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Building forecasting model of automobile industry based on Grey theory: A case study of Nissan motor corporation

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ABSTRACT

Forecasting a future development is always an important issue found in various fields, ranging from economics through physics to engineering. In recent years, the grey forecasting model has achieved good prediction accuracy with limited data and has been widely used in various research fields. This study presents a review of theory on Grey system theory to form the basis for forecasting the performance of automobile companies in the next few years. Grey Theory is truly a multidisciplinary and generic theory that deals with systems which characterized with poor information or which information is lacking. This study based on Grey system theory to forecast the Net sales which data are few and the behaviors of systems are unknown. Data used in this study are obtained from the annual report 2014 of the Nissan Motor Corporation for the forecasting of net sales in the4 coming years (i.e., 2014 to 2017). For the current research, in the first phase, the original predicted values of net sales are obtained individually by the GM (1, 1) and DGM (1, 1) model. Secondly, the forecasting results of two models are compared by Mean Absolute Percentage Error (MAPE). Interestingly, this study found that the accuracy levels of these two models are much the same with the excellent ability. Finally, by referring the expectations and forecasting of sales activities of Nissan Motor Corporation in different market in the world, this study would like to compare and report the analysis of sales and marketing activities through this current study. In the meantime, this study also shows the research implications and managerial applications by doing the task of forecasting sales and net sales.

1. Introduction

Automobile industry is defined as the business of producing and selling vehicles (Kung and Chang, 2004). It consists largely of a wide range of companies and organizations involved in the process of design, developement, manufacturing, marketing and so on. Moreover, the automobile industry is also evaluated as one of the key driver of economic sectors by revenue because it has positively encouraged the development of an extensive road system, supported the growth of suburbs and shopping centers around major cities, and played a key role in the growth of ancillary industries (Kulkarni and Rao, 2014). In addition, the large number of people currently employed the industry has made it a key determinant of economic growth as well.Automotive also contributes significantly to several important dimensions of nation building, such as generating government revenue, creating economic development, encouraging people development, and innovation (Fig. 1). Consequently, the automotive sector impacts global economic activity in a variety of ways and also affected by the global economic situation (NAR, 2013).

About the history of automobile industry, it began in the 1890s with hundreds of manufacturers that pioneered the horseless carriage (Genre, 2014). After 1945, the U.S auto industry has a lot of influence over the global market with 83% of all sales, but as Europe and Japan rebuilt their economies, their auto industries grew and the U.S. share dropped to about 25%. Throughout the 1990s, the automotive industry in Japan rapidly increased and over took the U.S. as the production leader with over million cars per year and significant exports (Liker et al., 1996). Japan is now currently the third largest automotive producer in the world with an annual production of 9.9 million automobiles in 2012 and Japanese investments also give a great

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help to support the development of other auto industry in many countries throughout the last few decades (BBC, 2012).

Nissan Motor Company Ltd is a Japanese multinational automobile manufacturer headquartered in Nishiku, Yokohama, Japan. Nissan was the sixth largest automaker in the world behind Toyota, General Motors, Volkswagen Group, Hyundai Motor Group, and Ford in 2013 and also the leading Japanese brand in China, Russia and Mexico. Since 1999, Nissan has a clear vision for the future for forming the Renault–Nissan Alliance that both aim at providing unique and innovative automotive product and services that deliver superior measurable values to all stakeholders in alliance with Renault. Today, Nissan manufactures vehicles in 20 countries of the world and provides products and services in more than 160 countries with two business segments including automobile segment and sales financing segment.

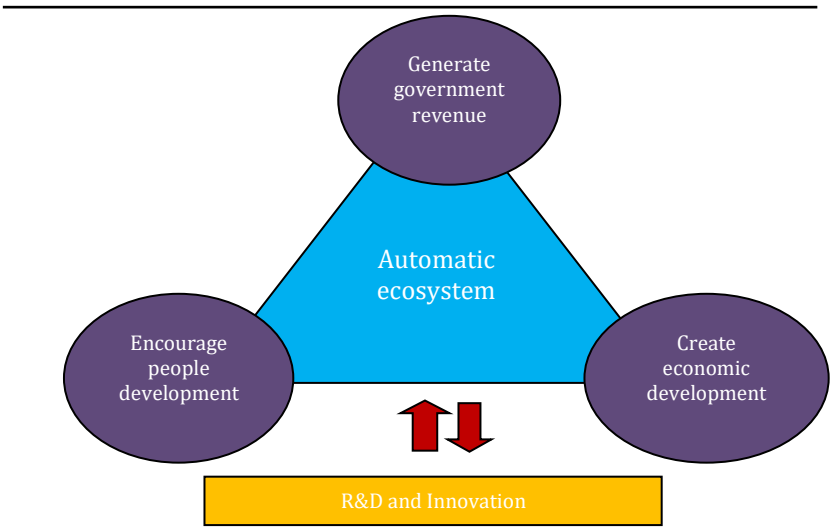


Fig. 1: The auto industry's contribution to the economy (NAR, 2013)

According to Nissan's annual report 2014, the global demand for Nissan's sales volume rose from 5.6%and company's global market share reached as 6.2%.Net sales of Nissan Motor Company reach 11,434.8 billion yen in the year 2013. Operating profit was 605.7 billion yen, for a profit margin of 5.3%.

