CHAPTER – 2

A STUDY ON SHARE MARKET SITUATION: FUZZY APPROACH*

* “A Study on Share Market Situation (Investment): Fuzzy Approach”,
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A STUDY ON SHARE MARKET SITUATION: FUZZY APPROACH

Abstract

Investment in the share market is a very risky factor and at the same time it is the only way to get high returns. The literature survey and data collection in Indian Share Market reveals that, if we invest an amount in a bank and in a share market, the return on investment is some times even more than 100 times what we earn through bank investment. Therefore, proper identification of time is important while investing in a share market. In this chapter, the fuzzy logic approach is used to analyze the share market situation. The proposed method not only quantifies the index value but also compares the factors that influence it.

Relatively less of research on quantifying the usage of share market investment has found its way into actual practice because of the reason that the analyzers are bound to deal with imprecise objectives and constraints, which are mainly due to insufficient data and imperfect methods that have been followed. The fuzzy weight method is employed to overcome the above problems on the best possible method. Del Grande’s levels are obtained by way of attaining the degree of acquisition of various share market situation and the level of qualifying can be calculated through Van Hiele levels. These two levels are the basis for evaluating share market situation to invest money in a best possible manner and the proposed method gives the best solution because of combining qualification and quantification in a single platform.
2.1 Introduction

The instability of share price indices is an important characteristic of share markets for investors, speculators and forecasters. Stable share prices series provide a sounder basis for the purposes of prediction and for the portfolio choices of agents. This applies particularly to emerging markets, such as the Indian Share Markets which are the focus of so much international investment attention at present.

In the financial industry, there are three main approaches to investment: the fundamental approach, where strategies are based on fundamental economic principles, the technical analysis approach, where strategies are based on past prices behavior, and the mathematical approach where strategies are based on mathematical models and studies. The main advantage of technical analysis is that it avoids model specification, and thus calibration problems, misspecification risks, etc.

On the other hand, technical analysis techniques have limited theoretical justifications, and therefore none can assert that they are risk-less, or even efficient. Consider an unstable financial economy. It is impossible to specify and calibrate models which can capture all the sources of instability during a long time interval. Thus it is natural to compare the performances obtained by using erroneously calibrated mathematical models and the performances obtained by technical analysis techniques.
The BSE SENSEX (SENSitive IndEX) is not only scientifically designed but also based on globally accepted construction and review methodology. First compiled in 1986, SENSEX is a basket of 30 constituent stocks representing a sample of large, liquid and representative companies. The base year of SENSEX is 1978-79 and the base value is 100. The index is widely reported in both domestic and international markets through print as well as electronic media.

2.1.1 Technical Analysis of Indian stock market BSE Sensex Index

The Index was initially calculated on the basis of "Full Market Capitalization" methodology but was later shifted to the free-float methodology with effect from September 1, 2003. The "Free-float Market Capitalization" methodology of index construction is regarded as an industry’s best practice globally. All major index providers like MSCI, FTSE, STOXX, S&P and Dow Jones use the Free-float methodology.

Due to its wide acceptance amongst the Indian investors; SENSEX is regarded to be the pulse of the Indian stock market. As the oldest index in the country, it provides the time series data over a fairly long period of time (From 1979 onwards). SENSEX the small wonder has over the years become one of the most prominent brands in the country.

2.1.2 Classification of Factors Affecting Share Market Investment

From the available information, we classify the following reasons due to which the Sensex index is either increased or decreased.
TYPE – I: Foreign Institutional Investors (FII)

Foreign capital flows have come to be acknowledged as one of the important sources of funds for economies that would like to grow at a rate higher than what their domestic savers can support. The Investment by FIIs have been registering a steady growth since the opening of the Indian capital markets in September 1992. That this trend has come to stay is evident from the fact that the FIIs investment in equity and debt markets amounted to Rs.130 billion in the first quarter of calendar 2004, nearly 447% higher than Rs.24 billion in the corresponding period of calendar 2003. Equity investments by FIIs amounted to Rs.112 billion between January and March 2004 as compared with Rs.17 billion in the corresponding period last year. The equity investment by FIIs in the first quarter of calendar 2004 are close to 50% of the total equity investments worth Rs.244 billion made in the year 2003.

