Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries

A Thesis submitted as a requirement for the degree of

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University of Dhaka

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Session: 2015-16
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CERTIFICATE

This is to certify that the dissertation titled: "**Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries**" submitted by Sadia Islam for the fulfillment of the requirements for the degree of Master of Philosophy in Economics is her own independent and original research work carried out at Dhaka University under my supervision. This work has not been submitted in part or full to any other university or institution for any degree or diploma. I, therefore, forward this thesis for evaluation and necessary action.

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DECLARATION

This is to certify that the dissertation titled, "**Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries**" submitted in partial fulfillment of the requirements for the degree of Master of Philosophy in Economics under the University of Dhaka is a research work carried out by me under the supervision of Syed Naimul Wadood, PhD. I, further, declare that this study has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title of recognition. Moreover, I would also like to declare that, this paper has not submitted or presented to any journal, conference, seminar or other similar title of recognition.

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(**Sadia Islam**)

LIST OF ABBREVIATIONS

ARIMA - Autoregressive Integrated Moving Average Model

AFC- Autocorrelation function

AIC-Akaike Information Criterion

BIC-Bayesian Information Criterion

BBS – Bangladesh Bureau of Statistics

BER- Bangladesh Economic Review

BTMA-Bangladesh Textile Manufacturers Association

BGMEA – Bangladesh Garment Manufacturers and Exporters Association

CLRM-Classical Linear Regression Model

CFA-Confirmatory Factor Analysis

EC – European Commission

EPB – Export Promotion Bureau

EFA-Exploratory Factor Analysis

GHG- Greenhouse Gas

GDP-Gross Domestic Product

GoB –Government of Bangladesh

GRI – Global Reporting Initiative

GIPS –Green Industrial Performance Scorecard

IFC – International Finance Corporation

ISO – International Organization for Standardization

IUCN – International Union for Conservation of Nature

IPCC-Intergovernmental Panel on Climate Change

KMO-Kaiser-Meyer-Olkin

KII- Key Informant Interview

LFMEBA- Leather Goods and Footwear Manufactures and Exporters Association of Bangladesh

NSDS –National Sustainable Development Strategy

OECD – Organisation for Economic Co-operation and Development

PACF-Partial Autocorrelation Function

RMG – Readymade Garment Industry

SDGs – Sustainable Development Goals

SME- Small and Medium Enterprise

SD – Sustainable Development

SID- Sustainable Industrial Development

7FYP – Seven Five Years Plan

UNIDO – United Nations Industrial Development Organization

USD –United State Dollar

USA – *United States of America*

UNEP-United Nations Environment Programme

UNDP–United Nations Development Programme

UN – United Nation

UNCED – United Nations Conference on Environment and Development

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNFCCC- United Nations Framework Convention on Climate Change

VIF-Variance Inflation Factor

WCED – World Commission on Environment and Development

WWF –World Wildlife Fund

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Abstract

The world has already witnessed by the massive growth and this boom of economy brought detrimental changes in environmental quality. Due unplanned industrial development, the environment is losing its own balance. There is anxiety about the future of the world. So, to solve this problem the world need to find out some solutions. The world needs a kind of development process which will increase economic growth, but without harming the balance of the environment. Moreover, Sustainable development is a universally agreed development process to address all these challenging issues. Considering these issues the main goal of the study was to find out the prospects of Bangladesh to promote sustainable industrialization by 2030, and to examine the impact of the eco-innovation in the environmental sustainability performance to formulate long term policy for sustainable industrialization program. The nature of the work demands the collection and analysis of both primary and secondary data. Hence, to project how close the Bangladesh to achieve the target of SDG 9.2, this study considers indicator 9.2.1a and 9.2.1b. To forecast the country's overall progress related with sustainable industrialization this study use ARIMA model and after forecasting the value this paper found that the manufacturing value added as a percentage of GDP will be 21.26 percent and Manufacturing value added per capita (in USD) for the year 2030 will be 354.33 USD in Bangladesh by 2030. This study found that indicator 9.2.1a is still far from achieving the target of manufacturing share of GDP by 2030. However, from the forecasting value of indicator 9.2.1.b this paper can claim that, the forecasted value USD 354.33 is very close to the targeted value USD 360.96. To fulfill the second specific objective, this study collected data from the manufacturing sector (RMG industry and Leather industry). The questionnaire was collected and complied from different important documents from the literature reviewed, but considering the data collection problem (during this Covid-19 pandemic), the study