Nissan is the top 10 of the world's largest automaker with main product models such as Nissan Sedan, Sport and SUV, Minivan/Wagon, Compact, LCVs and Nissan electric vehicles. However, the company is facing several significant challenges: (1) how to maintain their competitiveness in fierce markets, (2) how to expand scales and produce high quality products with low-cost and protect environment which can bring more advantages for the company and the core value of life.

Sales forecasting is also an important part of starting a new business (Previts et al., 1994). Almost all new businesses need loans or start-up capital to purchase what are necessary to get off the ground such as office rental, equipment, inventory, etc. Particularly in getting the loan, an entrepreneur must demonstrate his business plan or the valuable guaranty or mortgage. As business grows, sales forecasts continue to be an important measurement of company's ability (Doyle, 2000). Wall Street measures the success of a company by how well it meets its quarterly sales forecasts (Jensen, 2001). If a company predicts robust sales in the fourth quarter but only earns half that amount, it's a sign to stockholders that not only is the company performing poorly, but management is clueless (Nguyen and Tran, 2015; 2016). When attracting new investors to a private company, sales forecasts can be used to predict the potential return on investment (Barber and Odean, 2007).

Sales forecasting is particularly important because its outcome affects many functions in the organization (Armstrong et al., 2000). Based on the forecasting results, business operations may respond lost orders, inadequate service and poorly utilized production resources in the short term; or managers may easily adapt with financial issue and make right market decisions so that the organization may be brought into question in the long-run (Kotsialos et al., 2005). In fact, most conventional sales forecasting methods used either factors or time series data to determine the sales prediction (Nguyen and Tran, 2017a; Nguyen et al., 2015; Wang et al., 2015). Grey system theory, a new research method which was formulated by Deng (1982) to study the problems of less data, poor information and uncertainty (Liu et al., 2004) is used forecast sales in this study. It is to make positive analysis about the increasing of the net sales of Nissan Motor Company from 2008 to 2013, which are used for the prediction of the 4 coming years, 2014 to 2017.

The purpose of this research is to build a Grey model which fits into *net sales* and to see its feasibility and how it works in forecasting net sales. Collectively, there is some empirical evidence

indicating that the subjective techniques popular for all types of forecasting situations are effective. Among the statistical forecasting approaches, exponential smoothing has recently been gaining in popularity (Nguyen and Tran, 2017b; Tran, 2016; Tran, 2017; Trinh and Tran, 2017). In particular, in recent years, Grey system theory have been applied to many other areas like during the past several years, the grey system theory has been widely used to explore in various fields and demonstrated satisfactory results (Kayacan et al., 2010).

In this paper, the author are motivated by going deeply to take the Nissan's financial statements and collect this company's net sales data from 2008 to 2013 and use as these data set to build, testing and compare the accuracy of forecasting models.

Specifically, in this section, the practical process of twogrey prediction models: GM (1, 1) and DGM (1, 1), and the net sales data from 2008 to 2013 is employed to set up and the expected forecasting results of net sales data from 2014 to 2017 are used to test and compare model accuracy of these two forecasting models.The results of this study can be referred to Nissan's forecast net sales for the future year period 2014-2017. The author also wants to have a past-future vision about the changes of net sales so that this would contribute to Nissan's development in long-term because one of the main reasons for this objective is that there are a few prediction methods applied to the numbers in economic indicators.

2. Methodology

2.1. The basic of Grey system

In Grey systems theory, a system can be defined by colors. For instance, a system can be called as a black box if its internal characteristics or mathematical equations that describe its dynamics are completely unknown. On the other hand if the description of the system is, completely known, it can be named as a white system.

Similarly, a system that has both known and unknown information is defined as a grey system. In real life, every system can be considered as a grey system because there are always some uncertainties. There are many situations in which the difficulty of incomplete or insufficient information is faced. These factors are generally random and make it difficult to obtain an accurate model.

