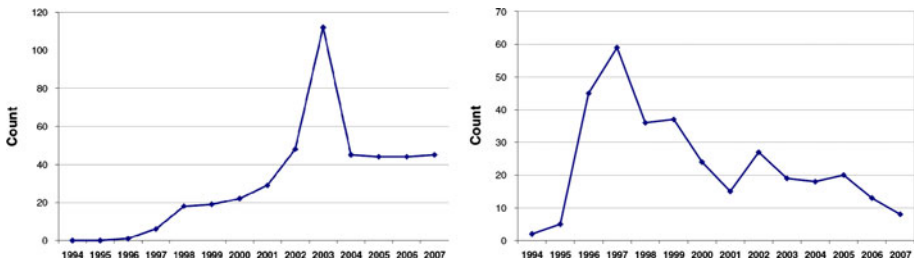
Fig. 3 Pattern of exposure for DVD related reports in the New York Times (*left*) and the Electronic Engineering Times (*right*)

Such bibliometrical approaches to the hype cycle of the life cycle can also be found in the works of Makovetskaya and Bernadsky (1994) and Watts and Porter (1997). However, Makovetskaya and Bernadsky (1994) presented a methodology of analysis of scientometric data such as articles, patents and standards reflecting the dynamics of R&D, the study detected the life cycle of technology-oriented R&D. Watts and Porter (1997) identified the bibliometrical indices that enable approaches at each phase, as presented in Table 1. Although, according to the results of a study by Järvenpää et al. (2011), the phase-by-phase categorization indicated in Table 1 cannot be regarded as the general, representative characteristics of each phase, it is certain that each index offers a valuable resource for empirically analyzing the technology hype cycle.

In actuality, Järvenpää and Mäkinen (2008a) analyzed the case of DVD technology using news articles, one of the indices included in Table 1, for the objective of identifying the technology hype cycle, but failed to demonstrate a clear hype cycle pattern for DVD technology in all of the English-language newspapers examined. Järvenpää interpreted that this failure was due to the inclusion of DVD films rather than DVD technology. However, the study also made some achievements in this area, demonstrating that the press specializing in technology and the general press have differing bubble phase peaks (refer to Fig. 3).

In another study conducted by Järvenpää and Mäkinen (2008b), the target technologies were expanded to include MP3, Bluetooth, and Blu-ray technologies, and the indices were also modified to use both news reports and technological literature ("Compendex"). As a result, the study succeeded in identifying a clear hype cycle in the news pertaining to MP3 and Bluetooth, but on the other hand, for Blu-ray, the study detected only the decline of the bubble phase. Even in the identified patterns, there were difficult challenges to interpreting the results since the study overlapped with the period of the collapse of the dot-com bubble and falling expectations.
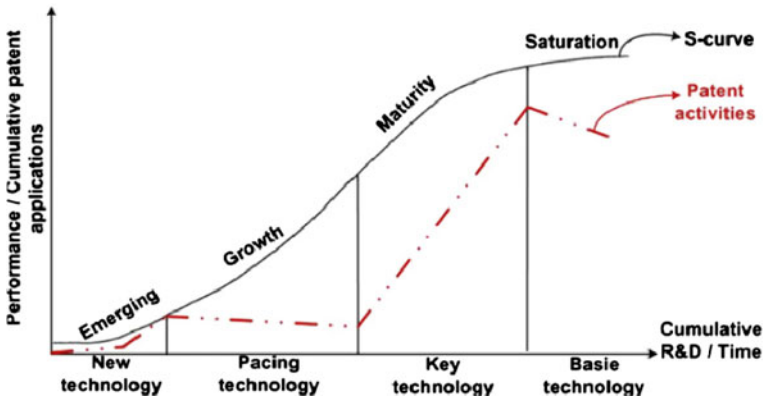
Fig. 4 Comparison of the technology life cycle and patent activities. *Source*: Chen et al. (2011)

