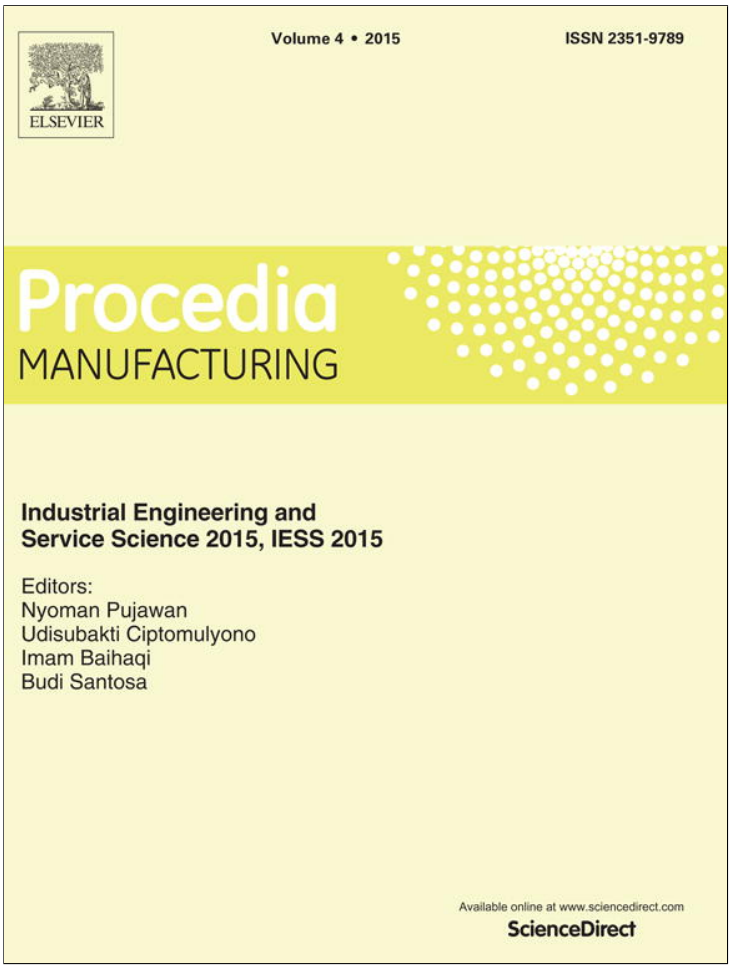

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Market response as a function of design, competition, and socio-political condition: An empirical model

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Abstract

Some previous researches about market response focus on the design of the product, some others focus on market and competition, and a few researches consider politic and regulation. All of those factors affect the market response. Therefore, this study concerns to consider all of those factors. An empirical model of market response as a function of product design, company income, product trend, competitor's condition, marketing effort, socio-economic condition, and political condition is developed in this study, then a set of real case data of an automotive product are utilized to finalize and validate the model. Chi-square tests show that the output of the model is close to the real data. The final model developed can be used to assess current condition of the factors, to predict the future condition, and to help the decision maker in prioritizing the actions to maintain the market response.

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Keywords: Market response; design; competition; socio-political condition; assessment

1. Introduction

Non-commodity products, goods or services, have finite market life, or in other word, life cycle. The life cycle of a product starts from the time at which the product launches to the market until it disappears from the market, and can be divided into four stages, i.e. introduction stage, growth stage, maturity stage, and decline stage. The length of

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product life cycle varies according to type of industry, product, technology, and/or market [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]. Before the time a product enters the decline stage, new product(s) must be introduced to the market to substitute the old product in order to maintain, or even improve, the company revenue. Thus, identifying the stage of the life cycle is important to decide the time new product should be introduced.

The stage of the life cycle of a product could be identified from product performance, as well as its market response. Many researchers believe that the most important factor affecting product performance is the design of the product [12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23]. Further, reference [14] describes three factors lead to product success, by which the gap analysis in designing a new product conducted, are social trends, economic forces, and technological advances. Reference [15] considers regulations, policies, and design decision as the factors to find the optimum benefit, and uses engineering performance, consumer demand, and manufacturing costs to measure the overall performance. It also believes that the product performance is affected by demographics and product characteristics.

Some researches about market response concern to examine the profile of market response. A model of the growth rate of market share and sales [24] and a model of weekly seasonality of market response of 96 brands and non-linear price effects due to historic reference prices [25] are the examples.

