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Research on Innovation and Strategic Risk Management in Manufacturing Firms

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(Full Paper)

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ABSTRACT

Chinese manufacturing companies in Bangladesh are committed to achieving optimal investment policy for investors in different industries. The purpose of this research is the strategic risk assessment; where the research approach involves collecting qualitative data through questionnaire survey and compute variables with programmed Rough Set Theory. Researchers have identified a set of key internal and external strategic uncertainties and also accessed the most important attributes from strategic risks. Here, Sector regulation, changing the tax law and organizational governance as the most degree of risk factors in strategic risk analysis. Overall, the focus of our research is to identify strategic risk attributes and proposed a risk assessment framework by demonstrating empirical study analysis of specific industries in Bangladesh those are directly invested by Chinese investors.

Keywords: Risk Assessment, Strategic Risks, Rough Set Theory, Manufacturing Companies.

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INTRODUCTION

Risk analysis involves risk identification, estimation, analysis, evaluation, and control. Assessing risks is an ongoing process; it typically involves an organization engaging in a rigorous analytical process to identify risks and, where possible, to quantify them and the board of directors or senior management to determine the risk tolerance, based on an assessment of the losses of the organization. Subsequent to risk identification, an assessment of the risks concerning their probability of occurrence and the extent of the adverse effect on the entire business ought to be carried out (Khan & Zsidisin, 2011). In conceptualizing different risk management approaches and their associated limitations, we have identified some important factors that need to be given special emphasis while developing a generic risk management framework. Here, in this research paper, our main focus is to identify strategic risk factors with RST mathematical theory. Primarily, we have collected the factors decision by questionnaire survey from selected companies which are invested by Chinese investors in Bangladesh.

In essence, the rough set theory design study is going to be employed to empirically ascertain the extent of such vague attributes. Rough set theory (RST), which is based on knowledge acquisition and discovery, would have a brilliant application prospect in the research topic. In many practical systems, there are various degrees of uncertainty, especially in the data collection process which often contains inaccurate and missing data. RST is a suitable mathematical tool to deal with vagueness and uncertainty (Pawlak, 1995). Considering that the research approach involves collecting qualitative data through questionnaire survey and compute variables with programmed RST theory in this study.

The research process is divided into three stages. Stage 1 involves secondary research in which literature review has been conducted to understand the state of the existing scholarly work related to the topic of interest. The deliverable of the first stage is a tentative list of indicators for strategic risk assessment. The second stage is primary research with the main objective to verify the proposed indicators and data collection. Semi-structured interviews were carried out in recent years to gather opinion and information from the industry. Altogether, 107 usable responses out of around 180 questionnaires from the Chinese company's management personnel were returned and have been analyzed and presented in this paper. In this connection, the user response rate of 62.75% from companies was considered satisfactory and representative of Chinese companies in Bangladesh. The interviewees have given information and opinion on the indicators strategic risk analysis. Then Stage 3 involves modeling by the rough set approach. Through a numerical example, RST is applied for obtaining the importance degree of each indicator in quantitative characterization, that is, to obtain the weight vector of each indicator. Finally, based on the output of the evaluation model, result in interpretation and judgment on risk mitigation as well as validations are demonstrated. The study will explore relevant strategies needed in managing national manufacturing industry growth and strategic risk assessment.

Background of the Study

An organization needs to develop an effective risk culture along with a specific risk identification and management program. Otherwise, the success of any risk management framework would be incomplete. It is found that numerous research studies

have been carried out on risk analysis and risk management. Most of them, however, have focused on particular industries such as nuclear plants, aviation, space exploration, chemical process plants and other areas where the consequence of system breakdown is considered severe or catastrophic for human beings or the environment or where the potential financial loss is significant (Seastroma *et al.,* 2004; Sadgrove, 2005). The utilization of standard risk assessment methodology in the manufacturing industry, in general, is usually limited to food and chemical process sectors. Government regulations, public demand and self-regulatory requirements associated with these industries, basically encourage and in some cases oblige them to implement certain risk management methodologies.

In contrast, lower priority has been noticed in the management of risk in the other manufacturing sectors where the risks are considered to be less than catastrophic and most studies have concentrated solely on the risks associated with safety and occupational health and hazards. These sectors are found to be less focused in their practice for risk management as a part of a self-regulatory system. Both the scarcity in the organizations is found to lack appropriate tools and techniques needed to deal with operational disturbances and their associated risks. In addition, they did not appear to have any systematic approach for self-assessment which would enable them to identify the risk determinants for their businesses academic research literature and practitioner concern supports this claim.

For the past decade, Bangladesh is struggling to achieve optimal investment policy for investors in different industries even though the country's industries are dominated by different risk factors. In order to reduce industry risks and encourages more manufacturing companies to set up and run into an efficient way, must ensure to practices of risk assessment models and way to identify the factors. Various industries or companies will set different risk coefficients or use different evaluation models because of the different tolerances of risk and the different risk attitudes. In the banking industry, for example, the variability of bank stock returns reflects the risks associated with all aspects of bank holding company activities culture to manage and control risks.

Instead of the above scenario, Chinese companies need to emphasize risk management issues to keep up stable growth; also to survive in a foreign country by controlling existing and upcoming risk. In the organization, risk management is an integral part of the decision making and control process that takes into considerations to social, political and engineering factors with relevant risk assessments (Jeynes, 2002; Neuberge, 1991) indicated that because of the different tolerances of risk and the different risk attitudes, various industries or companies will have to set different risk coefficients or use different evaluation models. Although much research has demonstrated the theory of risk management and its positive effects on business performance, there is still a lack of empirical evidence as to how the theory will be applied effectively in manufacturing organizations in the studied sectors, and how the effects occur in practice. So, a gap is prevalent between strategy formulation and strategy implementation. The research also identifies that there are substantial weaknesses in the organizations, in terms of developing a healthy risk management profile.

We attempt to fill this gap and provide empirical evidence of the means by which conceptual limitations in risk management leads to the ineffective application of traditional risk management methodologies. The fact is that significant hazards and operational disturbances are present in every manufacturing organization and an integrated approach which considers operations, employees, assets and the management approach, is necessary to discover the risks and to develop methodologies for managing them.

The Aim and Significance of Research

Investor's motivations for investing in emerging markets and determinants of investment location differ among and across the economic sectors as the importance of a sound investment climate and flow of investment in promoting economic growth in emerging countries (Sun *et al.* 2002). The climate for investment is determined by the interplay of many factors-economic, social, political, and technological -which have a bearing on the operations of a business. Risk management is a pro-active approach to identify, analyze, and manage all potential risks faced by a company. To sustain a business in today's environment, it is necessary to assess the risks faced by the organization and develop contingency plans to mitigate consequences and assure the continuation of critical processes (Pai *et al.*, 2003). Therefore the research titled is well aimed and has significance regarding Bangladesh climate index and risk management for selected companies.

The aim of the paper is to identify the risk factors and the determinants of international investment of emerging country like Bangladesh to make the investment decisions and investigate the relationship among decision factors. After that, to minimize the risk and sustainable growth of Chinese companies, we would like to formulate a risk management model. On the basis of the investigation result, it is expected to draw a model on the basis of the mathematical analytical hierarchical model. From the investors' viewpoint, the study will reveal the rationale of risk management and how best to mitigate risks in their investment. The ultimate object of risk management is to be able to mitigate risk before it occurs. However, risk can't be avoided but can only be reduced to acceptable levels. As different ownership business entity is going to investigate in this thesis paper, it is expected that the findings will be unique regarding the international research also.

Research Organization and Methodology

Consisting of the significance of the study, research organizations have been selected. The target organization is the manufacturing sector of China and Bangladesh. We have selected emerging industrial sector which is invested by Chinese

investors in Bangladesh like Fuel & Energy, Food, Textile & Spinning, Pharmaceuticals industry with collaboration from Bangladesh investors.