used only total 50 RMG and leather industries for collection of primary data. The collected data from the questionnaire survey was analyzed both by factor analysis to form an index for environmental sustainability performance, eco-innovation and eco-process innovation. The Classical Liner Regression Model was employed to prove the hypotheses. From the descriptive analyses of the study it is found that, eco-innovation concentrated on the reduction of materials use, reduction of energy use, reduction of pollution and replacing of materials with less polluting substitutes. The empirical result of this study has shown the eco- innovation has a positive relationship with environmental sustainability performance in the case of the manufacturing sector and also in the case of RMG sector of the Bangladesh. Specifically, from the empirical results it was found that eco-product innovation has a positive impact on environmental sustainability performance, but the eco-process innovation does not have any positive impact on environmental sustainability performance in the case of overall manufacturing industry and as well as RMG industry. But due to the inappropriateness of the data for factor analysis this study could not able to identify the impact of eco-innovation in the case of the leather sector. Therefore, for the implementation of sustainable industrialization in the manufacturing sector of the Bangladesh, it is necessary to implement various policies and programs covering all these factors.

Chapter One

INTRODUCTION

1.1 Background of the Study

Over the past few decades, the world has witnessed of the rapid economic growth and this achievement has been driven by the astonishing technological advancement and industrialization. Undoubtedly, this economic growth is a matter of great aspiration in the world but unfortunately, it is also true that there is a connection between economic growth and environmental degradation (Zheng et al., 2019). The massive economic activity that took place in different countries of the world as a result of the industrial revolution caused far-reaching changes in the environment. Excessive and unplanned industrialization is causing greenhouse gas emissions every day and resulting in environmental degradation. Although industrialization has bought economic progress, it has also created urbanization and pressures on the environment (Patnaik, 2018). The renewable resource use and fossil fuel emission have increased. The activities of all these industrial organizations brought about a kind of transformation of the environment. Broadly, industrial revolution can transform the environment in two ways. One is direct and the other is indirect, but both transformations can have dire consequences for the environment. A change in the soil, forest or water body of an area for setting up an industrial plant is identified as a direct transformation of the environment (NRC, 1992, pp.44). Direct conversions are usually quick and clear. On the other hand, indirect transformation occurs slowly and is often not realized without observation. However, after a certain period of time, its dire consequences become clear. When we dump industrial waste into rivers or wetlands, this is an example of an indirect transformation and it brings with it terrible impacts for the environment. Therefore, rising industrializations are responsible for destroying the world's rivers, reservoirs, forests, grasslands, nature and the atmosphere (Appannag, 2017). As a result of unplanned industrial development, the environment is losing its own balance. Due to these anthropogenic activities greenhouse gases (GHG) emissions is increasing day by day. Rising global warming and climate change has greatly alarmed the human community (Singh & Singh, 2012). Environmental management has thus become a topic of common concern among businesses, governments and consumers (Hoffman, 2004). So one issue that is being discussed all over the world now is how to conduct economic activities without harming the environment (Cordano et al., 2010). That is, in what ways, will we can solve this issue related to the environment and the economy **(**Everett et al., 2010**)**. There is anxiety about the future of the world. So, to solve this problem the world need to find out some solutions. The all nations of the world have realized that it is essential to limit the harmful impacts of economic development on the environment. From this consciousness of the people, the concept sustainable development beings by the Brundtland Commission in 1987. Sustainable development is a universally agreed development process to address all these challenging issues (Bhattacharya, 2001). Sustainable development is a kind of development process that will increase economic growth, but without harming the balance of the environment and reduces the socio-economic inequality of the people in the society (Romeiro, 2013).Ensuring sustainable development is an effective way to avoid the potential bad consequences (Ekins, 2010). Sustainable Development policies are being supported by individuals, organizations, national governments and international organizations. Various international organizations, including the United Nations, are encouraging all countries and organizations to engage in sustainable development activities.