The most researches about market response study the impact of marketing effort to the market response [20, 22, 26, 27, 28, 29]. How new-product introductions and promotional incentives influence top-line, bottom-line, and stock-market performance [26], and the effectiveness of volatility of marketing practices [27], are some examples. Some other researches observe some factors related to market response and business success such as market-share, advertising/promotion, brand strength, cost structure/model, distribution channels, customer loyalty, product/technology differentiation, quality, price, and place [30, 31, 32, 33]. Public policy and litigation support as the factors affecting market response are also included in some researches [34].

Market response models developed this far are some models of advertising response, for instance basic linear model, multiplicative model, exponential attraction and multinomial logit model, Koyck and distributed lag models, and hierarchical model [30]. A review [35] maps and evaluates twelve models that describe demand, sales, and market share as function of price, competitor's price, advertising expenditures, advertising expenditures of competitor, quality measure, quality measure of competitor, and environmental variables. Other review [33] examines some model like Ansoff Matrix model, product life cycle model, product diffusion curve model, Boston Consulting Group Matrix model, and General Electric/McKinsey Matrix model, to develop a new model of scoring and portfolio to assess the level of market response by measuring some factors.

Based on the factors and variables discussed, the previous researches about market response described above could be classified into three categories, i.e. (1) the ones focus on the design of the product, (2) the ones focus on market and competition, and (3) the ones focus on politic and regulations. Considering that all those factors have been proven to affect market response and that they are still evaluated separately this far, this study concerns to involve all of those factors.

An empirical model of market response as a function of design, competition, and socio-political condition is developed in this study, then a set of real case data are utilized to finalize and validate the model. The final model developed can be used to assess current condition of the factors, to predict the future condition of the factors, and to help the decision maker to prioritize actions for maintaining the market response. The model developed here is dedicated to short-life-cycle products, such as fashion products, electronics, and automotive. In this paper, the case used is an automotive product in Indonesia which is observed during 2005 to 2012.

2. Model development

2.1. The variables

Based on observation on some virtual discussions (chats, blog comments, etc.), factors related to the design of an automotive product in Indonesia are the design itself, the trend came from trendsetter, communication of the design to the consumers, and the money available to do the product development. Factors relevant to competition are marketing effort of the company and competitors' power. Socio-politic condition can be derived into socio-economical conditions and political condition. Thus, the complete model explain the effect of design, company

income, trend, competitor, marketing, socio-economy, and politic as the independent variables, to market response of an automotive product as the dependent variable. Design could be considered also as moderator variable, as it is affected by trend, competitor, and company income. Fig. 1 shows the possible relationship among those factors.

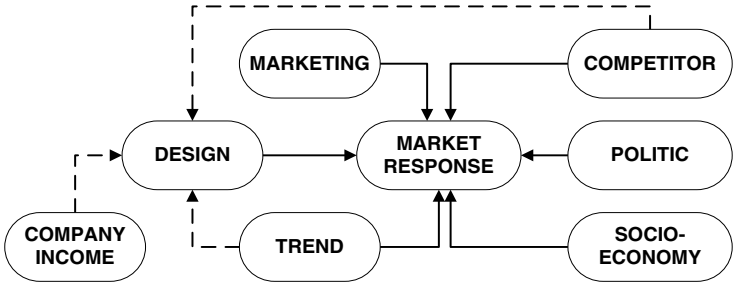

Fig. 1. Variables affecting market response of an automotive product.

Variable MARKET RESPONSE is presented by sales volume and market-share. Market-share is measured based on all products similar to the product studied, i.e. the multi-purpose-vehicle (MPV) type.

Variable DESIGN defines the effort and the result of product design or re-design process. It is measured from the level of product development and cost of development. The level of development includes the number of sub-system changed and the level of changes. There are 6 sub-systems for automotive product according to US EPA [36], i.e. engine system, transmission system, body system, break system, electrical power supply system, and electrical distribution and control system. The level of changes is low when the change is a partial change, otherwise, it is high when the change is a total change. Cost of development is the cost required for technology investment related to the changes performed.

Variable COMPANY INCOME affects the DESIGN in the term of R&D budget availability. COMPANY INCOME related to a product is presented by product sales and B/C ratio of the product development.

In automotive industry, trend includes technology implementation, physical performance like color, dimension, type, and the other additional features. Variable TREND here is evaluated and scored based on conformity of the design of product to the trend restrained by trendsetter.