The study has followed the same classification as used by BoI (Board of Investment) to avoid any controversy. The total number of Chinese invested listed company at present is more than 450 in BoI. Nature of business of Banks, NBFIs, investment companies, and insurance companies are different from firms of other industries. These industries are also regulated by separate regulatory bodies and laws. Companies are randomly included in Power & Fuel, Food, Pharmaceuticals, Textile & Spinning industries are found to have wide varieties of product offerings that made them unrealistic to be included in a single industry. As to keep the risks categories in similar industries, we have also selected within the same industries when we have compared with few Bangladeshi invested in other industry's companies. We have followed the case study methods to find out more relevant risks for Chinese investors and to justify the business analysis factors.

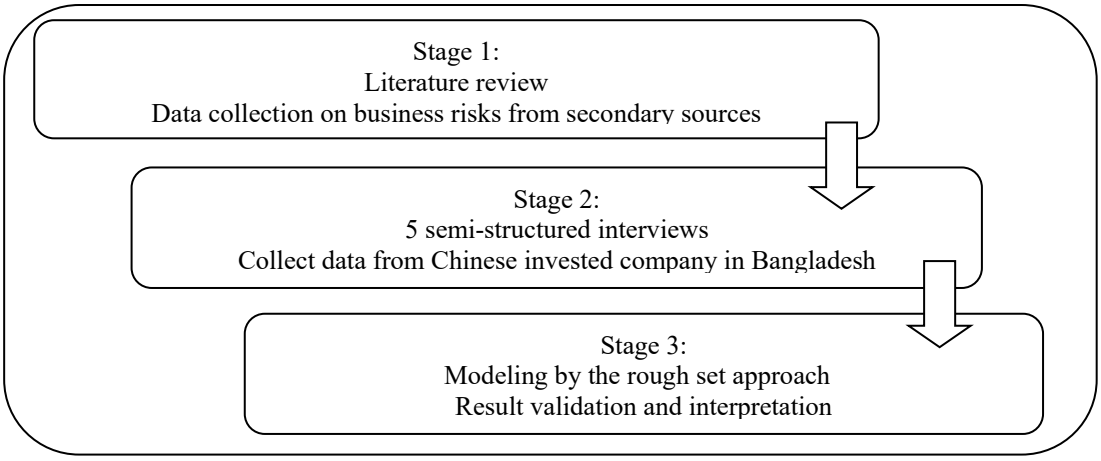
Research Methodology refers to the method and procedure follow in conducting a given research. It clearly entails the steps taken to source data and reveals the techniques employed to arrive at research findings. In order to achieve the desired objectives of the study, the following methodology will be used.

Research Approach and Strategy

Deep diagnoses, analysis and providing a clear presentation of the analysis on the basis of data are mainly required to achieve the proposed objective of the study. To do the required task, the deduction approach will be more meaningful, as it is proven in discovering and uncovering the facts along consistent with the Phenomenology philosophy. Moreover, it is possible to ensure more flexibility to the researcher in determining research emphasis as the research progress by this approach. The data analysis process involves several steps to transform the gathered data into a more convenient and interpretable form. As the thesis is going to deal with qualitative research, collected data and information will be analyzed through the qualitative approach.

This study is absolutely descriptive in nature. The core purpose is to examine the business risk analysis factors and also indicate the economic variables. In essence, the rough set theory design study is going to be employed to empirically ascertain the extent of such vague attributes. Rough set theory (RST), which is based on knowledge acquisition and discovery, would have a brilliant application prospect in the research topic. In many practical systems, there are various degrees of uncertainty, especially in the data collection process which often contains inaccurate and missing data. RST is a suitable mathematical tool to deal with vagueness and uncertainty (Pawlak, 1995). Considering that the research approach involves collecting qualitative data through questionnaire survey and compute variables with programmed RST theory; also with statistical models specified in this study.

The research process is divided into three stages as shown in figure 1. Stage 1 involves secondary research in which literature review has been conducted to understand the state of the existing scholarly work related to the topic of interest.



Source: Authors' Calculation

Figure 1: Research Process

Also, various sources such as company annual reports, trade journals, databases, and the internet were consulted for collecting data and information especially on the company's business risk and risk management. The deliverable of the first stage is a tentative list of indicators for business risk assessment. The second stage is primary research with the main objective to verify the proposed indicators and data collection. Five semi-structured interviews were carried out in recent years to gather opinion and information from the industry. The interviews were targeted at the management personnel of various BoI (board of investment of Bangladesh) listed Chinese invested companies in Bangladesh and some targeted experts from this risk management fields which are the most relevant for the study topic. Companies represent a natural choice since they are investing and doing business in Bangladesh and are in charge of the business. The companies have domain knowledge in business management including the handling of the associated business risks. As for other research and rating companies, they

are professional organizations in managing risks by underwriting risks policies, thus being able to provide relevant information and opinion on the subject matter. Though the interviews were performed in Bangladesh, the organizations involved are all international entities serving a wide coverage of the global market. The organizations are among the largest investment in Bangladesh in their respective industry sector. The interviewees have given information and opinion on the indicators business risk analysis. A minor adjustment was made to the list of indicators according to the interview outcome of Stage 2. Then Stage 3 involves modeling by the rough set approach. Through a numerical example, RST is applied for obtaining the importance degree of each indicator in quantitative characterization, that is, to obtain the weight vector of each indicator. Finally, based on the output of the evaluation model, result in interpretation and judgment on risk mitigation as well as validation is demonstrated. Details of the rough set approach will be presented in later in the section.

Research Data Collection

Data can be described as facts, observations or information in isolation and relating to the subject of the study. Generally, there are two types of data, primary and secondary data. Significance portion of this study will rely heavily on secondary data which are normally published for the consumption of various users. Where it deems necessary and compelling, the primary data which is to be sourced directly by the researcher will be used to complement the quantitative findings. The two main types of data are hereby explained below. The primary data refers to the data the researcher sourced by himself. It is normally acquired through various means of instruments and is often regarded as a row data which is not manipulated by any other person. The secondary data is the data that has been sourced, recorded and published by someone else or by an agency or institution which is legally authorized to document such information. The more authentic the custodian of the data is the more the reliability of the data. The advantage of secondary data is that most at times it is subjected to through verification, editing, and authentication by authority concern before finally published, this makes the data reliability strong and acceptable. In this study, the bulk of the data to be used is going to be sourced from the several issues of the Central Bank of Bangladesh Statistical bulletin. Other secondary data sources include the National Bureau of Statistics, (NBS), World Bank report, United Nation Trade, and Development Conference (UNTACD) and so on.

Sampling Methodology, Instrumentation, and Procedures

On a broader perspective, the study of risk analysis on Chinese invested companies in Bangladesh could either be based on a micro or macro level. Some studies use industries aggregate data to assess the relative impact of risk on company performance, while some studies focus on one country investment and some are the focus on the factors relative to specific sector-wise investment. However, most of the studies of risk analysis pass-through were conducted in advanced countries where data are very much available both at country or industry level. In the case of this study, the researcher intends to use the primary data that relates to the company risk variables and economic to country factors specified above for statistical computation and analysis. Bangladesh as a small open-economy lacks sufficient industrial and others data that will permit research into specific industries as done in advance risk analysis and management. Therefore, in terms of the mathematical computation company, specific risk factors are to be included as a whole. In other words, the researcher intends to use the primary questionnaire of the estimated values of the variables under investigation rather than taking the sample of other previously collected data related to countries or specific industries.

However, for the primary source of which comprises the use of interviews or questionnaire, where possible, judgmental sampling technique will be employed to select the appropriate number of respondents. Since the findings of this study are strictly going to be based on quantitative data, the small sample size of the respondents will be used to ensure adequate representation of all the selected industrial participants of the Chinese invested company's personnel in Bangladesh. The process of gathering the primary data is summarized as follows:

The needs for data in this study are intensive that warrants the necessity for the field trip. The researcher intends to embark on the trip back to Bangladesh to source relevant data that would not be obtainable on the internet. Most data relating to the risk variables under study can only be accessible to contact directly with company officials. Similarly, during the field trip, I will visit four major commercial cities of Bangladesh where have EPZ with Chinese investment to interact with the major participants of the foreign exchange market in the country.