Grey models predict the future values of a time series based only on a set of the most recent data depending on the window size of the predictor. It is assumed that all data values to be used in grey models are positive, and the sampling frequency of the time series is fixed.

2.2. Generations and model of Grey sequences

The most frequently used grey forecasting model is GM (1, 1) due to its computational efficiency. In this study, GM (1, 1), a time series forecasting model, was used to get the predicting results. This model contained a group of deferential equations adapted for parameter variance. Its deference equations have structures that vary with time rather than being general deference equations. It is suggested that the potency of the series must be more than four to construct the GM (1, 1). In addition, the data must be taken at equal intervals and in consecutive order without bypassing any data. The grey model prediction is a local curve fitting extrapolation scheme. At least four data sets are required by the predictor to obtain a reasonably accurate prediction (Chung et al., 2010; Deng, 1989).

Discrete Grey Model (DGM) is adopted to do the task of forecasting employment by industry, which is shown step-by-step as below:

$$x^{(1)}(k+1) = \beta_1 x^{(1)} \beta_2$$

is written as a basic of discrete grey model (DGM) or a discretization of the GM (1, 1) model.

2.3. Calculating process of Grey system theory

The basic mathematical model of Grey system GM (1, 1) and DGM (1, 1) is the foundation to make progress for the program of grey forecasting. This can handle such kinds of data like data of a single point, set up a forecasting model automatically, dynamically output and display curvilinear figure of the model, forecast all parameters and model equation error terms, and predict future value of one time series or some time series based on the predicted time series set. Following is the Flow chart of Grey System Theory (Fig. 2).

The Net Sales of Nissan Motor Corporation from 2008 to 2013 is listed in the Table 1. From the Table 1 it can be seen that the Net Sales is increased from 8,436,974 (2008) to 10,482,000 (2013) that proving the dramatic change in the number.

In this section, the practical process of grey prediction models: GM (1, 1) and DGM (1, 1) The Net sales data from 2008 to 2014 is employed to set up the four grey prediction models and the net sales data from 2015 to 2017 is used as data set to compare model accuracy.

2.4. Calculation and applying GM (1, 1)

This paper is about to apply the grey prediction model GM (1, 1) as the study focus. It precedes the prediction based on historical data of the Net sales of Nissan Company from its main website.

Firstly, take the Net sales data from the fiscal years 2008 to 2013 as example to understand how to compute in GM (1, 1) model, and then in accordance with the grey prediction method, do the calculation in the following steps:

The original series are:

$$x^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), x^{(0)}(4), x^{(0)}(5), x^{(0)}(6)\right)$$

= (8436974, 7517277, 8773093, 9409025, 8737320, 10482520),

and then use the least square method to find a and b

$[a,b]^T = (B^TB)^{-1}B^TY$; $a = -0.063877029, b = 7077501.118$

Use the two coefficients a and b to generate the whitening equation of the prediction model. Derive the predicted value of the original series according to the accumulated generating operation and obtain Table 2.

Table 1: The Nissan's Net sales in fiscal years from 2008-2014 (NAR, 2014)

Years	Net sales (Millions of Yen)
2008	8,436,974
2009	7,517,277
2010	8,773,093
2011	9,409,025
2012	8,737,320
2013	10,482,520
2014	--