In 1991 India was again hit by a very serious political and economic crisis compared to that of 1966. Foreign exchange reserves decreased to a level which is sufficient for only two weeks of imports and India faced a debt crisis. Then India introduced a New Economic policy guided by the IMF and the World Bank. The main features of the New Economic policy consisted of stabilization with deregulation, liberalization, privatization and globalization.

Though the FIIs flows to India have been almost positive, they have also been negative during the periods of external shock or a domestic political uncertainty. For example, the literature survey elaborates that the FIIs flows turned negative in September 2001 following the 9/11 terrorist attacks. Another
example was nuclear tests in May 1998. With the help of FIIs Investment the foreign Exchanges reserves increased rapidly.

Oil price is one of the main factors affecting Indian economy as well as Indian stock markets. The price of oil going forward, we cannot control the rupee depreciation. We can observe the last few years some kind of stable equilibrium between the rupee and the dollar has been achieved and, while there clearly will be some volatility, dramatic changes in the exchange reserves are unlikely. The probability of an exchange rate shock exacerbating the impact of high oil prices is relatively low and India is not exposed to price risks to a greater extent than the world economy.

**TYPE II: Foreign Exchange Reserve (FER)**

India's capital account liberalization measures have been largely effective. Among other factors, suitable policy measures in respect of the external sector insulated India from the 1997 Asian crisis. We have moved forward gradually towards Capital Account Convertibility with a broad reform agenda that encompasses trade, competition, reform of the financial system and industrial restructuring.

As evident from various economic indicators, the liberalization process that has been underway for some time has created a more competitive environment for Indian industry than that existed earlier. Consequently, the Indian companies have upgraded their technology and expanded to more
efficient scales of production and refocused their activities to areas of competence. Increasingly, Indian companies are looking to become global players. Reform measures in the external sector, including dismantling of exchange control have been a contributor to this development. We would continue to participate actively in the process of economic and financial globalization, to accelerate domestic economic reforms and to continue with our firm commitment to liberalization so as to serve the needs of economic growth and development of the country. An increasingly liberalizing foreign exchange regulatory regime will be an essential ingredient of this vision.

As per newspaper reports (The Hindu, 2004) the reserves had crossed US $ 100 billion mark and continued to head upwards. By the end of fiscal year 2001-02, the reserves had exceeded 12 months import cover. Nevertheless, it is important to note, that around 30 per cent of these deposits comprised of NRI funds, which was attracted by both higher Indian relative interest rates, and full capital account convertibility for NRIs in the post-2002 changes. In addition there are annual flows of remittances between US $10 billion to US$15 billion, which might be affected by a change in sentiment, which could occur as the global interest rate regime changes and as the perception of risk of depreciation of the Indian rupee increases. Bank inflows have also increased mainly driven by foreign banks. This could improve competition though it could also slow down improvements in NPAs of government-owned banks. Such sharp increases have made the task of managing the inflows difficult; both in terms of their sterilization and in terms of ensuring a competitive exchange rate. There is also
the risk of large outflows due to the increased perception of a depreciation of the rupee as a result of change in global interest rate. Improvements in reserves have enabled the RBI of relax to controls on resident Indians.

**TYPE III: COP (Crude Oil Prices)**

The global markets for crude oil are fairly well developed and are characterized by the presence of spot, forward, and derivatives markets. The market price responds to demand and supply perturbations arising from various influences, including any change in OPEC (Organization of Petroleum Exporting Countries) policy, or the weather pattern of any major crude consuming country. As the Middle East region has global predominance in reserves and production of crude oil, any destabilizing political developments in the region have a major impact on the price (Figure 5.1). The market also responds to threat perceptions. Oil and gas industry is the most important sector in any economy since it caters to a wide range of industries including petrochemicals, fertilizers, automobiles etc., Thanks to its importance and limited availability; it is one of the highly regulated sectors in India. This report gives a comprehensive picture of the oil and gas industry.