The technique of focus groups will enable the researcher to define and target relevant participants of the foreign investment in Bangladesh and also company top managers to systematically have faced -to- face brainstorming with them. The rationale is to generate ideas that would not be readily available in published sources. How they have faced some specific risks and some sensitive risks that will not be disclosed? Then, what attributes of risk more important for some industries? How they face, especially for Chinese management to work with local experts? After that can be arranged a focus group discussion with industry experts to get the opinions. All these are some of the fundamental issues which can only be clarified through formal discussions with people concerns to articulate the relevant information relating to the actual effects of exchange rate volatility.

Where applicable the questionnaire may be used by the researcher to acquire relevant information which might be difficult to obtain during the face-to-face discussion, in such a situation a structured questionnaire format will be constructed using 5 point likert-scale to sample the opinions of the respondents more conveniently.

Data Analysis and Interpretation

The data analysis process involves several steps to transform the gathered data into a more convenient and interpretable form. As the thesis is going to deal with quantitative research, collected data and information will be analyzed through a quantitative approach. Most researches in qualitative and quantitative finance involve collection and computation of numerical data that can be subjected for empirical analysis. This study aims at utilizing quantitative data to draw inferences. The researcher intends to use the following software statistical packages for the computation.

In this research calculation, the researcher has made a customized programming to risk analysis with RST theory. That software will work as other statistical software, but it is programmed only for risk management analysis by using this research method. It deducts the attributes and dissemination table. Furthermore, it will help to calculate risk assign value and predict the analysis result.

The SPSS package will also be used to augment the RST approach. SPSS will be used in the empirical presentation of data, plotting charts, and frequency table. The package is very essential in data tabulation and computation of mean and standard deviation. In the situation where questionnaires are used, the SPSS will be used to conduct the reliability test and compute the qualitative responses in a form that will suit the analysis and enable draw authentic inferences. In order to accurately document the references refer in this study, endnote software is used which provide easier means of recording references, and APA style referencing is used throughout the study.

LITERATURE REVIEW

The term risk can be defined and explained in many different ways depending on the aim and perspective of a discussion. Kaplan & Garrick (1981) stated that a risk is an uncertainty combined with damage or a loss. They mean that something that is uncertain does not have to incur a risk; however, if an event is considered as both uncertain and a loss is included, it can be defined as a risk. The research on the international investment decisions in emerging countries and risk management is getting concentration again because of the current stage of the world economy is a tremendous force that greatly affects the activities of multinational firms in general (Bartlett & Ghoshal, 2000; Dunning, 2005) go further and stress that firms from developing countries may seize the opportunity to move overseas even if they do not necessarily have any specific advantage based on superior technology or competitive products. Most of the studies on international investment decision location using micro-level data focus on variables such as Research and Development (R&D), factor cost differences, advertising expenditures, wages, trade cost, market size, and taxation (Carr, Markusen, & Maskus, 2001; Disdier & Mayer, 2004; Hanson, Mataloni, & Slaughter, 2001).

Some of the studies have concentrated on the regulatory framework and government influence on the growth and patterns of geographical and sector-wise distribution, as well as the investment motives of Chinese companies (Hong and Sun, 2004; Taylor, 2002; Wang, 2001; Wong and Chan, 2003; Zhan, 1995). Other studies have applied an international management perspective, focusing on the internationalization strategies of Chinese companies (Buckley *et al.*, 2007; Child and Rodrigues, 2005; Deng, 2008). Dollar, Hallward-Driemeier and Mengistae (2006) analyze the importance of the investment climate on export and international investment probability for eight Latin American and Asian countries using firm-level data. On the other side, many uncertainties are affecting the business operating environment of an organization. Many of them are unpredictable and would occur suddenly, they include financial crisis, terrorist attacks, and natural disasters. These risks can have the significant impact on both the short- and long-term performances of a business organization (Tang, 2006) and organizations are likely to suffer loss if they do not actively manage these risks.

Johanson and Vahlne (1977) are among the first to discuss the internationalization process and state that understanding the marketplace or having market knowledge is essential for making new market commitments. It is also indicated that the globalization of financial markets and the complexity of financial products have increased investor uncertainty and risks. They demonstrated investment projects under uncertainty and risk using break-even analysis, sensitivity analysis, and game theory. Orbett (2004) applied multi-criteria decision models and used multi-group hierarchical discrimination to classify countries into four groups and obtained similar classification results. By considering alternative scenarios generated by a risk management process, an organization can judge their respective merits, select solution and undertake the implementation.

Risk Management using RST theory

The concept of rough sets was introduced by Pawlak (Pawlak, 1991; Pawlak & Skowron, 2007) as an extension of the set theory, which allows defining an approximate classification of the given set of data objects (data universe) in presence of data vagueness. The basic assumption is that every object present in the considered data universe can be described using only the available associated information. For example, information associated with a portfolio of financial assets forms a data universe, where each individual transaction represents an object described by properties of the used financial instrument and associated characteristics, transaction size, value, trade date, etc. The rough set approach was criticized for its requirement to discrete data (Grzymala-Busse and Ziarko, 2000), strict definition of lower and upper approximations (no fuzziness) and sole reliance on the available data to induce knowledge about the real world. Consequently, the rough set theory has been studied intensively since their introduction and numerous extensions have been proposed, which alleviate many of the above-mentioned limitations and allow the use of rough sets beyond the pure supervised learning-based data classification domain (Pawlak and Skowron, 2007); Shen and Jensen, 2007).

The risk management understood as the way to discover and predict the possibility of financial losses, business failures, and financial crises, has an obvious and prominent importance for economic ecosystems. Among many types of risk, the valuation of a solvency risk or the assessment of the business risk likelihood is of great interest to the financial sector in particular and the public in general. The ability to correctly classify a transaction counterparty or security issuer (be it a commercial company or a sovereign) according to its bankruptcy likelihood (credit scoring) allows one to correctly price it into the transaction or reject it altogether if the risk is deemed to be too large. The plausible assessment of financial health is also crucial in the heavily regulated financial services sector, where mere rumors about solvency problems may cause a deep financial stress to the affected financial institution, market panic, and liquidity squeeze, resulting in the country- or worldwide financial crises.

It is even important to develop alternative methods for credit assessment as well as propose ways to verify the given credit rating and explain the rationale behind it, without knowing the actual methodology employed by the rating agencies. Consequently, these problem areas attracted a lot of research attention – an early survey of Dimitras *et al.* (1999) showed the usage of methods ranging from the discriminant analysis and logit/probit models to recursive partitioning (tree) algorithms and expert systems. A more recent discussion of empirical research on financial crises and business failures in the banking sector and the artificial intelligence methods proposed for their prediction was given by Demyanyk and Hasan (2010).

An early work of Slowinski and Zapounidis (1994) applied the rough set theory classification approach to the problem of credit scoring for a sample of 39 companies described by a set of 12 conditional attributes, being a mixture of selected financial ratios (quantitative attributes) and descriptive variables (qualitative attributes). Each company in the learning set was assigned a credit score (decision attribute) by a domain expert. The numerical (quantitative) attributes were discretized into qualitative ranges using the experts' opinion (i.e. using the best practice with regards to the interpretation of financial ratios). Based on the decision system, the significant set of conditional attributes (reduces) and resulting if-then rules were generated. The authors pointed out the importance of qualitative input variables in the induced decision rules (e.g. management experience), which were not considered by traditional quantitative risk models.