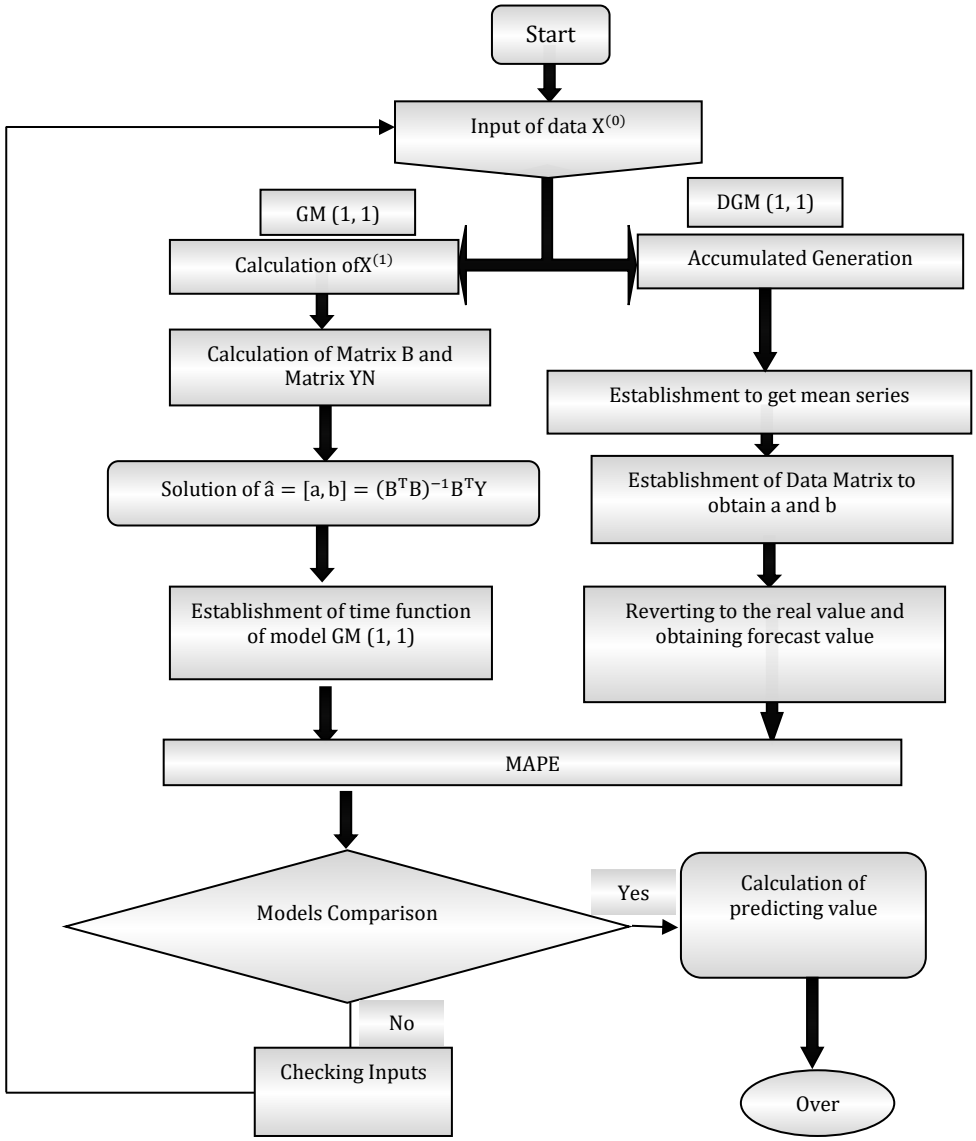


Fig. 2: The flow chart of the calculation process

Table 2: The predicted value of the original series

Year	k value	Actual value	Forecasted value	Residual error (F-A)
2008	1	8,436,974	8,436,974	0
2009	2	7,517,277	7,864,951	347,674
2010	3	8,773,093	8,383,733	(389,360)
2011	4	9,409,025	8,936,735	(472,290)
2012	6	8,737,320	9,526,214	788,894
2013	7	10,482,520	10,154,575	(327,945)
2014	8	--	10,824,385	--
2015	9	--	11,538,375	--
2016	10	--	12,299,461	--
2017	11	--	13,110,750	--

After next, this paper uses the Matlab with the forecasting method on Grey system model.

2.5. Calculation and applying DGM (1, 1)

$x^{(1)}(k+1) = \beta_1 x^{(1)}\beta_2$ is written as a basic of discrete grey model (DGM) or a discretization of the GM (1, 1) model. The overall procedure to obtain all details about Discrete Grey models can be referred to a full book about Grey Systems Theory written by Lin and Liu (2010), which is mentioned in previous section.

Finally, the calculations with the parameters of DGM (1, 1) are illustrated below: the calculation is with the following parameters: $\beta_1 = 10655$; $\beta_2 = 7324371.7455$, so the equation $x^{(0)}(1)(\beta_1 - 1) + \beta_2 = 7877310.7322$.

With the above developed parameters, we also calculated to have the precious forecasting results which are illustrated in tables and figures concisely. Table 3 shows the true values and forecasting results by DGM (1, 1) model for Net Sales of Nissan for the next four years (2014-2017).

Table 3: The forecasting results for Net sales by DGM (1, 1)

Year	k value	Actual value	Forecasted value	Residual error (F-A)
2008	1	8,436,974	8436974	0.00
2009	2	7,517,277	7877310.73	360033.73
2010	3	8,773,093	8393570.73	(379522.27)
2011	4	9,409,025	8943665.18	(465359.82)
2012	6	8,737,320	9529811.48	792491.48
2013	7	10,482,520	10154372.4	(328147.59)
2014	8	--	10819865.6	--
2015	9	--	11528973.5	--
2016	10	--	12284554.7	--
2017	11	--	13089654.9	--