Variable COMPETITOR means the superiority level of the product to the competitors. In the case of automotive industry in Indonesia, the power of competition can be seen from the market-share, price, and product advantage. In Indonesia, product advantage is mostly driven by the conformity to the trend, because the technology and management aspect of automotive industries there, are not significantly different one to another. Hence, variable COMPETITOR will be presented by three sub-variables, i.e. the joint competitors' market-share, the ratio of competitor price to product price, and the ratio of product's conformity-to-trend to competitor's conformity-to-trend.

Marketing effort is represented in communication with consumers and after-sales services that can be seen from its impact. Variable MARKETING is scored based on two parameters, i.e. ratio of communication impact of product to main competitor and the relative superiority of the after-sales service of product compared to the competitors.

Suppose that the socio-economic condition in this case is related to consumer's buying ability, thus the variable SOCIO-ECONOMY is calculated from gross domestic product (GDP) per capita, percentage of non-poor population, and conditions affecting infrastucture support i.e. population density and vehicle density.

Based on the historical facts that the sales volume of most capital goods decrease significantly around a political event like general election, variable POLITIC is involved and it is scored by judgement based on experience.

2.2. The data

Data related to the variables described above are shown in Fig. 2. This figure shows that the relationship among the item data might be linear or non-linear. Therefore, there are three alternate models developed here.

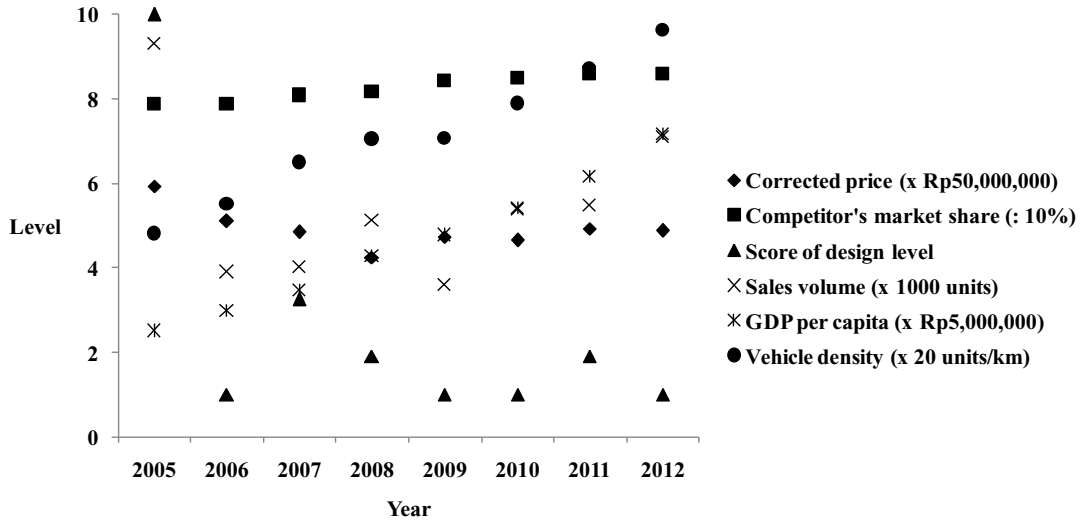

Fig. 2. Yearly profile of some variable-related items.

2.3. The alternate models

The first alternate model is a polynomial model as presented in (1) and (2).

$$D = d_1 + iI^{\iota} + t_1T^{\tau 1} + c_1C^{\chi 1} \tag{1}$$

$$M = m_1 + dD^{\delta} + t_2T^{\tau 2} + c_2C^{\chi 2} + kK^{\kappa} + sS^{\sigma} + pP^{\pi} \tag{2}$$

D, M, I, T, C, K, S, and P are the score of DESIGN, MARKET RESPONSE, COMPANY INCOME, TREND, COMPETITOR, MARKETING, SOCIO-ECONOMY, and POLITIC, respectively. Constant d, i, k, s, and p are the coefficient of D, I, K, S, and P, respectively. Constant d_1 and m_1 are the intercept. Constant t_1 and t_2 are the coefficient of T in D function and M function, respectively, while c_1 and c_2 are the coefficient of C in D function and M function, respectively. The δ, ι, κ, σ, and π are the exponents of D, I, K, S, and P, respectively. The τ_1 and τ_2 are the exponents of T in D function and M function, respectively, while χ_1 and χ_2 are the exponents of C in D function and M function, respectively.