Government policies in India have changed considerably in the post-liberalization era, with private and foreign players getting the nod to indulge in oil exploration and production through schemes like New Exploration and Licensing Policy (Nelp) I, II and III. Hence, there is a
good scope for domestic private players and foreign players to enter into this sector.

**TYPE IV: SI (Saving Investments)** indicates gross domestic savings and is directly proportional to investments in stock markets.

One of the prerequisites of putting India on a high growth path is a substantial rise in domestic savings. This will require tighter fiscal policies and strong structural reforms, including liberalization of financial markets.

India's saving rate is relatively high, compared to that of other countries. Historically, domestic savings has been dominated by household saving in physical assets. However, the recent increase in saving has been driven mainly by financial household savings, partly reflecting a continuing expansion of financial institutions' branch networks into rural areas and, more recently, the increasing availability of alternative investment opportunities. Private corporate saving has also shown a steady increase over the last twenty years, although it remains below 5 percent of GDP. Public saving weakened in the early 1990s to reach a low of 0.5 percent of GDP in 1993/94, which a significant reduction is compared with the levels of 45 percent of GDP seen in the early 1980s.

**TYPE V: GDS (Gross Domestic Savings)** indicates the purchasing capacity of Indians and also the investments in stock markets.
TYPE VI: PCI (Per Capita Income) indicates the investments and purchasing capacity of the Individuals and development of the Indian economy in the context of world economy.

Per capita income is defined as total personal income divided by total population. It is the broadest statistical measure of well-being of the country. Changes in real per capita income indicate trends in a country’s standard of living, or the material security measured by the availability of resources to an individual, family, or society. Real per capita income tends to follow the business cycle, rising in the peaks and falling in the troughs. It can also be used to measure the amount of funds a country is eligible to receive from certain grant making organizations.

TYPE VII: MO (Monsoons) is the main factor affecting Indian share markets and Indian economy because most of the Indians mainly depend on agricultural incomes. 60% of population in India, directly or indirectly depends on agriculture for its livelihood. The monsoon is crucial to India’s economic growth as agriculture contributes 25% to the GDP. With only a third of the country irrigated, Indian agriculture depends heavily on monsoons. GDP growth decelerates to sub 5% levels in years of decline in agriculture, while good agricultural years have enabled 6.5% + growth in GDP in the past.

TYPE VIII: PPI (Policy and Political Impact) after the year 1991 Indian Government Policy is favorable for FII's and Indian stock Markets.
Market-oriented economic reforms in India began in 1991. With the removal of administrative controls on bank credit and the primary market for securities, the capital markets came to occupy a larger role in shaping resource allocation in the country. This led to a heightened interest amongst policy makers in the institutional development of security markets. The efforts towards empowering the securities market regulator (SEBI), and the first efforts towards attracting foreign portfolio investment began early in the reforms process. Almost immediately after the reforms began, there was a prominent scandal in the fixed income and equity markets, which was exposed in April 1992.

For detailed investigation of geographical structure of the people, investment period and returns on investment, etc., we make use of the Del Grande’s categories [Kauffman, 1975] to achieve the degrees / grade of investment and Van Hiele level [Saads, S. and Davis, 1997; Van Hiele, P.M, 1986] is used to obtain the order of ROI. It shows that Del Grande’s investment categories are not hierarchical. However, it is possible for a particular year to invest without following any specific order according to Del Grande’s level.

The object of this case study is to find the best period of investment with the help of Del Grande’s categories that involves the Van Hiele levels as multiple criteria. This is done by applying the weighted fuzzy similar choice (WFSC) method on the investment over a period of years, the Saads and Devis (1997) work in degrees of investment. The WFSC method is developed by Liu
and Shi (1995) and this mathematical method is used to rank the acquisition of degree of returns on investment.