3. Applicable case results

3.1. Forecasting analysis

3.1.1. Recent productivity and sales results of Nissan

In Japan, Nissan out-performed the market with unit sales up 11.1% to 719,000, representing a market share of 12.6%. In China, Nissan took over the overall market growth was up 14.0%, while its sale volume increased 17.2% (1.27 million units) and the demand for Qashqai, all-new Sylphy, along with new models from Venucia and Infiniti, contributed to this out-performed. In North America, Nissan sales volume increased by 13.0% (1.29 million units) demonstrated a strong interest for the new Rogue and the Altima. In Canada, Nissan successfully won the market with net sales increased from 20.9% to 96,000 units. In Mexico, Nissan occupied the top one position with a market share of 24.9% and unit sales of 265,000. In Russia, Nissan's sales rose 2.4% to 676,000 units, compared with a 1.8% rise in the overall market. Nissan's market share was steady at 3.9%. In Asia and Latin America sales declined 17.8%and 16.1% respectively.

In the period of fiscal 2014, Nissan expected to improve retail volumes significantly with 5.65 million units and to rise by 1.6% for total industry volumes.

3.1.2. Factors affecting sales

- The Quantitative Factors:

1. The influence of price and quantity of goods has the following formula:
   Revenue from sales of goods = Number of unit x Unit price
2. The impact of factors of workforce and labor productivity to revenues formula:
   Revenue = Number of employees x Average labor productivity
3. The relationship between the total revenue and the speed of turnover which is determined by the formula:
   Revenue = Speed of turnover x Average capital

- The qualitative factors:

There are two types of qualitative factors affecting sales: Objective factors and subjective factors.

(1) Objective factor:
Market
Economic-social policy
Political environment and law
Environment-culture-social
(2) Subjective factors:
Business items
Reputation, brand and product
System organization and management lightweight
Facilities and capital of the business
Employers

3.2. Results analysis

With this advanced characteristic, GM (1, 1) and DGM (1, 1) forecasting model is able to achieve fine prediction results (Table 4 and Fig. 3). This research uses the GM (1, 1) and DGM (1, 1) for the comparison of two forecasting models. The Net Sales of Nissan Motor Corporation from 2008 to 2013 is adopted to demonstrate the effectiveness and practicability of these two models. In order to verify the accuracy of GM (1, 1) and DGM (1, 1), the author need some specific methods like accuracy inspection analysis of forecasting ability for measuring and controlling it.

Forecasts always exists errors and they can be classified as bias errors and random errors. Bias errors caused by neglecting or not accurately estimating patterns of demands, such as trend, seasonal, or cyclical patterns, while random errors results from unpredictable factors that cause the forecast to deviate from the actual demand. Forecasting analysts have made a lot of efforts to minimize the effects of bias and random errors by selecting appropriate forecasting models.

3.2.1. Accuracy inspection analysis of forecasting ability

Previous studies have presented numerous methods for evaluating forecasting accuracy. Mean Absolute Percentage Error (MAPE) is often used to measure forecasting accuracy (Hyndman and Koehler, 2006). According to Mui and Chu (1993), MAPE has become popular as a performance measure in forecasting in previous studies. One of

the major reasons for its popularity is that it is easy to interpret and understand (Nguyen et al., 2015).

Table 4: Model values, real values and error of the forecast model (Millions of Yen)

Year	Real value	GM (1,1)		DGM (1,1)	
		Model value	Error (%)	Model value	Error (%)
2008	8,436,974	8,436,974.0	0.00%	8,436,974.0	0.00%
2009	7,517,277	7,864,950.7	4.62%	7,877,310.7	4.79%
2010	8,773,093	8,383,733.2	4.44%	8,393,570.7	4.33%
2011	9,409,025	8,936,735.2	5.02%	8,943,665.2	4.95%
2012	8,737,320	9,526,213.9	9.03%	9,529,811.5	9.07%
2013	10,482,520	10,154,575.4	3.13%	10,154,372.4	3.13%

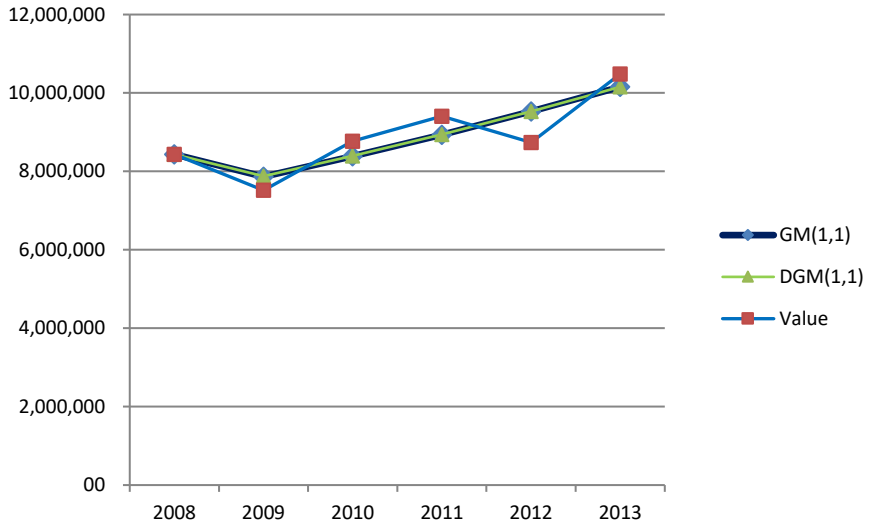


Fig. 3: Real values and models values (Millions of Yen)