The second alternative is a linear model as written in (3) and (4), while the third alternative is a non-linear model as shown in (5) and (6). Constant d_2 and m_2 are the coefficient of D function and M function, respectively.

$$D = d_1 + iI + t_1T + c_1C \tag{3}$$

$$M = m_1 + dD + t_2T + c_2C + kK + sS + pP \tag{4}$$

$$D = d_1 + d_2I^{\iota}T^{\tau 1}C^{\chi 1} \tag{5}$$

$$M = m_1 + m_2D^{\delta}T^{\tau 2}C^{\chi 2}K^{\kappa}S^{\sigma}P^{\pi} \tag{6}$$

Using historical data of an automotive product during 2005 to 2012, every variable above is scored from 1 to 10. The scores are calculated from the weighted average of the rating of the related sub-variables. The rating of a sub-variable is ranged from 1 to 10, and it is converted from real data obtained from many resources. The weight of every sub-variable is approached from the result of previous researches, correlation coefficient, survey, and/or expert judgment. Expert judgment here means opinion from practitioner and professional in automotive, observed

from company reports, press releases, and news. The rating and weight data are presented in Table 1, while the score of the variables computed is shown in Table 2.

Table 1. Ratings and weights of the sub-variables.

Year	M_1	M_2	D_1	D_2	D_3	I_1	I_2	T	P	C_1	C_2	C_3	K_1	K_2	S_1	S_2	S_3	S_4
2005	9.2	8.3	10.0	10.0	8.3	9.2	8.4	9.0	10.0	6.0	3.8	6.4	3.0	10.0	1.8	8.1	9.7	1.8
2006	3.1	8.3	1.0	1.0	1.0	2.8	2.2	7.0	10.0	6.1	3.8	4.8	2.2	10.0	2.5	7.8	8.9	3.0
2007	3.3	7.4	2.5	3.3	2.7	2.7	1.5	7.0	7.0	5.1	4.1	4.8	2.4	10.0	3.2	7.5	7.8	4.1
2008	4.5	7.0	2.5	1.9	1.1	3.1	1.8	3.0	4.0	4.8	3.1	2.3	3.0	10.0	4.4	7.2	7.1	5.1
2009	2.8	5.8	1.0	1.0	1.0	2.3	1.2	3.0	1.0	3.6	3.2	3.2	2.4	10.0	5.2	6.9	7.1	6.3
2010	4.8	5.6	1.0	1.0	1.0	3.7	2.3	3.0	10.0	3.3	3.5	3.2	3.0	10.0	6.1	6.6	6.2	7.0
2011	4.9	5.0	2.5	1.9	1.1	4.1	2.5	3.0	10.0	2.8	2.6	2.3	1.6	10.0	7.2	6.3	5.3	7.8
2012	6.8	5.1	1.0	1.0	1.0	5.4	3.6	3.0	7.0	2.9	4.0	2.3	1.6	10.0	8.7	6.0	4.2	8.5
w_i	0.5	0.5	0.5	0.2	0.3	0.5	0.5	1.0	1.0	0.4	0.2	0.5	0.7	0.4	0.2	0.3	0.2	0.3

Table 2. Score of the variables.

Year	M	D	I	T	C	K	S	P
2005	8.75	9.53	8.76	9.00	5.80	5.42	5.27	10.00
2006	5.72	1.00	2.50	7.00	5.09	4.92	5.50	10.00
2007	5.32	2.70	2.09	7.00	4.80	5.05	5.63	7.00
2008	5.76	2.00	2.45	3.00	3.33	5.41	5.98	4.00
2009	4.30	1.00	1.69	3.00	3.34	5.00	6.39	1.00
2010	5.18	1.00	2.97	3.00	3.28	5.43	6.51	10.00
2011	4.96	2.00	3.27	3.00	2.51	4.53	6.67	10.00
2012	5.94	1.00	4.48	3.00	2.80	4.52	6.90	7.00

M_1, M_2, D_1, D_2, D_3, I_1, I_2, C_1, C_2, C_3, K_1, K_2, S_1, S_2, S_3, and S_4 are the rating of sales volume, market-share, number of sub-system changed, level of product changes, cost of product development, sales, B/C of product development, joint competitor's market-share, price ratio of competitor to product, conformity-to-trend ratio of product to competitor, communication impact of product to competitor, superiority of after-sales-service of product to competitors, GDP per capita, population density, non-poor population, and vehicle density, respectively, while w_i is the weight of sub-variable i.