2.2 Problem Formulation

To investigate the various factors affecting ISM (Investment on Share Market) given in the abstract, we take a model of Indian share market (BSE), for collecting related data. From the data collected (1991-2005), the status of each category is listed below by year wise:

<table>
<thead>
<tr>
<th>Year</th>
<th>Van Hiele level</th>
<th>FII (1)</th>
<th>FER (2)</th>
<th>CO (3)</th>
<th>SI (4)</th>
<th>GDS (5)</th>
<th>PCI (6)</th>
<th>MO (7)</th>
<th>PPI (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>V.poor</td>
<td>Poor</td>
<td>V.poor</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>1992</td>
<td>6-7</td>
<td>Satis</td>
<td>Fair</td>
<td>Fair</td>
<td>V.poor</td>
<td>Satis</td>
<td>Satis</td>
<td>Satis</td>
<td>Fair</td>
</tr>
<tr>
<td>1993</td>
<td>7</td>
<td>Fair</td>
<td>Good</td>
<td>Satis</td>
<td>Poor</td>
<td>Satis</td>
<td>Satis</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>1994</td>
<td>3</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Satis</td>
<td>Satis</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>1995</td>
<td>1</td>
<td>V.good</td>
<td>Good</td>
<td>Fair</td>
<td>V.poor</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>1996</td>
<td>5-6</td>
<td>Fair</td>
<td>Satis</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>1997</td>
<td>1-2</td>
<td>V.good</td>
<td>V.Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Good</td>
<td>Fair</td>
<td>Satis</td>
<td>Satis</td>
</tr>
<tr>
<td>1998</td>
<td>3</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Satis</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>1999</td>
<td>2</td>
<td>Good</td>
<td>V. good</td>
<td>Fair</td>
<td>Good</td>
<td>Satis</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
<td>Poor</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Satis</td>
<td>Good</td>
</tr>
<tr>
<td>2001</td>
<td>2-3</td>
<td>Satis</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>2002</td>
<td>2</td>
<td>Fair</td>
<td>V. good</td>
<td>Good</td>
<td>Good</td>
<td>Satis</td>
<td>Poor</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>2003</td>
<td>8</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Satis</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>V.good</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>2005</td>
<td>5</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table – 2.1: Degree of quantification of Del Grande’s Categories
2.2.1 Quantification of degree of acquisition: From the past 15 years data (1991-2005), the Van Hiele levels of dominating factor of situation and also the degree of actual performance of each factor, namely, Del Grande's categories are put up in Table-2.1. The procedure to find the Van Hiele levels and the Del Grande's categories are given in section 2.2.1.1.

Table-2.1 represents the various distinctive quantitative degree of acquisition of the Del Grande's categories, namely, Very Poor, Poor, Satisfactory, Fair, Good and Very Good.

The difference between the Del Grande's categories and the Van Hiele levels is analyzed below. The Del Grande's categories depend on the actualities of the various climate conditions that affect share market index, where as the Van Hiele levels describe the dominancy of the particular factor to fluctuate more on the share market index in the upwards directions.

2.2.1.1 Calculation of Del Grande's Categories:

The actualities of the various climate conditions that affect the share market index are purely imprecise, ambiguity and uncertainty in nature, because it depends on various factors, mainly FFI, FER, CO, SI, GDS, PCI, MO and PCI. Therefore it is essential to create a knowledge base through the fuzzy logic concepts. Each year the knowledge base is created in each item and depending on the data collection, each item falls into any one of the factors which are based
Based on the percentile value, the various quantitative degree of acquisition is given in table-2.1. Depending on the view and the geographical structure, the degrees are classified. The classification of degree of quantification is given in table -2.2

<table>
<thead>
<tr>
<th>Degree of Quantification</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Satisfactory</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees (Percentile)</td>
<td>&lt; 05</td>
<td>05 - 20</td>
<td>20 - 40</td>
<td>40 - 60</td>
<td>60 - 80</td>
<td>80 - 100</td>
</tr>
</tbody>
</table>

Table – 2.2: Degree of Quantification of actualities of various share market situation.