Slowinski, Zapounidis and Dimitras (1997) continued to research the application of classical rough sets in the business domain by applying it to the problem of predicting a company acquisition, based on a sample of Greek companies. The rough set based prediction delivered a classification accuracy of 100%, 75% and 66.7% for 1, 2 and 3 years before the acquisition, respectively. Objects not matching any of the generated rules have been assigned the 'closest' rules – a distance measure based on the valued closeness relation (Mienko *et al.* 1995) has been introduced for this purpose. The other advantages of the rough set approach were also presented, like the ability to deliver a minimal subset of significant attributes (reducts) or the possibility to generate human-readable if-then rules. Furthermore, an empirical evidence of advantages of rough sets vs. discriminant analysis, especially their explanatory power, was shown.

Dimitras *et al.* (1999) compared the effectiveness of the rough set model with that of discriminant analysis and logit models, applied to the case of Greek companies. In comparison to Slowinski *et al.* (1997) and Slowinski and Zapounidis (1994) a relatively larger learning and test samples of firms (80 and 36, respectively) across several industrial sectors were created and similarly, an expert judgment used to identify conditional attributes (12 out of 28 financial ratios) and discretize the entry dataset. Similarly to Ruggiero (1994), authors reported a better predictability using rules generated with the rough set approach against the results of a discriminant analysis, whereas the effectiveness of rough sets and a logit model were comparable. The effectiveness of the valued closeness relation (VCR) approach to classifying objects not exactly matching the generated rules was also confirmed (VCR helped to correctly classify 60% of previously not classified objects). The availability of the minimal set of most significant attributes (the selected reduct had 5 variables) and resulting compact decision rules was quoted as additional advantages of the rough set approach. The authors admitted, however, that the induced rules were most relevant to the bank and the expert user, who delivered the data sample and selected decision rules.

Another empirical confirmation of rough set theory suitability for the business failure prediction was delivered by McKee (1995). The author used the rough set methodology to construct a company failure prediction model generated and tested using financial report data for years 1986 – 1988 of a sample of 200 US companies, whereas 100 companies constructed the learning sample and another 100 the testing sample. The information table had 8 conditional variables, being financial ratios selected arbitrarily based on prior research and the author's experience. The author used decision class rule strength and valued closeness relation based classification for objects having no exact match to the generated rules. The model accuracy was given as 93% for the learning sample and 88% for the testing sample. The model accuracy was much better than that of the recursive partitioning method developed previously using the ID3 method (McKee 1995), which when applied to the same data sample had an accuracy of 65%. A related work and findings were published by Liu and Zhu (2006), who applied the rough set theory to the analysis of construction industry in China, using a sample of 16 financial ratios for 296 Chinese construction contracting companies.

Similarly to Bose (2006), the authors used the ROSETTA software and noted the better performance of the rough set model in classifying negative samples (unhealthy companies) than the positive ones. They have also noted a large number of reducts and redundant rules. The constructed rough set model had 5% to 10% worse classification rate than the other methods tested (decision tree, logistic regression, and neural network). Sanchis *et al.* (2007) provided a discussion of financial crisis and insurance company insolvency phenomena and proposed explanatory models for both the macro- and microeconomic problem

based on the rough set theory. The authors mentioned the dominance relation rough sets, introduced by Greco, Matarazzo and Slowinski (1998), but decided to use the classical rough set theory based on the observation that the considered financial ratios exhibit complex correlations which prevent the applicability of the dominance relation.

Greco, Matarazzo and Slowinski (1998) showed the usability of the rough set model to the generation of decision rules, which describe the rating process, based on the data set containing the rating information. The authors applied the rough set model to the data sample describing the investment risk ranking of 52 countries as compiled by the Wall Street Journal using 27 indicator variables. An extension of the rough set model able to cope with incomplete information was also described and used to generate the decision table, as 9.5% of data were missing. Bioch and Popova (2003) introduced a related method of rough set-based analysis based on the concept of the monotone discernibility matrix and monotone reduct. The authors showed the applicability of the proposed model to the case of the bankruptcy risk analysis and compared the effectiveness of the proposed approach with this of the dominance based rough sets.

Shuai and Li (2005) used a combination of rough sets and worst practice data envelopment analysis to construct a business failure predicting model for Taiwanese companies. The model used 9 quantitative and 4 qualitative input variables derived from annual reports for years 2003-2004 of 396 firms (352 going concern and 44 failed). The DEA model was used to classify the input sample based on quantitative variables. Rough sets were used to generate classification rules based on qualitative variables only. The authors reported a 100% accuracy of the analysis.

Trends in Chinese investments in Bangladesh

The emerging trends in Chinese investments in Bangladesh need to be analyzed in the context of Chinese foreign direct investment (FDI) as a whole. China began to make investments abroad with the onset of the economic reforms in the late 1970s. Initially, the amount of capital was limited and outward investment was dominated by the state-owned enterprises (SOEs). By the late 1980s, China not only opened up its economy welcoming foreign capital, technology, and expertise but also encouraged its own enterprises to invest abroad. Subsequently, overseas investment became one of the major elements in [China's] economic development strategies (Wu and Chen 2001: 1236-37). Since 1991, more and more Chinese corporations started to invest overseas to develop new markets, increase exports, exploit advantageous local conditions and obtain resources

Although starting from near zero in the early 1970s and early 1980s, by the end of 2010, more than 13,000 Chinese companies/corporations had established about 16,000 overseas enterprises, spread over 178 countries, with accumulated outward FDI standing at US$317.21 billion. In the case of Bangladesh, the volume of Chinese investments is not particularly noteworthy; until 2010, Bangladesh did not get much priority. Between 1977 and 2010, China invested only US$250 million; however, in 2011 alone, it invested some US$200 million (Imam 2012). (In this paper the terms outward FDI and overseas direct investment are used interchangeably).

Chinese Investments in Bangladesh

FDI has played a key role in the development of the Bangladesh economy. FDI volume increased in Bangladesh from an inflow of US$666 million in 2007 to US$1.136 billion as of 2011(Board of Investment, Bangladesh 2011). There is also an increase in Chinese investment in Bangladesh (Tables 1 and 2) It is also notable that China was the third-largest investor in Bangladesh after Saudi Arabia and South Korea in the year 2009-2010 recording 12 projects amounting US$21 million (Table 3) (Board of Investment, Bangladesh 2011).

Most Chinese projects in Bangladesh fall in either the infrastructure or service sectors. China has built six bridges in Bangladesh – the important 4.8 km-long Mukhterpur Bridge over the river Dhaleswari, built by China Road and Bridge Corporation, was inaugurated on February 2008. The agreement to build the 7th China-Bangladesh Friendship Bridge at Kajirtek in Madaripur was signed in January 2012 and the consultations are ongoing with regard to the 8th China-Bangladesh Friendship Bridge (*Financial Express* 2012). Furthermore, China is also interested in investing in the Padma Bridge2 and some Chinese firms have come up with specific offers in this regard. Poly Technologies, a state-owned construction company in China, for instance, has proposed an investment of US$2.4 billion in the project, which will be financed by the Exim Bank of China (*Daily Star* 2013, *Prothom Alo* 2013a). In July 2012, another Chinese company Spare Energy Creations Australia Pty Ltd (SECA) also submitted a proposal for building the bridge with the Chinese government proposing to bear 70 percent of the cost (Imam 2012).

Bangladesh merited more attention from China as an investment destination. During the visit of the then Chinese vice-president Xi Jinping to Bangladesh in 2010, China agreed to provide RMB40 million (approximately US$6.5 million) as the grant under an economic cooperation agreement and two agreements were concluded, one for a fertilizer factory and another for a telecommunication project.

The competitive low wage is one of the major reasons for increased Chinese interest in investing and relocating some of its companies to Bangladesh. Alongside, strategic location, regional connectivity and worldwide access, growing local market and growth, proven export competitiveness, advantageous trading agreements, attractive business and investment climate, competitive cost base, fiscal and non-fiscal incentives and export processing zones" are important factors that attract Chinese

investments to Bangladesh (Board of Investment, Bangladesh 2011). Another significant point is that Bangladeshi environmental laws are much more flexible than those of China.