This study focuses on the experiences of Bangladesh, a developing country and also known as one of the next eleven emerging markets (Hoque, 2011). Industrial development has no viable alternatives for a country like Bangladesh which needs to accelerate its economic growth via industrial development in the face of high incidence of poverty and unemployment (Perspective Plan of Bangladesh 2010-21, pp.3-4). It is projected to play a very critical role in the country's economic progress in the years to come. Despite that, the indiscriminate industrial development path that Bangladesh followed over the past decades has created different environmental problems. Among those, the most significant is the enormous volume of solid wastes and wastewater which are being produced regularly, but not managed properly (Rasul et al., 2006). Such pollutions are usually called anthropogenic pollutions, pollutions which are induced by human interference. To save our environment from these types of the anthropogenic pollution; ensuring sustainable economic growth is essential (Jacobus et al., 2006). Even though Bangladesh is a developing country; it has the intention to make economic progress by industrialization. But unfortunately it is also true that unplanned industrialization has bad impacts on the environment. Safe and friendly environment are essential for sustainable development. So it is a big challenge for Bangladesh as well as to the world to establish and accomplish an adequate policy which can ensure economic growth without hampering the environment.

We can argue that, there is always a conflict or trade-off between *economic growth* and *environmental sustainability* (Macnaghten & Jacobs, 1997). The GOB has initiated various activities to solve this complex problem related to growth and the environment. The Government of Bangladesh has already started considering these important issues and has undertaken various projects and policies. One of them is the Industrial Policy (2010); it focuses to accelerate industrial growth and expands the share of industrial labor force ratio by initiating environmental friendly and technologically advanced growth. According to the Industrial Policy (2010) by 2021, near to 40 per cent of the share of GDP is expected to come from the industrial sector (The Industrial Policy, 2010 pp.5). To fulfill this target govt. gives special focus to improve the performance of the industrial sector (GoB, 2012: pp. 8-9). The Perspective Plan of Bangladesh 2010-2021 includes discussions of how to save Bangladesh from the harmful impacts of the environmental pollution (Perspective Plan, 2010-2021, pp.94).The Government of Bangladesh has set a target of 10 per cent GDP growth by 2021 and a handsome share of this growth will come from the industrial sector is mentioned in the Perspective Plan 2010-2021 (Perspective Plan, 2010-2021, pp.36). The government plans to expand the industrial sector so that huge profits can be made from the industrial sector. By 2021, more than 37 per cent of the share of GDP is expected to come from the industrial sector and GDP share from the agricultural sector would decline gradually. In this case, the Perspective Plan indicates that in order to increase the country's GDP, the industrial sector would be expanded and shifted from the agricultural sector to the manufacturing sector (Perspective Plan, 2010-2021, pp. 36). This shifting from agricultural to manufacturing sector is also suggested in the development economics model. According to the one of the familiar model '*dual sector'* or '*Lewis model*', when an economy accelerates towards economic development, workers move from the agricultural sector to the manufacturing sector and industrial development is one of the primary sector which helps to accelerate the country's GDP growth (Todaro & Smith, 2002, pp.115-116).

It is very important for Bangladesh to formulate policies while maintaining balance between economy and environment for ensuring sustainable economic growth and measures to protect Bangladesh from the harmful effects of the unplanned and unsustainable industrialization (Kemper & Fan, 2018). However, the draft of the National Industrial Policy adopted in 2016, rightly highlights the importance of environmentally sustainable and inclusive industrial development in Bangladesh (Roy, 2017). The Seventh Five Year Plan (7^{th} FYP, 2016-2020, pp.446-447) suggested some plans to assure effective economic enhancement by maintaining the proper merger of investment in human and physical capital. The Seventh Five Year Plan has focused mostly on the implementation of the Green Economy. According to the plan 7^{th} FYP by adopting a green growth strategy through implementing eco-efficiency the country can move towards to the inclusive and sustainable development (7^{th} FYP, 2016-2020, pp. 446). But implementing a green economy for profit maximizing market is not an easy task

(Woolverton & Dimitri, 2010). Since most of the industries in Bangladesh want to increase profits so making environment-friendly productions are a big challenge for them. But at present Bangladesh is facing multiple environmental imbalances. The implementation of green industrialization has now become very urgent for Bangladesh. As a result of the unplanned industrial system, Bangladesh is already facing various negative externalities. Due to the impacts of negative externalities, it is not possible to ensure proper use of resources and that is responsible for market failure. Furthermore, in the year 2012, National Report on Sustainable Development published by the Ministry of Environment and Forests mentions that to ensure environmental sustainability it is essential to concentrate on clean production in the industrial sector. (NSDS, 2012).