As examined above, there have been many efforts to empirically demonstrate the technology hype cycle up to recent times, and there have been positive developments as in the identification of indices and the attempts at analysis, but these efforts were also beset by many limitations. In particular, because there has been an absence of consideration given to the technology life cycle, it has been difficult to provide sufficient interpretation of the bubble phase and the disillusionment phase. More effective interpretations will become possible when a comparison is made of the hype cycle indices in conjunction with the conventional technology life cycle, as undertaken in the research by Chen et al. (2011). Early on, Ernst (1997) had argued that patent related activities undergo a period of decline during the growth phase of the technology cycle, though he did not adduce the hype cycle in his explanation (refer to Fig. 4). As implied in these preceding studies, it is necessary to analyze the life cycle and the hype cycle in correlation with one another.

However, there is one index of the hype cycle that has been overlooked by Järvenpää, Watts and Porter, and this is none other than the consumer's hype cycle. This paper seeks to analyze the consumer's hype cycle using web-searching traffic, which can be defined as part of the index of information collection within the five stages outlined in the consumer behavior model. As well known, within the information research stage of the consumer behavior model, consumers often only conduct their search within the scope of very limited quantities of information, and the pattern of such searches also differ according to the user category. Therefore, web-searching is a useful tool for analyzing consumer information researching patterns in this age when internet usage has become commonplace, and it will also make a significant contribution to the analysis of search patterns in accordance with the user categories found in the consumer adoption model.

In the works of Järvenpää or Fenn and Raskino (2008), who created the hype cycle model, expectation was simplified in definition as the manifestation of people's human nature, but the project to connect the life cycle with the hype cycle must be preceded by the demonstration that there exist hype cycles for users. This paper conducts empirical identifications and comparisons of users in the market.

Also, as in the preceding studies, analyzing visibility or measuring expectations using only quantitative data (counts or number of hits) entails the risk of reflecting changes in the media environment concomitant to the development of the internet environment in the form of noise. In other words, the concept of exposure through news, etc., can be

interpreted more accurately when compared through frequencies or intensities rather than through absolute values. For this reason, this paper refrains from the analysis of simple quantities (number of counts), and instead uses frequencies or intensities to analyze the hype cycles of producers (researchers), the market, and consumers.

Research methodology and case studies

Research methodology

To measure the hype cycle from the user perspective, the methodology of bibliometrics that measures statements and information in documents is used. Bibliometrics is an effective methodology for historically and systematically analyzing large volumes of documents. Bibliometrics is capable of analyzing technology life cycles that exist embedded, and has even been utilized in linkage with consumer adoption forecasting models such as the Bass model to predict the future of technologies (Daim and Suntharasaj 2009). To secure the objectivity of the interpretation of these patterns, additional comparative analysis is conducted on market sales volumes (for interpreting life cycles) oil prices and GDP growth (as an environmental variable).

Upon examining each respective measurement methodology in further detail, it should be noted that for the purpose of measuring the user's expectations (visibility) from the perspective of consumer behavior, the measurement was made through the intensity of search traffic for searches made on a website, in contrast to the method used in other preceding studies. The site selected for analysis was Google, which provided the search statistics for this study and which occupies the highest global market share of searches, reaching 82.8% as of May 2011 (netmarketshare.com). The search traffic on Google was adopted as the index of consumer behavior based on the reasoning that Google's search engine already occupies a monopolistic position in the market. Moreover, though producers also use Google searches, the majority of the Google users in this regard consist of consumers who are restricted from access to other specialized DBs.

With Google Trends, We can compare the world's interest in our favorite topics and also can see how often they've been searched on Google over time. Google Trends also shows how frequently certain topics have appeared in Google News stories, and in which geographic regions people have searched for them most. The Google search statistics (Google trends) analyses a portion of web searches to calculate the number of searches for the terms input by the user within a specific time period in relation to the total number of searches conducted on Google. This is equivalent to expressing the probability that a particular individual user will search for a certain search term within a specific time period in a particular region. The search statistics set the criteria of minimum traffic for the search term and hence search terms with low search volume is not indicated in the statistics. Also, search terms that were repeatedly input by a particular user over a short time period is also excluded from the tally, preventing the possibility of artificially manipulating the level of interest through repetition (www.google.com).