Challenges and Opportunities in Bangladesh

There are a number of challenges regarding Chinese investments in Bangladesh such as poor infrastructure and political instability. Shortage of electricity and gas is the main hindrance for foreign investments in Bangladesh. According to the World Bank's *Doing Business 2012* report, in 2005, foreigners needed 185 days to get the permission for construction in Bangladesh and it worsened to 201 days in 2011; similarly, the days required for getting electricity connection in industries in 2011 was more than a year (372 days).

Table 1: The position of Bangladesh of ease of doing business

	Bangladesh	**China**	**India**	**Pakistan**
Starting Business	19	38	29	21
Construction permit	201	311	227	222
Registering property	245	29	44	50
Getting electricity	372	145	67	206
Overall Rank	122	91	132	105

Source: World Bank, 2012.

Another important determinant for FDI is the political risk factor. The home country wishes to make sure that host countries are politically stable in order to avoid production disruption, damage to property, threats to personnel and so on. According to the *Global Investment Report 2012,* countries in the South Asian region rank high in the country risk guides of political-risk assessment services and this has deterred FDI inflows. Bangladesh, for example, sees frequent *hartals* or strikes and political violence. Another challenge is regional geopolitics and the internal political dynamics of Bangladesh. Like India, China is also often used as a trump card in Bangladeshi politics for political gains.

Although there are challenges for Chinese investments in Bangladesh, there are also several opportunities. Since Bangladesh has enough cheap labor, particularly in the RMG sector, China should utilize it but in order to be a win-win situation, Chinese companies should also ensure the minimum wage for laborers. It needs to be noted that while in the first half of 2012, FDI inflows declined by 11 percent in developing Asia and 40 percent in South Asia, strong interest by foreign investors in manufacturing, especially in garments, helped keep FDI inflows to Bangladesh at a relatively high level, at about US$430 million in the first two quarters in 2012. The energy sector can be another area for Chinese investments since the energy demand of China is growing and Bangladesh is rich in energy resources. According to Energy Information Administration, Bangladesh has proven reserves of 5 trillion cubic feet (tcf) of natural gas and the potential to meet the rising demand for energy in Asia. Needless to say, this huge volume of energy reserves can be an opportunity for further Chinese investments.

MODELING THROUGH ROUGH SET THEORY

This paper studies strategic risk in Bangladesh for Chinese manufacturing company which faces high uncertainty and dynamism in a multi-facet environment. After a comprehensive literature review, we propose the Rough Set approach firstly introduced by Pawlak, (1982) as a new solution tool for risk factor identification, which has successful applications in data mining, prediction, control, pattern recognition and classification, mechanism learning, and decision analysis. The concept of rough sets was introduced by Pawlak (Pawlak, 1991; Pawlak and Skowron, 2007) as an extension of the set theory, which allows defining an approximate classification of the given set of data objects (data universe) in presence of data vagueness. The method classifies the study objects into similarity classes containing objects that are indiscernible. The condition of company uncertainties and risk management is usually dynamic and hard to predict, which leads to difficulty in finding pre-requisite knowledge. RST does not require any preliminary or additional information about the data, unlike requiring the grade of membership or the value of possibility in fuzzy set theory used in previous risk studies. (Grzymala-Busse, 2014; Kusiak, 2001).

Set Information Table

U= {1, 2, 3, 4, 5, 6…..} represents the study objects, i.e. a set of company managers evaluation value about strategic risk factor, represents the all risks evaluation indicators as explained in uncertainties assumption section. Based on interview data, from the evaluation value by the company, regarding the probability of occurrence of an event, it is advisable to compare several points of view. They are also assessed on a scale of 0 to 5, where 0 is the lowest and 5 is the highest probability. Assessments based on the worst impact and probabilities are not representative and cannot be used. In addition, the outcome of the investment is represented by D = {outcome}. 'Y' stands for 'loss', and 'N' means no 'loss'.

Table 2: Initialized Information 'S (Sample of Strategic risk attributes)

	SR1						**SR2**		**SR3**		**SR4**		**SR5**	
U	**SR 11**	**SR 12**	**SR 13**	**SR 14**	**SR 15**		**SR 21**	**SR 22**	**SR 31**	**SR 32**	**SR 41**	**SR 42**	**SR 51**	**SR 52**
1	5	4	3	2	2		2	*	5	3	2	4	1	3

2	4	3	1	4	1	2	1	5	3	2	2	1	1
3	5	3	1	3	3	2	1	4	3	2	1	1	1

Source: Authors' Calculation

*denotes that data unavailable and/or assessor is unable to give the score

Similarity Relation from Information Table

(A) denotes a subset of the attribute, i.e. risk evaluation indicators, A refers to a particular indicator within A. SIM (A) denotes binary similarity relation between objects that are indiscernible with regards to indicator's value. The similarity relation can be defined as

$$SIM(A) = \{(x,y) \in U \times U | \forall_A \in A, a(x) = a(y), or\ a(x) =* or\ a(y) =*\} \quad [1]$$

Where (x, y) stands for the pair of study objects. This means, two study objects (x, y) has binary similarity relation if the value of each attribute for object x, i.e. a(x), is the same as the value of the corresponding attribute for object y, i.e. a(y). For any value of the attribute which is missing, i.e. a(x) =* or a(y) =*, a(x) and a(y) are considered the same since * can represent any number. SA(x) represents the maximal set of objects which are possibly indiscernible by A with x.

$$S_A(A) = \{y \in U | (x,y) \in SIM(A)\} \quad [2]$$

Referring to Table 2, we compute the objects' attributes. No object has the same attribute values as the other object. Hence, o objects are similar in this case. Then the similarity relation is given below.

$$S_A(1) = \{1\}$$
$$S_A(2) = \{2\}$$
$$\dots\dots\dots\dots\dots$$
$$S_A(N) = \{N\}$$

A reduct is a minimal set of indicators from A that preserves the original classification defined by A. This can be determined by establishing Boolean Discernibility Matrix (Pawlak and Skowron, 2007) with $\alpha_A(x,y)$for any pair (x, y) of the objects. Attributes x∈U and ∈{z∈U|d(z)∉δA(X)}, where z is a particular object, d(z) is the outcome of object z showing in the last column of table 1,δA(X)is the outcome of object x. Let ∝A(x, y) be a set of indicators, which a∈A and (x, y) ∉SIM ({a}). This means those objects which are dissimilar in terms of outcome. Let ∑∝A(x, y) be a Boolean expression which is equal to 1 if ∝A(x,y)=∅.Otherwise, let ∑∝A(x,y) be a disjunction of variables corresponding to attributes contained in ∝A(x, y). Δ is a discernibility function for information table,

$$\Delta = \prod_{(x,y)\in U\times\{z\in U|d(z)\notin\delta_A(X)\}} \sum \alpha_A(x,y) \quad [3]$$

Δ(x) is a discernibility function for Object x in the information table

$$\Delta(x) = \prod_{y\in\{z\in U|d(z)\notin\delta_A(X)\}} \sum \alpha_A(x,y) \quad [4]$$

In the below, Table 3 shows the Discernibility Matrix

Table 3: Discernibility Matrix (an example)

x\y	1	2	3	4	5	6
1				SR11OR22R31R42FR51	OR21FR31R51R52O11FR22	SR11OR21OR22FR31FR32OR41R61
2				SR11OR12OR22R31R51R52 ?	R21R22R31R42R51R52R62	R11R21R31R32R41R42R51R52 ?
3				SR11OR12OR21OR32R41R52 1	SR11OR21OR22OR31R42R51R52R61	SR11OR12OR21OR22R31R41R42 OR51
4						
5						
6						

Source: Authors'