In some forecasting problems, minimizing MAPE may be a good alternative to minimizing mean squared error (MSE). This is particularly valid in the applied studies of finance, economics and business management. In the book of Stevenson (2015), it stated out clearly that MAPE is the average absolute percent error which measures of accuracy in a fitted time series value in statistics, specifically trending MAPE is measure of accuracy in a fitted time series value in statistics, specifically trending. It usually expresses accuracy as a percentage. Smaller MAPE value indicates better forecasting ability (Table 5).

$$MAPE = \frac{1}{n}[\sum_{i=1}^{n}\left|\frac{A_i - F_i}{A_i}\right| \times 100],$$

multiplying by 100 makes it a percentage error.

Using the data from Table 1: The original and prediction values and errors and AGO (2009~2012) in previous section, MAPE as Table 6.

Table 5: Classes of reliability for MAPE

MAPE	Grade
<10%	Highly accurate forecasting
10%-20%	Good forecasting
20%-50%	Reasonable forecasting
>50%	Inaccurate forecasting

From Table 6, it can be seen that the errors of the GM (1, 1) model are small, and the DGM (1, 1) is also small. From that, we can know the MAPE of the two models which are 3.7941% of GM(1, 1), and 3.7912% of DGM(1, 1), interpreted very excellent forecasting ability.

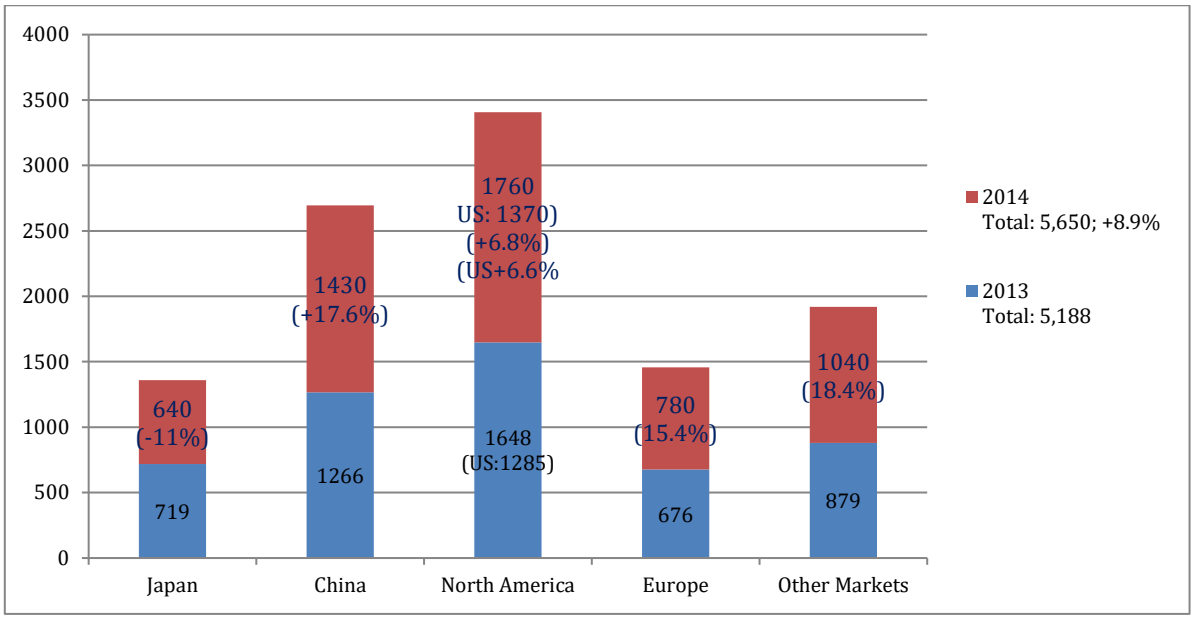
Table 6: Error analytical results for the different forecast model

Year	GM (1,1)	DGM (1,1)
	Error (%)	Error (%)
2008	0.00%	0.00%
2009	4.62%	4.79%
2010	4.44%	4.33%
2011	5.02%	4.95%
2012	9.03%	9.07%
2013	3.13%	3.13%
MAPE	**3.7941%**	**3.7912%**

3.2.2. Forecasting net sales of Nissan motor corporation

Based on the above analysis, the GM (1, 1) and DGM (1, 1) models appeal to be intrinsically excellent because it has merits of both simplicity of application and high forecasting precision, thus we use both GM (1, 1) and DGM (1, 1) model to forecast Net Sales in Nissan Motor Corporation for 2014 to 2017.