Another advantage of utilizing Google trends is found in its process of normalization. Research case studies in the past used absolute values (for example, the number of hits, etc.) and hence failed to exclude environmental factors behind consumer exposure resulting from the overall increase in news volume or the number of web pages. By contrast, all of the results of the search statistics in the Google trend data undergo a normalization process, dividing them by a common variable to eliminate the influence of

variables. Through this method, it becomes possible to compare the basic features of each set of data. If only the absolute values are indicated without the precaution of this normalization process, the data collected from regions or time periods with high search volume will always receive the highest score.

The frequency of all other indices for measuring the hype cycle, such as news and patents, are also measured in relation to the total data for the time period in question, and is again divided by the total average to ensure that normalized intensities are used in all comparisons. The market sales volume is also divided by the total sales volume to yield the sales market share of new products that is submitted to analysis. The sources for the major variables and the comparative data are listed in Table 2.

Case study: hybrid automobiles

The hype cycle has been actively utilized by Gartner in the IT industry. The elements that differentiate this hype cycle from the conventional technology life cycle are the bubble phase marked by a rapid rise in expectations (peak of inflated expectations) and the phase of disillusionment marked by declining expectations (trough of disillusionment), which are distinguished from the market growth occurring in the life cycle. These two characteristic phases occur over a relatively short time period in the IT industry, and there are many problems that complicate attempts to distinguish these phases from the noise in the external environment even when the phases are actually observed. While empirically verifying whether the hype cycle exists in industries other than the established IT industry, the hybrid car was chosen as the target for analysis, since hybrid cars have a long-term technology life cycle that makes it relatively conducive to excluding the external environmental noise.

Hybrid cars have been developed with an almost exclusive focus on the US market. In the United States, hybrid cars have grown into a market that occupied up to 2.5% of the new car sales volumes for 2010, with the cumulative sales volume reaching 2 million vehicles as of May, 2011. When estimating the cumulative maximum market to determine the growth cycle, considering that 25% of the car transactions in the US consist of new cars and that the total number of registered vehicles is 250 million (as of 2007), the cumulative maximum market for hybrid cars can be estimated at around 60 million vehicles (maximum potential number of cumulative consumers in the Bass model). When comparison is made to the new technology adoption cycle presented in Fig. 2 based on this calculation, the cumulative market share since 2009 exceeded 2.5% (around 1.5 million vehicles),

Table 2 Data sources for each major variable and index

| Variables and indices	Site	Explanation
Search traffic	Google trends	Weekly and quarterly search traffic in the United States (2004-present)
Oil prices (WTI)	KEEI (in Korea)	Monthly WTI crude oil price (2004-present)
GDP growth rate	US Department of Commerce	Quarterly US GDP growth rate (2004-present)
Market share	Hybridcar.com	Monthly, quarterly market share rate of case study technologies among new cars in the US (2004-present)
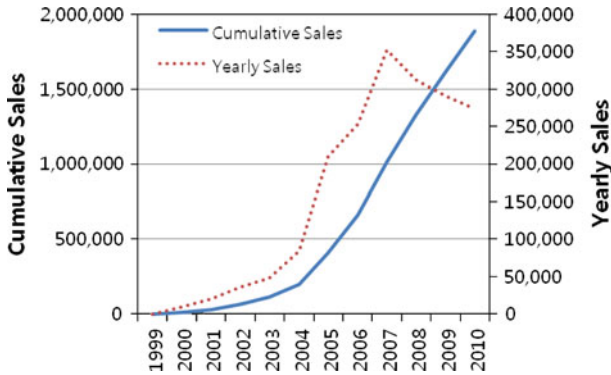
Fig. 5 The growth and current status of the hybrid automobile market in the US. *Source*: http://www. hybridcar.com

leading to the conclusion that the market has grown from a market for innovators into that of early adopters, and in terms of the conventional life cycle, the market has passed the introductory phase and entered into the early growth phase.