Figure-2.1 represents the Bar Diagram of the Del Grande’s acquiring categories year verses fuzzy grade.
Figure – 2.1 represents the bar diagram of the Fuzzy Grade and Year.

We can modify the given table-2.1 in the following manner. The years can be put together because they have the same Van Hiele level. From this idea, the table -2.1 can be modified as follows:
<table>
<thead>
<tr>
<th>Year</th>
<th>Van Hiele Level</th>
<th>FII (1)</th>
<th>FER (2)</th>
<th>CO (3)</th>
<th>SI (4)</th>
<th>GDS (5)</th>
<th>PCI (6)</th>
<th>MO (7)</th>
<th>PPI (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991, 1995,2004</td>
<td>1</td>
<td>P-VG-</td>
<td>P-G-</td>
<td>P-F-</td>
<td>VP-</td>
<td>P-G-</td>
<td>VP-</td>
<td>F-F-</td>
<td>F-G-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VG</td>
<td>G</td>
<td>P</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>&amp; 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>&amp; 3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
<td>P</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>F</td>
<td>F</td>
<td>G</td>
<td>S</td>
</tr>
<tr>
<td>2005</td>
<td>5</td>
<td>G</td>
<td>F</td>
<td>P</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>1996</td>
<td>5-6</td>
<td>F</td>
<td>F</td>
<td>S</td>
<td>P</td>
<td>G</td>
<td>G</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>1992,1993</td>
<td>6-7</td>
<td>S-F</td>
<td>F-G</td>
<td>F-S</td>
<td>VP-P</td>
<td>S-S</td>
<td>S-S</td>
<td>G-F</td>
<td>F-F</td>
</tr>
<tr>
<td></td>
<td>&amp; 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>8</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>S</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>G</td>
</tr>
</tbody>
</table>

Table – 2.2 Modification of Table – 2.1

We can quantify the grade / degree of each level of acquiring and domination of various investment categories in table -2.2 by representing percentile of each one with a segment graded from 0 to 100. The table – 2.3 represents the percentile
value of the grade points of each category. The grade and the fuzzy quantities are schematically given in figure -2.2.

With help of table -2.3, we can quantify the qu acquisition of the various domination of share market investment given table - 2.2. The results of quantification of table-2.2 are given below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Van Hiele Level</th>
<th>FII</th>
<th>FER</th>
<th>CO</th>
<th>SI</th>
<th>GDS</th>
<th>PCI</th>
<th>MO</th>
<th>PPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991, 1995, 2004</td>
<td>1</td>
<td>0.513</td>
<td>0.413</td>
<td>0.313</td>
<td>0.363</td>
<td>0.413</td>
<td>0.408</td>
<td>0.600</td>
<td>0.600</td>
</tr>
<tr>
<td>1997, 1999, 2002</td>
<td>1-2 &amp; 2</td>
<td>0.700</td>
<td>0.900</td>
<td>0.600</td>
<td>0.413</td>
<td>0.500</td>
<td>0.413</td>
<td>0.313</td>
<td>0.500</td>
</tr>
<tr>
<td>1994, 1998, 2001</td>
<td>2-3 &amp; 3</td>
<td>0.600</td>
<td>0.600</td>
<td>0.700</td>
<td>0.413</td>
<td>0.213</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
<td>0.125</td>
<td>0.700</td>
<td>0.500</td>
<td>0.700</td>
<td>0.500</td>
<td>0.500</td>
<td>0.700</td>
<td>0.300</td>
</tr>
<tr>
<td>2005</td>
<td>5</td>
<td>0.700</td>
<td>0.500</td>
<td>0.125</td>
<td>0.700</td>
<td>0.700</td>
<td>0.700</td>
<td>0.700</td>
<td>0.700</td>
</tr>
<tr>
<td>1996</td>
<td>5-6</td>
<td>0.500</td>
<td>0.500</td>
<td>0.300</td>
<td>0.125</td>
<td>0.700</td>
<td>0.700</td>
<td>0.125</td>
<td>0.125</td>
</tr>
<tr>
<td>1992, 1993</td>
<td>6-7 &amp; 7</td>
<td>0.400</td>
<td>0.600</td>
<td>0.400</td>
<td>0.075</td>
<td>0.300</td>
<td>0.300</td>
<td>0.600</td>
<td>0.500</td>
</tr>
<tr>
<td>2003</td>
<td>8</td>
<td>0.700</td>
<td>0.700</td>
<td>0.500</td>
<td>0.300</td>
<td>0.700</td>
<td>0.700</td>
<td>0.500</td>
<td>0.700</td>
</tr>
</tbody>
</table>
The entries of table-2.4 are now explained below. The number 0.500 is obtained by the percentile average of the middle value of fair and good level. That is 
\[
\frac{(40+60)/200 + (60+80)/200}{2} = 0.500.
\]
Likewise, we can fill the remaining entries of table -2.4.