Together with the forecasting results for the Net Sales, the current and expected sales of cars (in thousands) are also presented in Fig. 4. This apparently, Nissan expect and forecasting the cars sold the different markets increasing. In details, the company forecast to sell 5,650,000 cars in 2014 (have not announce its sale in 2014) increasing 8.9% compared with 2013. All the markets are forecasted to increase except Japan – at 640,000 cars in 2014 decreasing with 719,000 cars in 2013 (as discussed earlier), in which only in China its sales are expected to increase at 17.6% in 2014 at 1,430,000 cars.



Unit: Thousands of Cars; Source: Data adapted from Nissan motor company

Fig. 4: The current and expected sales of cars

Thus, this study would like to present the results of Net Sales forecasting of Nissan Motor Corporation for 2014 are: 10,824,38.5 (of GM (1, 1) and 10,819,865.6 (of DGM (1, 1) millions of Yen. With these results, the Company can make planning producing for 2014. Though there is still much change in the context of economic situation, the difficult macroeconomic one as in 2013 and 2014 has occurred. Evolution of the economic crisis makes goods not easy to be sold. Despite that, Nissan Motor Corporation is still one of the profitable businesses in the manufacturing industry. Annual net sales growth remains high and stable, this is one positive sign (Table 7). One of the advantages of the enterprise is to produce and sell goods where the demand is still high in society. Table 8 also shows that the Net Sales are still continued to rise in the 4 years later at the rapid stage.

Table 7: Annual net sales (Unit: Millions of yen)

Financial Highlights	2013	2012	2011	2010	2009	2008
	03/2014	03/2013	03/2012	03/2011	03/2010	03/2009
Net sales	10,482,520	8,737,320	9,409,026	8,773,093	7,517,277	8,436,974
Ordinary income	527,189	504,421	535,090	537,814	207,747	--
Net income	389,034	341,117	341,433	319,221	42,390	--
Comprehensive income	796,533	721,860	290,600	189,198	--	--
Net assets	4,671,528	4,036,030	3,449,997	3,273,783	3,015,105	--
Total assets	14,703,403	12,442,337	11,072,053	10,736,693	10,214,820	--
Net assets per share	1,035.06	890.38	750.77	703.16	663.9	--
Basic net income per share	92.82	81.39	81.67	76.44	10.4	--
Cash flows from operating activities	728,123	412,257	696,297	667,502	1,177,226	--
Cash flows from investing activities	-1,080,416	-838,047	-685,053	-331,118	-496,532	--
Cash flows from financing activities	396,925	433,817	-308,457	110,575	-663,989	--
Cash and cash equivalents at end of fiscal year	832,716	711,901	840,871	1,153,453	761,495	--

Table 8: Forecasted by GM (1, 1) and DGM (1, 1) for Nissan's Net sales (Millions of Yen)

Year	GM (1, 1)	DGM (1, 1)
	Model value	Model value
2014	10,824,384.5	10,819,865.6
2015	11,538,375.1	11,528,973.5
2016	12,299,461.4	12,284,554.7
2017	13,110,750.0	13,089,654.9

4. Conclusion

In 2012, despite the world economic recession and also motor industry facing many difficulties, but Nissan still had sparkling results with spectacular growth. In addition to strong international markets growth, Nissan products have been available in all countries around the world. More interestingly, under the pressure of fierce competition from the motor corporations in the world as well as the rise of domestic companies e.g., Honda, Toyota; Nissan has made an impressive breakthrough during the last 3 years as one of the leading motor companies in the world.

4.1. Managerial implications

In this study, we compare the accuracy of the grey forecasting models to predict Net Sales of Nissan Motor Corporations. The grey system theory could deal with the problems with incomplete or unknown information and also the small sample, so this paper uses it.

The results show that the accuracy of GM (1, 1) and DGM (1, 1) models in forecasting values of Nissan's Net Sales are really good (MAPE is under

4%). Based on the above analysis, the GM (1, 1) and DGM (1, 1) model can deal with the job of forecasting Nissan Motor Corporation for 2014 to 2017.