The Toyota Prius, the origin of contemporary hybrid cars, was launched in Japan in 1997, followed by the introduction of Honda's Insight in 1999. These cars have hitherto failed to receive much interest due to low oil prices, but since oil prices rose steeply in the late 2000s, they began to occupy an important position in the car market. Globally, the cars broke through to a cumulative sales volume of 100 million cars in March 2007, followed by 200 million in August 2009 and 300 million in February 2011, exhibiting a relatively rapid growth trend (Fig. 5).

Results

When examining the weekly search traffic for hybrid cars in the US and analyzing the data on a dimensionless scale, the results are as shown in Fig. 6. To reduce the risk of interpretive errors arising from external environmental factors affecting hybrid cars, a simultaneous analysis was conducted on the search traffic for electric cars in relation to hybrid cars. Up to
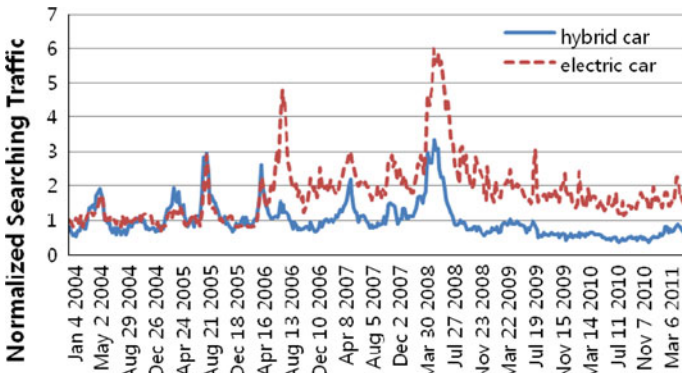
Fig. 6 Search traffic in the US for hybrid cars and electric cars (weekly data)
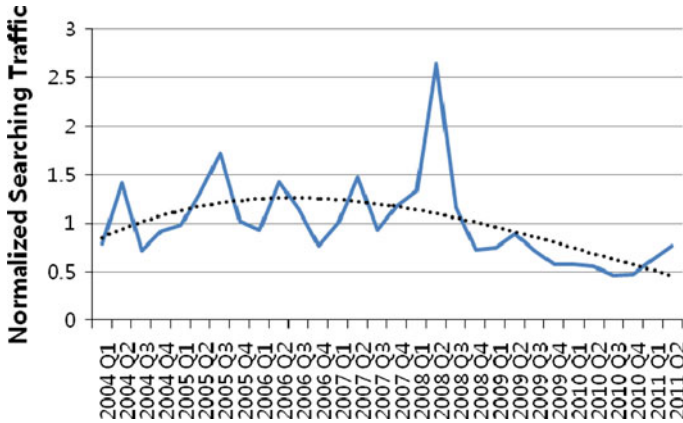
Fig. 7 Search traffic in the US for hybrid cars and trend analysis (quarterly data)
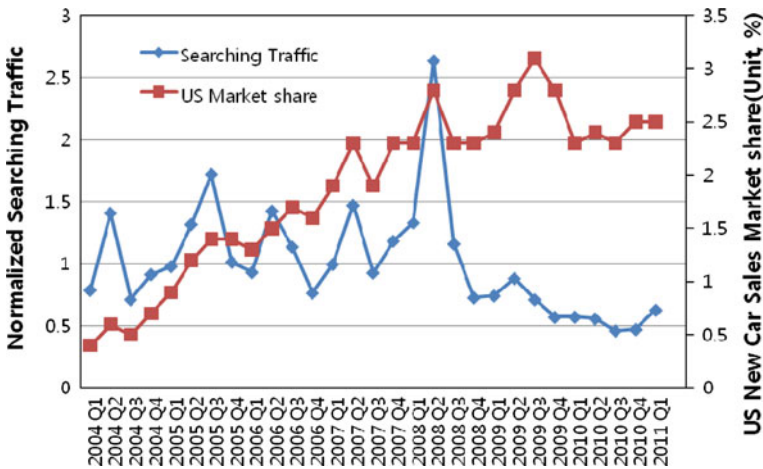