Using the scores available in Table 2, a procedure of linear transformation and multiple-linear regression [37] is applied. The final form of the polynomial model is presented in (7) and (8), the linear model is shown in (9) and (10), while the non-linear model is presented in (11) and (12).

$$D = -2.95 + 0.92I + 0.11T^{1.02} + 0.23C^{1.44} \tag{7}$$

$$M = -6.46 + 5.51D^{0.20} - 9.42T^{0.27} + 18.49C^{0.41} + 2.96K^{0.40} - 178.62S^{-1.24} + 1.84P^{0.13} \tag{8}$$

$$D = -3.66 + 0.93I + 0.13T - 0.58C \tag{9}$$

$$M = -24.09 + 0.37D - 0.98T + 3.14C + 0.70K + 2.94S + 0.06P \tag{10}$$

$$D = -0.62 + 0.22I^{0.83}T^{-0.39}C^{1.61} \tag{11}$$

$$M = -0.400 + 0.001D^{0.19}T^{-0.61}C^{1.98}K^{0.31}S^{3.51}P^{0.07} \tag{12}$$

3. Model evaluation

The profile of the comparison between the value of the dependent variables of the three models and the real data value are shown in Fig. 3. The result of chi-square test to evaluate the fitness of the model output to the real data and the average percentage errors, are presented in Table 3. The critical chi-square is 14.067 (p = 0.05, df = 7).

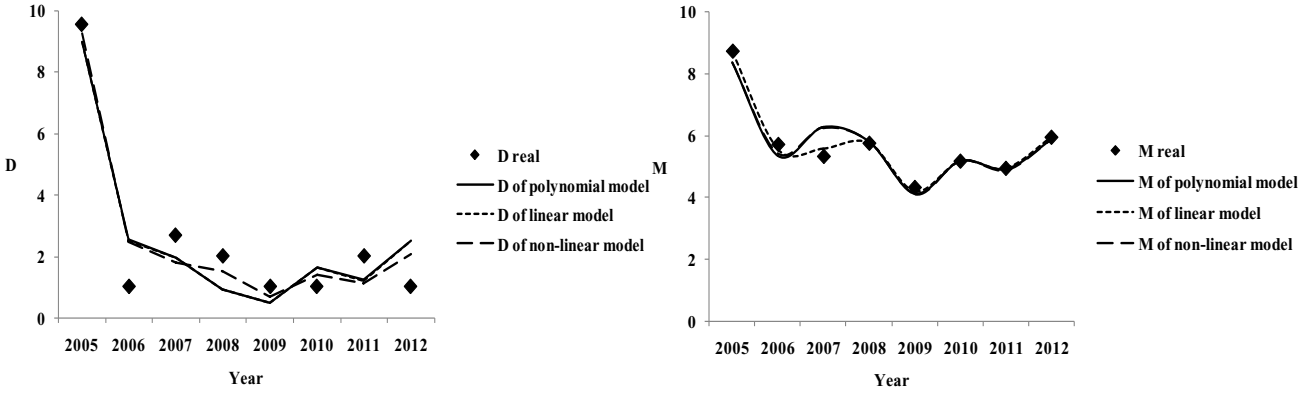

Fig. 3. Comparison between *D* and *M* of the models with the real value of *D* and *M*.

Table 3. Chi-square test and the average percentage error.

Test on	Chi-square	Average error (%)	Conclusion
D of polynomial model	4.644	9.10	Not significantly different
D of linear model	4.639	9.14	Not significantly different
D of non-linear model	3.029	7.27	Not significantly different
M of polynomial model	0.196	2.54	Not significantly different
M of linear model	0.020	0.80	Not significantly different
M of non-linear model	0.189	2.54	Not significantly different

4. Final model

The values resulted from the three models are not significantly different from the real data. We can arbitrarily choose any model to apply. However, using the best fit model, the non-linear model is chosen for *D* function and the linear model is chosen for *M* function. Thus the final model is described in (13).

$$M = -24.09 + 0.37(-0.62 + 0.22I^{0.83}T^{-0.39}C^{1.61}) - 0.98T + 3.14C + 0.70K + 2.94S + 0.06P \quad (13)$$

The value of the variables could be dynamically changed by time, and the model should be dynamically re-adjusted to be beneficial for decision making. Thus, as an integrated part of the model, the approach to be performed in defining the rating of the sub-variable is described in Table 4. The important points should be considered in defining the score are the possible range of the quantitative data and the criteria to judge the rating for the qualitative data. In general, rating or score 1 is the possible minimum value of the variable and 10 is the possible maximum value.

Table 4. Determination of ratings and scores.