Moreover, the Global Sustainable Development Goals 2030 were formulated in the year 2015 and adopted by the United Nations Member States, which has created a different dimension of development (UNDP, 2015). Sustainable Development consists of a combination of 17 goals, 169 targets and 230 indicators. All of the 17 Sustainable Development Goals (SDGs) leading to the way towards a more sustainable and inclusive, equitable and innovative development (UN, 2015, b). In sustainable development agenda goal9 speaks about the issue of sustainable industrialization. But in case of Bangladesh hugely populated and accepted target for sustainable industrialization is targeting 9.2 *"Promote inclusive and sustainable industrialization, and by 2030, significantly raise the industry's share of employment and gross domestic product in line with national circumstances, and double its share in least developed countries"* (Hossain, 2019). The country's main target towards sustainable industrialization is to increase industry's share of employment and GDP considering the line with national circumstances.

Therefore, sustainable industry is indeed an issue that we need to look seriously. As a developing country Bangladesh will need to sustain its economic growth and create employment opportunity for its growing labor force (Ali et al., 2019). So, the main target for ensuring sustainable industrialization is increasing the industry's share of employment and gross domestic product. Considering these ambitious plans of the Bangladesh government, what are the country's prospects for sustainable industrial development? Mainly, what will be the situation of Bangladesh for the target of SDG-9.2 by 2030, to ensure sustainable industrialization and significantly raise the industry's share of employment and gross domestic product, in line with the country's situations, and double its share in least developed countries? This study aims to find out macro scenario perspectives towards sustainable industrialization in Bangladesh. For identifying overall countries prospects towards sustainable industrial development this study analyzed the above research question.

Furthermore, as a developing country Bangladesh needs to focus on its economic growth and social welfare also not to jeopardize the environmental condition. In this circumstance, to create a dynamic economic growth Bangladesh need to take effective strategies that may able to increase international trade and as well as national investment. Due to global environmental problems and high level of pollution there is a need to develop new ways to solve environmental problem without minimizing growth, find new energy sources, reduce air pollutions, recycle wastes and to decrease water emissions. One of the fairly new ideas related to innovation is '***eco-innovation'*** (Garcia et al., 2015). Kemp and Pearson (2008) referred eco-innovation as one of the most effective environmental management innovation programs. They further ascertain the innovative programs related to environmental management named eco-innovation as follows:

Eco-innovation is a process which is related to the production of goods and services, production ideas, methods, process or management of the company and it helps to minimize environmental risk and negative impacts of the energy and resource use. It can be developed by the organization or the can be adopted from the other organizations. (Pearson 2008, pp.7).

Moreover, all of the OECD countries acknowledge eco-innovation as an effective method to meet today's environmental problems (Ekins, 2010). Now to clear the difference between "innovation" and "eco-innovation", the OECD added to the feature that differentiates eco-innovation from innovation.

1. This is a kind of innovation, which works for reducing environmental problems.
2. This innovation is not only related to the product or process, but also conscious about social and institutional wellbeing (OECD, 2009, P.2).

Thus, it can claim that, eco-innovation differs from traditional innovation practices due to its multidimensional benefits.