Calculate the Importance Degree of Each Risk Indicator

Then the importance degree of each indicator can be calculated by using the following equation:

$$f(a) = \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{\lambda ij}{Card(Eij)} \quad [5]$$

In equation (5), λij=1 when a∈Cij, λij=0when a∉Cij. Cij represents A risk evaluation indicator appeared. $Card(Eij)$ Means the total number of indicators in one entry (Table 3). Eij Represents the element of Boolean Discernibility Matrix in table 3. Thereafter, the importance degree can be normalized for easier comparison, which can be calculated by the following equation;

$$W_{ij} = \sigma_{cd}(C_{ij}) / \sum_{i=1}^{n}(C_{ij}), where\ \sum W_{ij} = 1 \quad [6]$$

The rough set approach is flexible and can accommodate any number of objects and indicators as long as they are finite sets. Also, other values can be taken according to different cases. For instance,

$$SIM(A) = \{(x,y) \in U \times U | \forall_A \in A, a(x) = a(y), or\ a(x) =* or\ a(y) =*$$
$$S_A(A) = \{y \in U | (x,y) \in SIM(A)\} \quad [7]$$

Integration with Attribute Weight and Expert Opinion

All values are distributed in Likert scale 1 to 5. This attribute value is a Qualitative value, so it's important to integrate with the distribution of importance degree. The basic rule of integration is to multiply with the average attribute value.

$$\text{Assessment value of risk} = W_{ij} \times \frac{\sum_{i=0}^{n} c_{ij}}{n} \quad [8]$$

The comprehensive value of risk factor can be calculated as;

$$W_j(j) = \frac{\sum_{k=1}^{r} w_k . x_j^k}{\sum_{k=1}^{r} w_k} \quad [9]$$

Index j(j=I,2, ... , n) given by k'th expert (k= 1,2, . . . ,r) and W_k is the weight of expert k

STRATEGIC RISK ANALYSIS USING RST

Strategic Risks attributes' literature suggests the core business environment, regulatory environment, brand and communication, Strategic information and behavior of any organization. Particularly it has suggested that firms should create proactive management practices that improve strategic risk-taking by preparing for the inherent uncertainty of strategic. Based on the literature, we have listed all types of risks and coding for our calculation with RST methodology.

Descriptive Statistics for Risk Assessment

Investor's motivations in international investment for investing in emerging markets and determinants of investment location differ among and across the economic sectors. However, certain general factors consistently determine which markets attract the most international investment. A sector-wise analysis of international investment reveals that China investors have so far made a major shift in their investments in Bangladesh from the Textile sector to another sector. Sector-wise analysis of international investment inflow shows a shift of international investment that has been made towards power and energy, manufacturing (especially in RMG) and agricultural industry and trade and commerce whereas, telecommunications, Food, Cement, Computer Software and IT Chemicals and Pharmaceuticals, NBFI sectors have been neglected from some year.

Table 4. Characteristics of the participating companies

Classification	Criteria	Number of organizations	Percentage Organizations (%)
Business category	Textile and wearing sector:	61	35.67%
	Chemical sector	47	27.49%
	Engineering sector:	38	22.22%
	Others	25	14.62%
Types of entry	Green Field	53	30.99%
	Joint Venture	118	69.01%
Amount of Investment	Over 0.1 (Mn. US$))	11	6.43%
	Less than 0.1 (Mn. US$))	160	93.57%
Location	Dhaka	137	80.12%
	Chittagong & others	34	19.88%

Source: Authors' Calculation

The list of invested companies selected for the mail survey and case studies was compiled from a variety of business databases from Bangladesh and as well as China also; these were randomly chosen to represent a range of manufacturing groups. These groups covered the four sectors of (1) metal-based product and equipment manufacturers, (2) wood and wood-based product manufacturers, (3) paper- and plastic-based product manufacturers, and (4) textile and garment manufacturers. These groups were selected because of the investment nature and their economic importance to Bangladesh. The characteristics of the participating companies in the mail survey are presented in Table 4.

In our mail survey, we could contact with almost 171 firms and get the acceptable survey results are nearly over from 100 companies. From Table 6.1 we can characteristics the selected companies in our survey. Among the companies, the Textile and wearing sector are the leading in almost 35.76% and then Chemical sector 27.49% and the rest of the others. Textile and wearing sector would be the representative in this survey because of the huge investment from Chinese investors and besides this is the leading industry in Bangladesh. Beside this, investors are interested to invest in another sector also. From our survey replay, we can find the more location choice in the capital of Dhaka and the business capital in Chittagong of Bangladesh. Most of the companies from Chinese investment are in the joint venture, it's almost 69.01% of our survey and invested more companies in less than (Mn. US$). Comparatively, Greenfield companies are also increasing the number of investment in Bangladesh. Finally, we have used our RST methodology to find out the risk attributes and risk analysis based on our survey companies.

Strategic Risk Analysis Results through Rough Set Theory

Rough set theory (RST), which is based on knowledge acquisition and discovery, would have a brilliant application prospect in the research topic. In many practical systems, there are various degrees of uncertainty, especially in the data collection process which often contains inaccurate and missing data. RST is a suitable mathematical tool to deal with vagueness and uncertainty (Pawlak, 1995). The study uses Rough Set method to classify and judge the risk attributes related to company risk analysis in

Bangladesh. This is very crucial for any risk analysis since the reliability of research outcomes significantly depend on the attributes' weight (Belton and Stewart, 2002). The focal point of this paper is to quantify the importance degree of each factor and to build a mathematical model that comprehensively evaluates the risk exposure of Chinese invested companies in Bangladesh and demonstrate a framework for risk assessment also to risk management. It is also an original attempt to use the rough set approach for Business risk problems. The novelty of this study is to address the concern of objective and precise weight of the factors in the framework of RST.

Here in this study, we have set up a risk attributes table for categorizing risk type; Strategic risk based on the literature review and company case study. After that, we have calculated the degree of importance of each risk attributes through this equation. Then the importance degree of each indicator can be calculated by using *Equation 5* and find the risk of attributes and ranked by *Equation 6.*

Strategic Risks attributes' literature suggests the core business environment, regulatory environment, brand and communication, Strategic information and behavior of any organization. If any business can identify and manage it effectively that would be the overall competitive advantages of any firm management.

Table 5: Risk Attributes for Strategic Risks

Code	***Kinds of Risks***	***Types of Risks***
SR11	Country Risk	Business environment SR1
SR12	Monetary Reforms	
SR13	Economic environment	
SR14	Investment capital	
SR15	Investment and lenders	
SR16	shareholders	
SR17	Business partner	
SR18	Competition	
SR19	Industry moves	
SR21	Sector regulations for competitors	Regulatory environment SR2
SR22	Business and tariffs	
SR23	Environment regulations and trade	
SR24	Changing law tax	
SR25	Government Regulation	
SR31	Reputation	Brand and communication SR3
SR32	opinion and trend	
SR33	License	
SR34	New products	
SR35	Marketing education	
SR41	General strategy	Strategic information SR4
SR42	Strategy analysis	
SR43	Investment environment and acquisition	
SR44	Substitution of products	
SR45	Entry-Exit strategy	
SR51	Organizational design	Organization behavior design SR5
SR52	Governance	
SR53	Employee Retention	

Source: Authors.

Particularly it has suggested that firms should create proactive management practices that improve strategic risk-taking by preparing for the inherent uncertainty of strategic decisions (Chatterjee *et al.*, 2003).

Based on the literature, we have listed all types of risks and coding for our calculation with RST methodology (Table 5). In the types of Business environment (SR1), it includes the country risk assuming the political and others indicators inside of those factors, and then also considers the Economic environment, Investment capital, Industry moves, Competition. In the risk types of Regulatory environment (SR2) includes the tax, business law, Government Regulation and industry sector regulation which indicates the easiness of doing business in any country. Brand and communication (SR3) are other important risk factors for companies, especially for international business. It upholds the uncertainty attributes like reputation, license, opinions, and

trends of that host country and also the marketing education of the business participants and country. It is very important to upgraded with information and achieve the capacity to use that information strategically. So, companies should concern about those information uncertainties, Entry-Exit strategy, Strategy analysis Investment environment and acquisition Substitution of products to identify those related risks and management for international companies. Governance, Organizational design are attributes of Organization behavior design (SR5) risks in the category of strategic risk management analysis.