Variable	Sub-variable	Rating or score = 1	Rating or score = 10
M	M_1	Possible minimum sales volume (unit)	Possible maximum sales volume (unit)
	M_2	Possible minimum market-share (%)	Possible maximum market-share (%)
D	D_1	Possible minimum number of sub-system changed	Possible maximum number of sub-system changed
	D_2	Small changes (not important component)	Total changes (important component or overall changes)
	D_3	Possible minimum cost of development	Possible maximum cost of development
I	I_1	Possible minimum sales	Possible maximum sales
	I_2	Possible minimum B/C of development *	Possible maximum B/C of development *
T	-	Completely not conform to trend	Completely conform to trend
C	C_1	Possible maximum joint market-share of competitor	Possible minimum joint market-share of competitor
	C_2	Possible minimum price ratio of competitor to product **	Possible maximum price ratio of competitor to product **
	C_3	Possible minimum of conformity-to-trend ratio of product to competitor ***	Possible maximum of conformity-to-trend ratio of product to competitor ***
K	K_1	Possible min. ad volume ratio of product to competitor	Possible max. ad volume ratio of product to competitor
	K_2	After-sales services are rarely available	After-sales services are available at every region
S	S_1	Possible minimum GDP per capita	Possible maximum GDP per capita
	S_2	The reciprocal of possible maximum population density	The reciprocal of possible minimum population density
	S_3	The reciprocal of possible maximum vehicle density	The reciprocal of possible minimum vehicle density
	S_4	Possible minimum percentage of non-poor population	Possible maximum percentage of non-poor population
P	-	Worst political condition (general election, chaos, etc.)	Best political condition

* = B is sales, C is investment cost or depreciation of investment of the product development
** = in case it is difficult to judge, use 0.5 for the minimum and 1 for the maximum
*** = in case it is difficult to judge, use 0.25 for the minimum and 1.5 for the maximum

5. Model benefit

The model developed in this study can be used to help companies to make a plan to anticipate the future market response. A radar chart as presented in an example in Fig. 4 can be utilized to shoot the weakest factor in a planning period so that the company can prioritize the action to maintain or improve the future market response.

In the example presented in Fig. 4, the weakest factors at year 2005 are *S*, *K*, and *C*. *S* is an external factor and the company could not control it. *K* and *C* are internal factors so that the company could take action to improve their status. *K* can be improved for example by increasing the advertisement volume or by innovation of the method of marketing. *C* can be increased by conducting product development. At year 2009, the weakest factor moves to *P*. However, company can do no action because that factor is externally driven. The second weakest factor is *C* that can be improved by product development action as mentioned before. The three weakest factors at year 2012 from the most to the least weak are *D*, *C*, and *T* respectively. Those factors lead the company to significantly develop the product. The trend of similar products is important to be considered in order to improve the competitive power of the product at the next-next year.

As well as an action could not change the condition instantly, the change of the condition will not also be happened suddenly. Thus, a continuous monitoring on the level of every factor should be performed to take the right actions.

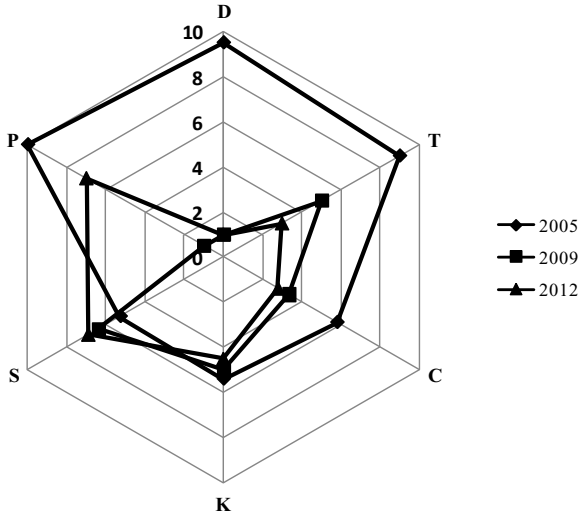

Fig. 4. Status of factors affecting the market response at year 2005, 2009, and 2012.

6. Conclusion and further work opportunity

This study examines market response of an automotive product which tends to be decline from the beginning, or in other words, a product that is in the declining stage of its life cycle. Therefore, the applicability of the result of this study is limited to the similar case. However, the phenomena that market response can be modeled as the function of product design, company income, product trend, competitor's condition, marketing effort, socio-economic condition, and political condition can be adopted as general basis to build market response model for other product type in different life cycle stage.

Furthermore, in order to get more general model, this study could be extended to some aspects. First, the case involved in the study could be widened to cover many type of non-commodity product. Second, the study could be continued to covers all stages in the product life cycle.

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