Fig. 8 Comparison of the search traffic (quarterly data) and the market share for hybrid cars in the US. *Source* www.hybridcar.com (market share only)

early 2006, there were almost no differences in comparison to the traffic of searches for electric cars on the web, but since the sales of hybrid cars stabilized and exceeded 1.5% beginning in late 2006, the differences between the search traffic for electric cars and the search traffic for hybrid cars begin to reveal a larger and larger gap. Rather than indicating changes in the users' method of collecting electric car related information, these results lead to the judgment that the expectations of users which had once concentrated on hybrids have gradually expanded to include other alternatives (refer to Fig. 6).

Upon analyzing the trends in the changes in search traffic for hybrid cars in the US, it was found that there has been a clear trend of decline with a turning point in the first quarter of 2007, as shown in Fig. 7. To determine whether such increases and decreases represent the bubble phase and the disillusionment phase within the hype cycle model, it is necessary to conduct a comparison to the technology life cycle, and accordingly, Fig. 8 shows the results of the comparison between the market share data, which enables the determination of the technology life cycle, to the search traffic data.
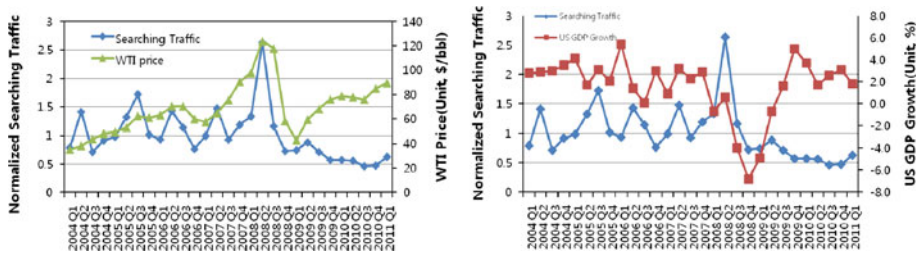
Fig. 9 Comparisons of the search traffic in the US for hybrid cars to WTI oil prices (*left*) and to the GDP growth rate (*right*)

Table 3 Results of the regression analyses for each major variable

|	Statics	GDP growth	Searching traffic	Market share
WTI Price	*p*-value	0.4226	0.0931	0.0001
	t test	−0.8144	1.7410	4.4183
	R coefficient	0.1548	0.3177	0.6478**
	(hypotheses)	None	H_0 B1	H_0 B2
GDP Growth	*p*-value		0.7693	0.0751
	t test		−0.2962	−1.8514
	R coefficient		0.0569	0.3356
	(hypotheses)		H_0 B3	H_0 B4
Searching traffic	*p*-value			0.7256
	t test			−0.3556
	R coefficient			0.0681
	(hypotheses)			H_0 A

* Significant at the 5% level, ** significant at the 1% level

As demonstrated in Fig. 8, when the market share in the US exceeded 1.5–2.0% between 2007 and 2008, the market share and the search traffic began to exhibit notably contrasting patterns. While the market share followed an exponential trend, the search traffic exhibited a polynomial (3–4 terms) trend.

Since such trends in search traffic or market share can be influenced by external environmental factors, comparisons were made to identify the relation of changes in the search traffic trend to the most representative macro-economic variables consisting of changes in oil prices or the GDP growth rate, and the results are presented in Fig. 9.

In the case of oil prices, since the data for oil prices in the US were required, the prices from WTI (West Texas Intermediate), which is intended for domestic consumption in the US, were selected for application from among the three representative types of oil price data available. In Table 3, the results of the analysis showed that there was no correlation between the search traffic and the GDP growth rate, and though the oil prices corresponded to a nearly identical trend up to 2008, beginning in 2009 it diverged into an entirely differing trend, thereby once again confirming that the expectations regarding hybrid cars markedly declined from 2009.