To summarize, we come up with main managerial implications for this study as follows:

- *The sound basis of budgeting:* Once the sales forecast is prepared, it becomes the key factor in all operational planning throughout the company. Hence, a good forecast must be the sound basis of budgeting. Financial planning for working capital requirements, plant utilization, and other needs is based on anticipated sales. The scheduling of all production resources and facilities, such as deciding labor needs and purchasing raw materials, depends on the sales forecast. The sales forecast also plays a critical role in sales force planning. The sales forecast helps sales executives determine the budget for the department; it also influences sales quotas and compensation of salespeople.
- *Accuracy and fast forecasting based on a few data and poor information:* If the forecast is in error, the plans derived will be in error too. For example, if the managers are overly optimistic in the coming business, the organization surely suffers great losses over expenditure once the prosperous sales are not as expected. On the contrary, if the forecast is too low, it may be very hard for the firm to get the customer orders due to not being well prepared in providing what the market demands. This certainly causes the company to forgo profits and give its competitors a good chance of snatching the market share.

Obviously, correct sales forecast can play a major role in the operational success of the company. In this regard, Grey systems theory (Liu et al., 2004; Liu and Lin, 2006; Lin, 2004), proposed by Deng (1982), is a useful method to study uncertain problems with a few data and poor information. It works on uncertain systems with partially known and partially unknown information. The grey system theory enables us to describe correctly or emulate effectively systems behavior by drawing out valuable information through the generalization and development of the given partial information. GM (1, 1) is one of the most important forecasting models (Chia-Nan and Ty, 2013) in the grey systems theory. In this study, the information is historical data of the net sales announced by the Nissan Motor Cooperation from 2008 to 2013.

Tools for Business Planning, Marketing, and Management Decision Making: GM (1, 1) and DGM (1, 1) is common and an essential tool used for business planning, marketing, and general management decision making. Grey system is a projection of the expected customer demand for products or services at a specific company, for a specific time horizon, and with certain underlying assumptions. Forecasts of different kinds are often prepared at different levels of a corporate enterprise. Managers from different backgrounds and fields use forecasts for a variety of purposes, including marketing planning, resource\investment allocation, production scheduling, and labor recruitment. In some cases the uses are simply informational, but in others forecasts are the basis for major decisions like: what product lines to pursue, how much to spend on production and in what ways, how aggressively to advertise or promote the products, how best to get the products to market in order to fulfill the projected demand.

Adjusting assumptions or decisions: Grey forecasting may cause management to adjust some of its assumptions or decisions about production and marketing if the forecast indicates that: (1) the current production capacity is grossly inadequate or excessive and (2) sales and marketing efforts are inconsistent with the expected outcomes. Management therefore has the opportunity to examine a series of alternate plans for changes in resource commitments (such as plant capacity, promotional programs, and market activities), changes in prices, or changes in production scheduling. Indeed, when a company is evaluating different courses of action it may develop separate forecasts for each option in order to assess the implications of each. Forecasting may also consider how the company rates against its competitors in terms of market share, research and development, quality, pricing and sales financing policies, and overall public image. In addition, forecasters may evaluate the quality and size of the customer base to determine brand loyalty, response to promotions, economic viability, and credit worthiness.

4.2. Research contributions

This study applied the advanced method-Grey model for forecasting particular data in a specific case of Nissan Motor Corporation. The results derived from the GM (1, 1) and DGM (1, 1) model help enterprises to figure out the target in the near future are shown with low tolerance proven by Mean Absolute Percent Error (MAPE). This indicates that the grey forecasting model performs well with poor information, which is very useful as a contribution for studies that cannot collect complete data. Another contribution in this study is to suggest the greater use of Grey theory in the research related to the adoption of manufacturing and selling goods applications which relies on actual data.

4.3. Limitations and future research

While GM (1, 1) and DGM (1, 1) are theoretically very appealing, language obstacles and ambiguous assumptions, prerequisites and restrictions of the model have hampered its widespread adoption. To make the model more reliable and robust, additional theoretical research into the foundations of the model are required, including clarification of constrains and prerequisites of the model. "Predictions are difficult especially about the future," the Danish physicist and Nobel laureate Niels Bohr

(1885-1962) once said ironically. In principle, it is impossible to forecast the future. However, certain methods can provide scenarios of the future and estimate their likelihood based on current circumstances and knowledge. As such, they can provide useful planning for information decision making.

In the current research, the forecast is confined to a specific company and is based on each product line, from which managers may make the decision more accurately for enterprise. However, it is still not clear whether this model can be referred to other products or industry. To generalize the research, more different industries can be assessed by proposed model in the future research.

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