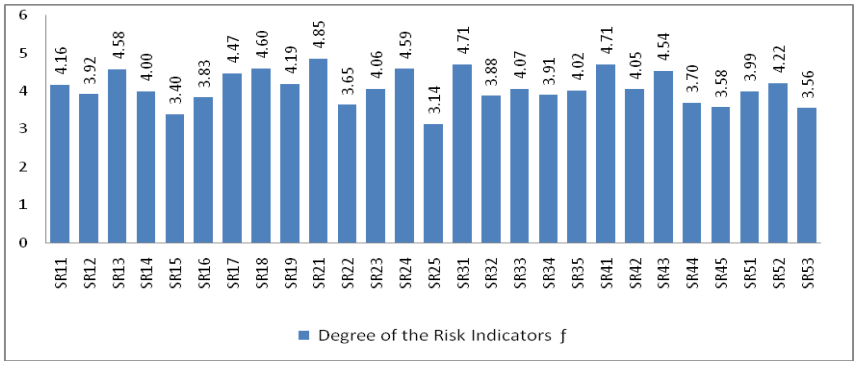
Calculate the Importance Degree of the Risk Indicators

After identifying the uncertainties and categorizing in major risk types, we set the data table and put in RST software coding to Initialized Information (Table 3). To find out the significant risk attributes, the weighted average function is used (Equation 5) to calculate the most significant risk evaluation indicators. Thereafter, the importance degree can be normalized for easier comparison. The importance degree of the Risk Indicators is shown in initial value *f* in Figure 1. We have also calculated the normalized value of all risk attributes of strategic factors for easier comparison. In another word, these factors are the risk indicators from getting the survey result from company managers and calculated with RST methodology. It may give the results of from the company's viewpoints and depends on the industry environment.

To illustrate the degree of risk importance from the above table, we can find the most important attributes from each risk types. In the risk types of business environment (SR1), the competitive environment is the most degree of importance and the economic environment is the second most important factors for business in Bangladesh for Chinese companies which indicates the normalized risk value of SR18=0.042) and SR13=0.042) respectively. Chinese companies emphasize on the business partner (SR17) and industry moves SR19) in doing business outside which calculated risk value is 0.041 and 0.038. In the Business environment (SR1) risk types, the important factor is the country risk and monetary reforms. But in the case of survey result, it gets the less risk value for assessment.

Regulatory environment (SR2) represents the sector's regulations for competitors (SR21=4.84) and changing the tax law (SR24= 4.58) as the most degree of risk factors in that segment. Business tariffs in less degree of impotent because of having the tax free zone in Bangladesh for foreign investors. Finally, environmental regulation is the last important factors among the regularity environment risk types.

The category of risk type, Brand and communication (SR3) has got the highest value for Reputation (SR31= 0.043) License (SR33=0.037) as the most important degree of risk indicators. Then, the others risk factors are not most significant. In SR4, Strategic information management achieves the highest points for the general strategy and investment environment and acquisition, which deserves the most important factors for investment outside of the country. The last types of risk in strategic risk attributes are organizational behavior (SR5). Here, organizational governance (SR52= 0.038) and design of the company management (SR51=0.036) shows the highest degree of importance in that category and getting the less important degree of risk as employee management.



Source: Authors' Calculation

Figure 2: Importance Degree of the Risk Indicators

To illustrate the degree of risk importance from the above table, we can find the most important attributes from each risk types. As an example, in the risk types of business environment (SR1), the competitive environment is the most degree of importance and the economic environment is the second most important factors for business in Bangladesh for Chinese companies which indicates the normalized risk value of SR18=0.042) and SR13=0.042) respectively.

Risk Analysis and Comparative Risk Ranking Analysis

As illustrated in Table 3, the relative significance of risk factors can be revealed and quantified. Further risk factors can be valued by calculating $Qij = Wij \times Vij$ and also with the equation from previous parts which derives the expert opinions can be used to calculate and evaluate the risk exposure of Strategic. Like those normalized values obtained from the table of the degree of risk indicators which is given by the experts and averaged from informational decision table, that's given as per values of risk uncertainties from lower to higher given risk. Thus the finally risk knowledge expert(s) illustrates a risk importance and compare with risk ranking, that's values having the highest Q value represents the greatest risk in that sectors.

From table 6, we can find the degree importance of risk value which is calculated by normalized risk value and the multiplication of expert opinion or the average information table value. For simplicity, we are using one by one to indicate the risk factors. Same as the first category of risk types, Business environment (SR1; the country risk (SR11= 0.1556) is the highest degree value of risk indicators after multiplying with expert opinion's value. This method is also justified our methodology and more validity of risk factors by comparing with experts value and with risk degree importance. This country risk factor was the less degree importance in degree indicator table, but here experts give them more important in the basis of the recent country situation in Bangladesh. It was more political unrest in recent times. Then, in the risk analysis, we can find out the next highest value of the economic environment (SR13=0.154), which indicates the same ranking value as the degree of importance (ω). Among the risk factors in the business environment risk types, the competition (SR=0.148), industry movement (SR=0.1249) are getting the significant value from experts opinions. The other factors like investment capital, monetary reforms, and business partners have less risk significant in the business of doing in Bangladesh for Chinese manufacturing companies.

Regulatory environment (SR2) shows the changing tax law and sector regulations for doing business are the main risk factors for companies which indicates the value as SR24=0.148 and SR21=0.138 respectively. If we find risk rank in table 6, we can find the same risk rank as the risk of degree importance of risk table. So we can assume that experts' opinion and the company managers' survey answers come into the same decision.

License (SR33=0.126), reputation (SR31= .10) are the most significant risk factors for brand and communication risk types segment. The others factors of this segment are the less significant in term of risk assessment. Even, if we look through the risk comparison table, it's slightly different with each attribute in this risk ranking but numerically very significant difference among the attributes.

Next, the strategic information risk analysis is very important in recent business and the main strategic key to success or competes with other companies. In that sense, investment environment is the most risk factors in the expert's eyes and the company strategy analysis for taking the right decision, so if companies miss the taking right decision in right time, they may face a risk in their host country. Exit-entry and the substation products having less significant in risk analysis, (SR45=0.07) and SR44= 0.06) respectively. Finally, the last risk types of strategic risk analysis, Governance (SR53= .07) is the highest risk analysis values. After that, the rest of the two factors also remains the same as previous risk indicators. All the risk factors are important based on their company characteristics and the company mission and vision.

Even though, if look through the attributes ranking table for strategic risk analysis, we can find the most of the risk is the same rank with risk degree of importance table. And it is very common to find the different risk assumptions between the expert's knowledge and company opinion interns of company or industry situation. And we can conclude here with assuming the validity of risk analysis results. In the graphical illustration in figure 2, all the risk attributes are shown for comparison with the degree of risk indicator (ω) and the risk analysis with experts' opinion. We can easily compare all the risk factors in that risk mapping figure. In that figure 2, all the attributes are visible as the based on the kinds of risk risks not as the categorized as risk types. So, it is also grouping comparison with each risk attributes.