2.3 Fuzzy Weighted Approach

The application of the Weighted Fuzzy Similar Choice Method (WFSCM) is now applied to the given share market investment problem.

Liu and Shi (1995) developed the WFSCM in order to find the “best” ranking over n-alternatives (Del Grande’s level) that involve m-criteria (Van Hiele level). The fuzzy matrix [Perdikaris S, 1996a] is developed by using the relationship between the Van Hiele level and Del Grande’s level.

Now, to evaluate the Del Grande’s categories, we find the “best” ranking of the Del Grande’s categories that involve the Van Hiele levels as multiple criteria. The final statistics will be given in table-2.4. The evaluation of best ranking among the various share market investment factors and its procedure starts now.

1. We consider the set of alternatives \( Y = \{ \text{FII, FER, CO, SI, GDS, PCI, MO, PPI} \} \). We also consider the set of multiple criteria \( X = \{ \text{Van Hiele levels, namely, from 1 to 8} \} \). The details of this information are given in table - 2.4.
2. From table -4, we choose the highest value of each row, and each of these higher values gives the better dominating level. The numbers are 0.600, 0.900, 0.700, 0.700, 0.700, 0.600 and 0.700. The first number 0.600 is the highest degree of acquisition in the first row of table -2.4. Likewise, we can get the other numbers as distributed in other rows of table –2.4.

3. Now, we define a new fuzzy matrix \( M = \{ m_{ij} \}_{8x8} \), where each row of this matrix is obtained by dividing each row of the matrix given table- 2.4 by its corresponding highest degree of acquisition given in step – 2. Finally, we take the transpose of \( M \) and denote the resultant matrix by \( M' \) is given below.

\[
M' = \begin{bmatrix}
0.855 & 0.778 & 0.857 & 0.179 & 1 & 0.714 & 0.667 & 1 \\
0.688 & 1 & 0.857 & 1 & 0.714 & 0.714 & 1 & 1 \\
0.522 & 0.667 & 1 & 0.714 & 0.179 & 0.429 & 0.667 & 0.714 \\
0.605 & 0.459 & 0.590 & 1 & 1 & 0.179 & 0.125 & 0.429 \\
0.688 & 0.556 & 0.304 & 0.714 & 1 & 1 & 0.500 & 1 \\
0.680 & 0.459 & 0.714 & 0.714 & 1 & 1 & 0.500 & 1 \\
1 & 0.348 & 0.714 & 1 & 1 & 0.179 & 1 & 0.714 \\
1 & 0.556 & 0.714 & 0.429 & 1 & 0.179 & 0.833 & 1
\end{bmatrix}
\]

4. We define another new matrix \( C = \{ c_{ij} \}_{8x8} \), where each entry of \( C \) is the difference between any pair of criteria.
For example, the number 2 in the first row of $C$ means that the criterion Van Hiele level 1 is twice important than criterion Van Hiele level 2.