In 1996, the idea of the eco-innovation was first provoked by the Fussler and James (Nicolai & Pillot, 2017). They have mentioned eco-innovation as a new way to alleviate harmful environmental consequences by introducing new products and processes to ensure economic and environmental benefits for all (Hojnik et al., 2016). Eco-innovation is one of the most effective environmental management innovation practices to reduce the environmental problems and risks (Kemp and Pearson, 2008 p.7). This method also used to reduce negative externalities related to environmental pollution. By creating new ideas, products and processes; eco-innovation helps to pay role in the sustainability goals (Rennings et al., 2000). According to Sezen et al. (2013) for the sake of sustainable development in manufacturing industries, eco-innovation can be considered as the useful strategic tools. By creating new ideas, products and processes, eco-innovations help to pay role in the sustainability goals (Rennings et. al., 2000). With the emerging importance of an environmental management technique named ***eco-innovation***, researchers started to present eco-innovation in different perspectives since the year late 1990s. At the very beginning are those works that make off factors that apply to the eco-innovation and the achievement arising from eco-innovation, with kammerer (2009) and Pujaru and Dangelico (2010) being the example of these types of studies. Another group is those that find out the dimensions of eco-innovation, with Hermosilla et al. (2010) as a best example of this category. Moreover, another important category of works is related to the measurement of eco-innovation such as, Arundael and Kemp (2009) and Cheng and Shiu (2012). According to Sezen et al. (2013) eco-innovation is a most effective tool for the sake of sustainable development in manufacturing industries. By creating new ideas, products and processes, eco-innovations help to pay role in the sustainability goals (Rennings et. al., 2000). Therefore, this study also examined the impact of eco-innovation in environmental sustainability performance to formulate long-term policy towards sustainable industrialization in Bangladesh. What are the impacts of eco-innovation (eco-product and eco-process) on environmental sustainability performance? Two of the leading manufacturing sectors in Bangladesh, RMG and leather industry, have been chosen for this study (Ferdous, 2015).

1.2 Justification of the study

From the beginning of the industrial development it has started to harm the environment with intense problems. It causes horrible impacts on the entire natural system components. It not only creates stress on components of nature like soil, water, air, but also it creates difficulty on eco-system (Patnaik, 2018). After ascertaining the hard-heartedness of the problem, impacts of industrialization on the environment need to be resolved with more severity (Chigbo, 2016).

So measurements of the influences of eco-innovation in the performance of the environmental sustainability of the selected industries like the RMG and the leather industries is a very important matter for this country's sustainable industrialization. Moreover, this study also forecast that what will be the position of Bangladesh for achieving the target of SDG9.2 by 2030. It has been identified that sustainable industrialization is an integral part of an economic, social and environmental welfare maximization model and still there is a knowledge gap on sustainable industrialization in the context of developing countries like Bangladesh.

To our best knowledge, there is no study that has conducted for identifying the impacts of eco-innovation on the environmental sustainability performance of the RMG and the leather industries in the case of Bangladesh. So, this study may be able to give an idea about the prospects of Bangladesh to achieve the target of SDG 9.2 by 2030 and also help to formulate a long term policy towards sustainable industrial development.

1.3 Research Objectives

1.3.1 Goal of the study

The main goal of the study was to find out the prospects of Bangladesh to promote sustainable industrialization by 2030, and to examine the relationship between eco-innovation and environmental sustainability performance to formulate long term policy for sustainable industrialization program.

1.3.2 Specific Objectives of the study

Based on the goal, the following specific objectives have been identified in the current study:

- To project how close the Bangladesh to achieve the target of SDG9.2, to promote inclusive and sustainable industrialization and, by 2030.
- To examine the impact of the eco-innovation on environmental sustainability performance.
- To provide possible policy inputs for sustainable industrialization program.

1.4 Working Hypotheses

Hypothesis 1: Bangladesh will be able to achieve the target of SDG 9.2 by 2030 for making its industry more sustainable.

Hypothesis 2: Eco-product innovation will have a positive relationship with industrial environmental sustainability performance in the Bangladesh.

Hypothesis 2(a): Eco-product innovation will have a positive relationship with industrial environmental sustainability performance in case of the RMG industry in the Bangladesh.

Hypothesis 2(b): Eco-product innovation will have a positive relationship with industrial environmental sustainability performance in the case of the Leather industry in the Bangladesh.

Hypothesis 3: Eco-process innovation will have a positive relationship with industrial environmental sustainability performance in the Bangladesh.

Hypothesis 3(a): Eco-process innovation will have a positive relationship with industrial environmental sustainability performance in the case of the RMG industry in the Bangladesh.