By contrast, according to the data in Fig. 10, the WTI oil prices and the market share followed nearly identical trends over the course of the entire time period, corroborating the
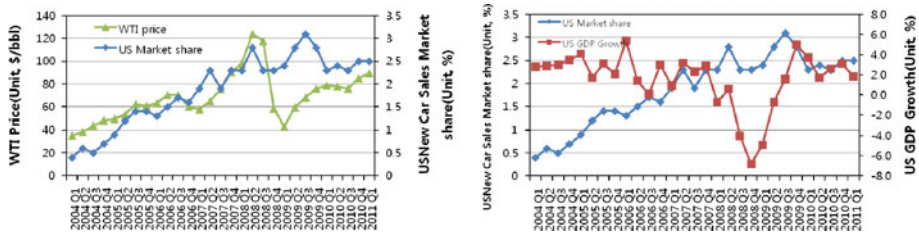
Fig. 10 Comparison of the market share of hybrid cars in the US (quarterly data) to WTI oil prices (*left*) and the GDP growth rate (*right*)

generally held view that oil prices probably exercised a great impact on the expansion of the hybrid car market (meanwhile, the GDP growth rate had almost no influence on changes in the market share). Therefore, it was possible to attribute the fall in search traffic to the characteristics of the users rather than to external environmental factors such as oil prices.

The above analyses verified that the information research behavior of consumers (or users) using the web exhibited the same characteristics corresponding to the bubble phase and the disillusionment phase within the hype cycle, in contradistinction to the exponential growth that takes place throughout the introductory and growth phases in the market.

In order to derive more generalized conclusions that build upon the results of the preceding descriptive research, hypotheses regarding the correlations between the pertinent variables were established and subject to verification. According to the consumer behavior model, the purchasing behavior of consumers and their information searching activities are factors that inevitably impact one another. However, if a hype cycle with characteristics that differ from the life cycle did indeed exist, then the information searching activities that take place only within a specific period would be shown to have a significant influence on purchasing activities: the following seeks to provide empirical evidence of the existence of the hype cycle in terms of the users by identifying this specific correlation.

First, the following null hypothesis and alternative hypothesis were established in accordance with the general consumer behavior model, with the hype reflected in information searching activities serving as the input variable and the purchasing behavior as the outcome variable.

H_0A The purchase of a hybrid car is not correlated with the intensity of the consumer's information searching activities.

H_1A The purchase of a hybrid car is influenced by the intensity of the consumer's information searching activities.

In the event that the null hypothesis cannot be rejected, it can be concluded that information searching activities, in other words expectation, did not exhibit corresponding tendencies with car purchases. In such cases, it is necessary to verify whether this discrepancy between the consumers' purchases and their information searching activities is merely an outcome of "data-snooping." Accordingly, the following verifiable hypothesis (null hypothesis) is established to determine whether such discrepancies resulted due to representative environmental variables.

H_0B1 Consumer's expectation (information searches) regarding hybrid cars is not influenced by fluctuations in oil prices.

H_0B2 The relative degree of hybrid cars purchases is not influenced by fluctuations in oil prices.

H_0B3 Consumers' expectation (information searches) regarding hybrid cars is not influenced by changes in income (GDP growth).

H_0B4 The relative degree of hybrid car purchases is not influenced by changes in income (GDP growth).

The results of regression analysis performed on the above hypotheses demonstrate that H_0A is adopted first. Therefore, it can be concluded that there are trends in information searching activities that differ from purchasing patterns and that cannot be explained solely based on the consumer behavior model, and the verifications of the hypotheses regarding environmental factors adopted all of the hypotheses with the exception of only H_0B2, which was rejected. Change in income (GDP growth) did not qualify as an environmental variable because it did not have an impact on consumers' information searches or their purchasing activities. Meanwhile, oil prices served as a significant environmental variable because oil prices influence the purchase of hybrid cars but does not influence the hype cycle: the fact that oil prices, which exhibited great explanatory for accounting for purchasing behavior, fail to account similarly for the information searches by consumers can be adduced as support for the argument that the consumers' hype cycle exists.