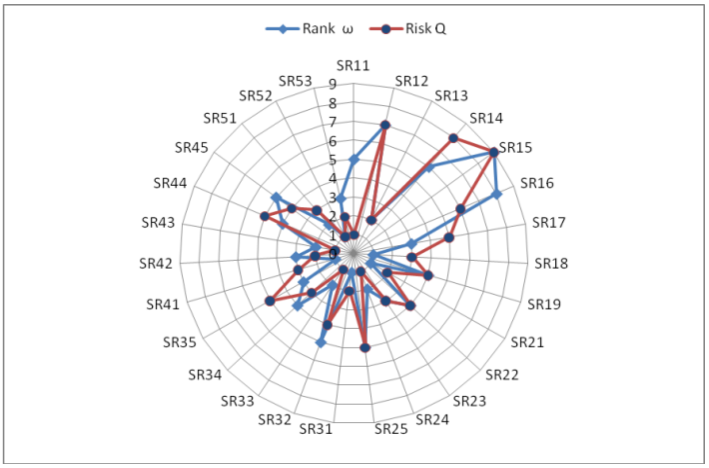
Table 6. Risk Attributes Risk & Analysis Results for Strategic Risks

Table: Risk Attributes for Strategic Risks			**Risk Analysis of SR**		
Code	***Kinds of Risks***	***Types of Risks***	***ω***	***V***	***Q***
SR11	Country Risk	Business environment SR1	0.038	4.095	0.156
SR12	Monetary Reforms		0.036	2.810	0.101
SR136	Economic environment		0.042	3.667	0.154
SR14	Investment capital		0.036	2.810	0.101
SR15	Investment and lenders		0.031	2.762	0.016
SR16	shareholders		0.035	2.952	0.002
SR17	Business partner		0.041	2.857	0.117
SR18	Competition		0.042	3.524	0.148
SR19	Industry moves		0.038	3.286	0.125
SR21	Sector regulations for competitors	Regulatory environment SR2	0.044	3.143	0.138
SR22	Business and tariffs		0.033	3.333	0.110
SR23	Environment regulations and trade		0.037	3.524	0.130
SR24	Changing law tax		0.042	3.524	0.148
SR25	Government Regulation		0.029	3.143	0.091
SR31	Reputation	Brand and communication SR3	0.043	2.333	0.100
SR32	opinion and trend		0.035	2.476	0.087
SR33	License		0.037	3.429	0.127

SR34	New products		0.036	2.714	0.098
SR35	Marketing education		0.037	2.190	0.081
SR41	General strategy	Strategic information SR4	0.043	2.333	0.100
SR42	Strategy analysis		0.037	3.048	0.113
SR43	Investment environment and acquisition		0.041	2.762	0.113
SR44	Substitution of products		0.034	1.762	0.060
SR45	Entry-Exit strategy		0.033	2.048	0.068
SR51	Organizational design	Organization behavior design SR5	0.036	1.762	0.063
SR52	Governance		0.038	2.524	0.096
SR53	Employee Retention		0.032	2.095	0.067

Source: Authors' Calculation

It is very important to find the different risk assumptions between the expert's knowledge and company opinion interns of company or industry situation. And we can conclude here with assuming the validity of risk analysis results. In the graphical illustration in figure 3, all the risk attributes are shown for comparison with the degree of risk indicator (ω) and the risk analysis with experts' opinion. We can easily compare all the risk factors in that risk mapping figure. In that figure 3, all the attributes are visible as the based on the kinds of risk risks not as the categorized as risk types.



Source: Authors'

Figure 3: Comparative images between the Risk indicators and Risk analysis ranking

CONCLUSIONS

In the dynamic and highly competitive business environment, manufacturing industries are under tremendous pressure due to the free market economy, rapid technological development, and continuous changes in customer demands (Islam 2008). To cope with the current business trends, the demands on modern manufacturing systems have required increased flexibility, higher quality standards, and higher innovative capacities (Monica 1999). The focus of our research was to identify the typical risk determinants of Chinese invested companies especially textile and engineering in Bangladesh that need to be considered in developing an integrated risk management approach.

The merits of RST to handle incomplete and uncertain information and its capability of minimizing subjective analysis have been exploited in this study. After identifying the uncertainties and categorizing in major risk types, we set the data table and put in RST software coding to Initialized Information. Then, to find out the similarity relation and set up a discernibility function for information table and discernibility matrix table. To find out the significant risk attributes, the weighted average function is used to calculate the most significant risk evaluation indicators. Thereafter, the importance degree can be normalized for easier comparison. We can find the most important attributes from each risk types. Such as in the risk types of business environment (SR1), the competitive environment is the most degree of importance and the economic environment is the second most important factors for business in Bangladesh for Chinese companies which indicates the normalized risk value of SR18=0.042) and SR13=0.042) respectively. Chinese companies emphasize on the business partner (SR17) and industry moves SR19) respectively.

This study provides in-depth analysis of how assessing the risk for Chinese manufacturing companies in Bangladesh. Nowadays globally, managing risk is the most prominent area of research in the field of international finance and risk management. Reference to the findings of this study the following could be creative areas of the research;

(1) The application of RST theory is coded as a methodology of assessing and analyzing of risks in Bangladesh for Chinese companies especially the attributes determination from a big quantitative and also qualitative data. This RST

mathematical theory along with fuzzy logic provides new innovative statistical framework or breakthroughs upon which simpler and more robust determination of risk analysis of attributes for any industry or in international business from its vague huge level of data set that could be computed with a high degree of accuracy.

(2) Through the same risk analysis assessment RST theory mentioned in (1) above, for the first time in literature to analyze risk in Bangladesh for Chinese invested companies, the researcher is able to contribute in risk analysis for Bangladesh and assessment framework for big data attributes. The risk attributes which is found in this research that is also justified with case studies as almost the results.

(3) The application of risk attributes ranking and weighted method coded is a technique as a tool provides the innovative methodology of evaluating risk among with different industry or country that attributes determinants based on specific country`s macroeconomic and microeconomic data. Inferentially, the result obtained via this method shows that apart from the constructive role play by BOI, different investment authority, companies, especially for Chinese investors. Finally, this research conducting with RST theory opens new theoretical aspects in management science for risk analysis with vast attributes that will contribute in more investment in Bangladesh and besides these more important to run their business for Chinese investors.

Conducting research in any of the above areas would probably provide empirical evidence that would support theories and serve as an important basis for risk attributes assessment for the business environment.

Research and Practical Implications

The study has contributed to research and practice in various ways. First, the study has provided a novel method for analyzing risk for business risk or in the big data area. In a broader sense, it is an original attempt to use the rough set approach for business risk problems in a big data or where to have more uncertain attributes. The novelty of this study is to address the concern of objective and precise weight of the factors in the framework of RST. This concern has not been tackled by the business risk assessment for Chinese invested companies in Bangladesh and risk studies reviewed previously, and virtually majority of the studies applying RST. This is very crucial for any risk analysis since the reliability of research outcomes significantly depend on the attributes' weight (Belton and Stewart, 2002). As illustrated by the study of the overseas company, we are able to calculate the significance of each risk factor based on the original data without assigning the weight subjectively. In fact, the main theme of RST is to measure the "ambiguity" inherent in the data and to reveal hidden patterns. Second, the method is capable of handling missing data. Unlike statistical analysis, it is not necessary to discard samples with incomplete data. More samples can be retained when the rough set method is used which reduces the limitation of data problems. Quality solutions can still be obtained without the hassle to collect extra samples, if at all possible. The method's advantage makes a valuable advancement to the risk management field. Furthermore, the quantitative importance degree of the risk evaluation indicators reveals the major root of uncertainties or risk attributes. Managerial implications can be drawn and appropriate actions can be taken accordingly.

Future Research Perspective

Same as other studies, the paper contains research limitation. A rather low number of uncertainties are used for illustration. Future research can be devoted to examining more samples. However, we should note that the number of companies and overseas countries in a particular industry may not be very high in practice. Also, a low number of samples do not pose any problems in the rough set algorithm. As a whole, the numerical example has clearly demonstrated the analysis and research outcomes and has fulfilled the objectives of the research. Regarding more future research, the research process and model developed to provide a lot of potential that study can be undertaken on other types risk analysis, such as specific company risk attributes or sampling in different countries uncertainties, as well as other risk management topics.

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