Now, we can find the Largest Eigen value and the corresponding Eigen vector of the matrix $C^T$. First, to find the Characteristic equation we use the formula

$$|\lambda I_8 - C^T| = 0.$$ 

Where $I_8$ represents the unit matrix of order 8. Expanding the above equation, we get the polynomial of order 8. Solving this equation we get 8 roots, out of these $\lambda_{\text{max}}$ is the maximum Eigen value. Therefore, $\lambda_{\text{max}} = 8.288339$.

From the following simultaneous equations, we obtained the Eigen Vector for $\lambda_{\text{max}}$.

$$[\lambda I_8 - C^T][z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8]^\top = 0.$$ 

Substituting $\lambda_{\text{max}}$ in the above equation and expanding it, we get 8 equations with 8 unknowns values namely, $z_1, z_2, z_3, z_4, z_5, z_6, z_7$ and $z_8$. Solving these
equations we get the values of \( z_1, z_2, z_3, z_4, z_5, z_6, z_7, \) and \( z_8 \), and which form the Eigen Vector.

The Eigen Vector is \[ [0.071119 \ 0.098693 \ 0.143911 \ 0.214097 \ 0.319636 \ 0.474563 \ 0.696176 \ 1.000000]^{T} \] and the normalized Eigen vector is \[ [0.02356 \ 0.032699 \ 0.047681 \ 0.070935 \ 0.105903 \ 0.157234 \ 0.2306597 \ 0.3313238]^{T} \] and this normalized Eigen vector is now denoted by \( C^{*} \).

The aggregate fuzzy similar degree \( R_{j} \) over the Del Grande’s acquisition through its domination factor are found by

\[
R_{j} = M^{*} C^{*} = \begin{bmatrix}
0.0249 \\
0.0697 \\
0.0795 \\
0.0719 \\
0.0626 \\
0.1345 \\
0.2346 \\
0.3222
\end{bmatrix}
\]

The best period of share market investment is type-VIII category namely, the government policy and instability of the political situation which causes very low sensex index. This is the right period for investment (this shows less risk period). Where as when the foreign investment (Type – I) is high, automatically the index rate is very high, leading to the best time for selling the shares. Therefore, in case of investment, Type – I is very risky and unsafe position. We can also interpret
the percentage of risk factors in terms of investment, namely, type-I is 97%,
type-II is 93%, type-III is 92%, type IV is 97%, type-V is 94%, type-VI is 86%,
type-VII is 76% and type-VIII is 68%. The ranking of the various investment
categories, from very low risk period to very high risk period is specified in the
following table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Type-I</th>
<th>Type-II</th>
<th>Type-III</th>
<th>Type-IV</th>
<th>Type-V</th>
<th>Type-VI</th>
<th>Type-VII</th>
<th>Type-VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>R,</td>
<td>0.0249</td>
<td>0.0697</td>
<td>0.0795</td>
<td>0.0719</td>
<td>0.0626</td>
<td>0.1345</td>
<td>0.2346</td>
<td>0.3222</td>
</tr>
<tr>
<td>Ranking of risky period</td>
<td>VIII</td>
<td>VI</td>
<td>IV</td>
<td>V</td>
<td>VII</td>
<td>III</td>
<td>II</td>
<td>I</td>
</tr>
</tbody>
</table>

Table-2.5: The chronological ranking of risky period of investment

2.4. Conclusion

Demonstration on the use of fuzzy approach to a practical investment
problem from investment – to – return on investment of share market is a special
area of interest, which is focused much in the chapter. One can easily conclude
that information fuzziness has a significant role. In this study, the ranking
depends on both period of investment and the returns-on-investment and both are
dealt in a single platform. This is the main significance of this method.