Discussion

Interpretation of the correlation between the conventional life cycle and the hype cycle

To examine the correlation between the two types of cycles, we must distinguish the introductory phase and the growth phase in our analysis. It is shown that from 2007 to 2008 and up to the introductory phase all variables exhibited similar patterns, but that upon entering the growth phase(as seen in Fig. 5), the observed values in the hype cycle pattern showed the characteristics marking the entry into the disillusionment phase.

The results of the above observations can be further generalized by the verification of hypotheses. If the existence of a hype cycle that differs from the life cycle accounts for the adoption of the null hypothesis H_0A, then it can be judged that the hype and purchase cycles may differ. Since by definition, the hype cycle and the life cycle exhibit such differences in the early phases of growth, based on this definition of the hype cycle, the cycle traced only up to the introductory phase ought to exhibit a certain degree of significance. To review this, the following additional null hypothesis was established (change in income (GDP growth) is excluded from consideration, since it has already been verified to be an insignificant variable). If hypothesis A and B1 have already been adopted in Table 3 but hypotheses A-1 and B1-1 are rejected, then this will strengthen the argument for the existence of the hype cycle.

H_0A-1   Even in the introductory phase within the life cycle, the purchase of hybrid cars is not correlated to the intensity of the consumer's information searching activities.

H_0B1-1   Even in the introductory phase within the life cycle, the consumers' hype (information searches) regarding hybrid cars is not influenced by fluctuations in oil prices.

Table 4 Results of the regression analysis for the introductory phase

Div.	Div.	WTI price		Market share	
	Period statics	Entire	$\sim$2008	Entire	$\sim$2008
Searching traffic	p-value	0.0931	0.0080	0.7256	0.0046
	t test	1.7410	2.9812	−0.3556	2.1359
	R coefficient	0.3177	0.5749**	0.0681	0.4497**
	(hypotheses)	H_0B1 (Table 3)	H_0B1-1	H_0A (Table 3)	H_0A-1

* Significant at the 5% level, ** significant at the 1% level

Table 4 presents the results of regression analysis performed on the additional hypotheses above and demonstrates that while hypotheses A and B1 were already adopted, hypotheses A-1 and B1-1 were rejected. Therefore, it was possible to use the consumer behavior model to explain the serial process by which the stimulus provided by oil price induces the information searching activities (hype) of consumers and lead to purchases in the introductory phase. However, as shown in Table 3, this consumer behavior model fails to account for patterns evident across all sections encompassing not only the introductory phase but also the growth phase. Upon entering the growth phase since 2008, the variables which exhibit a hype cycle and the variable that exhibit a life cycle are clearly distinguished. Table 4 thus once again provides clear empirical evidence corroborating the existence of a hype cycle does not differ from the life cycle in the introductory phase but begins to exhibit differing patterns in the growth phase.

Therefore, postulating that the beginning of the disillusionment phase in the hype cycle appears generally during the early growth phase, or in other words, that the difference in the respective trends of the life cycle and the hype cycle occurs in the early growth phase, it is possible to estimate the conventional life cycle based on the hype cycle.

Interpretation of consumer behavior

The surface manifestation whereby the search traffic of users (consumers) declined despite being within the growth phase of the typical life cycle with actual increases in market sales was explained by means of the hype cycle. In order to extend these research results to future applications, however, it is necessary to interpret the causal relations. In Gartner's hype cycle model, the disillusionment phase is generally attributed to the causes of disappointing experiment results, technological problems, declining interest in the media, the aftereffects of excessive marketing exposure, or deficient usage infrastructure, etc. Because hybrid cars adopt the pre-existing infrastructure for internal combustion engine cars, the cause of the disillusionment can be attributed more to the failure of the claim of fuel cost efficiency to fully meet expectations or to the reduction in media exposure rather than to infrastructural problems or "marketing hype" backlash.

In addition to such macroscopic analysis, we can also apply the microscopic interpretive perspective of consumer behavior, addressing the possibility of changes in the information collecting pattern of consumers. However, as seen in Fig. 6, though the search traffic for hybrid cars diminished, the total traffic for electric cars contrastively increased, allowing us to preclude this possibility, since this data indicates that the consumers of electric cars continued to use web searching as an important channel for information collection.

Another aspect of consumer behavior open to interpretation is the possibility that the critical sales volume (critical mass) has been reached to enable changes in the communication channel. In this case, it is possible that purchasing decision making has become diffused to focus on interpersonal channels, bypassing the exposure in the media or the active searches on the part of users. In other words, the significant escalation in the number of imitators and the word of mouth effect can provide an explanation. However, in this case, additional observed values must be secured before reaching a conclusion since the search traffic has recently resumed increasing as shown in Figs. 7 and 8, and moreover, additional studies will be necessary to determine whether the usage of interpersonal channels necessarily results in reduced search traffic in the recent internet environment. This is because the development of social networks such as information sharing services, blogs, and Facebook has shifted the form of information distribution via the web from the mass media type channels to interpersonal channels.

It is also possible to simultaneously consider both the consumer behavior model and the consumer adoption model, acknowledging the possibility that consumer behavior may have changed in a market that has become initiated into the category of a consumer group with new consumer behavior characteristics. In other words, a novel category of a consumer group may have emerged within the categorization of consumers according to their level of adoption. The decrease in search traffic that occurs during the disillusionment phase approaches in similarity to the behavioral characteristics of the early majority shown in Fig. 2, but since in the definition of the hype cycle, the transition from the disillusionment phase to the stabilized phase is determined by the entry of the early adopters, the fact of the decrease in search traffic cannot be adduced as evidencing the entry of the early majority. Rather, this can be judged to reflect the entry of the early adopters, and it will be more valid to interpret the decrease in search traffic which occurred despite their entry as due to the possibility that they may have conducted some degree of their informational search at an earlier period than their purchase (at least 1–2 years in advance). As described above, the purchasing decision making process in the consumer behavior model can take place through the awareness of the problem based on internal and external stimulants and through informational research implemented at a period far in advance of the actual act of purchase. Although the early adopters began making their actual purchases in earnest in 2008, this interpretation posits that they had already begun researching the technology in 2006, and that the purchasing preparation activities of innovators have ceased to exist any longer.

Conclusion

This study offers multiple conclusions with implications for various cases in which the hype cycle or technology life cycle will be desired to be utilized. Firstly, this paper demonstrates that hype cycles can exist not only in the IT industry but also in other traditional industries. Secondly, it is possible to measure consumers' expectations using search traffic. Thirdly, in the new product adoption model, the expectation level may already enter into decline once the period of adoption by innovators has passed and the early adopters set out to adopt (or purchase).

Though my case study analysis offers only a limited value for generalization, there are other significant implications that can be derived from this study. In the process of securing a more objective understanding of consumer behavior through a bibliometric approach, this study presented the caveat that the promise of a particular technology should not be

evaluated based exclusively on the frequency changes found in indices such as search traffic (Xie et al. 2008). Consumer groups are not homogenous, and therefore it is possible that the search traffic trend may inversely exhibit a decline during the growth phase. For this reason, a more objective assessment of the promise or diffusive potential of a technology can be made when the life cycle (or adoption model) is simultaneously analyzed in conjunction with the hype cycle.

If empirical studies of various industries and types of innovations are hereafter implemented based on the results and methodology presented in this research, such studies will contribute to enhancing the objectivity and explanatory power of various analyses and forecasts utilizing technology cycles such as the hype cycle or the life cycle. Furthermore, it is expected that these findings can also apply to the consumer behavior models utilized in many fields such as marketing, thereby even further extending the contribution of this study to the establishment of actual corporate strategies including marketing strategies.

One limitation of this study was that it ultimately utilized secondary data for the analysis of user hype cycles, despite the benefits of Google in providing a large volume of information regarding raw data and research methodologies. Henceforth, there will need to be various additional empirical research to reach more generalizable conclusions about the hype cycle, as well as additional model research to illuminate the differences between the hype cycles of different actors within the socio-technical system as revealed in this paper.

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