Hypothesis 3(b): Eco-process innovation will have a positive relationship with industrial environmental sustainability performance in the case of the Leather industry in the Bangladesh.

1.5 Scope and Limitations of the Study

The scope of this study is to analyze the current scenario and also forecasting the future scenario of the Bangladesh related to the sustainable industrialization. The study is expected to generate policy inputs by the result of forecasting the target 9.2 for attaining sustainable industrialization in the country by 2030. The benefits of using eco-innovation in the manufacturing industries and its impacts on environmental sustainability are also presented in this study. Findings from the analysis may help in understanding the impacts of eco-innovation, on the environmental performance. Hopefully these outcomes will serve to be very useful for policy makers, particularly designing policies for ready-made governments and leather industries to introduce sustainable industrialization in the country. So the scope of this study is to help in promoting sustainable industrialization in the case of RMG and leather industry. This study may help to the government to formulate long term policy for sustainable industrialization program in Bangladesh.

This study has analyzed the relationship between eco-innovation and environmental sustainability in the manufacturing sector of the Bangladesh. Due to lack of knowledge and awareness people are less aware about the environmental sustainability of the industrial sectors in Bangladesh. The primary data were gathered from different RMG and leather industries, in Dhaka city, through personal interviews where personal biasness might exist with regard to information related to eco-friendly products and processes of industries. The primary data were collected from only 50 manufacturing industries in the Bangladesh because the data was collected during the covid-19 pandemic period. Thus, it is very difficult to generate any aggregate statement about the country's manufacturing sector from the outcome of this study. Since this is an academic research there was a time and budget constraint.

1.6 Organization of the Study

The anterior chapter has discussed the introduction part of the thesis. The rest of the sections of this thesis are embodied as follows: *Chapter two* contained literature review and the reviews covers mainly about the issues related to sustainability and sustainable industrialization. The literature review chapter will also review eco-innovation related study. The methodological part was discussed *Chapter three*. The methodology chapter Present about the information related to the data, data collection method and analysis procedures. In the methodology chapter covers discussion about forecasting with ARIMA and also discussed about factor analysis to generate index. *Chapter four* discussed about the results found from the statistical and empirical analysis and also discussions of the findings. Conclusion and recommendation were presented in the *Chapter five*.

Chapter Two

Literature Review

2.1 Introduction

The industrial sector is a major contributor to the economic development of Bangladesh. Being a developing country Bangladesh need to accelerate its economic growth and raise the employment share through the expansion of the industrial sectors. But at present, there is no alternative but to establish a system of sustainable industries in order to survive in the world. In this literature review chapter this paper discussed about different issues of sustainable development. Furthermore, this paper has tried to find out by reviewing the literature what is ***sustainable industry*** and what are the established methods through which processes it can be implemented. Detailed discussions that are presented in this literature review chapter. Here the literature reviews for this study was divided into several parts. In first steps it was present ***sustainable industrialization*** related works. After that it was discussed about ***eco-innovation measurement tools*** and studies which use ***eco-innovation measurement tools***. Finally, this chapter discussed about the research gap indentified from the literature review.

2.2 Issues of the industrialization and economic growth

The significance of industrialization in the economic growth and social uplifting of a nation is beyond any debate in today's world. If we look at the economic history of the developed nations it's very common to see their industrial background. Industrialization is a process of technological, cultural, social and economic change which converts an agricultural society to an industrial one (Chigbo et al., 2016). This type of structural change is the drivers of not only technical, but also organizational, institutional innovations (Grubler, 1995). So it can be argued that, industrialization plays crucial role in economic uplift, labor efficiency, and sharp increase in national and per capita income (Harley, 2003).

The first industrial revolution (1760-1870) began in England and spread throughout Europe and North America (Haradhan, 2019). Britain's industrial revolution first began in the 1760's and later spread around the world (Horn et al., 2010). The Industrial Revolution is a very significant event in the history. The industrial revolution is associated with changing the standard of living of the people. The beginning of the industrial revolution is compactly associated with the different innovations and technologies. This has led to a massive increase in material production and trade. New industrial factories were set up due to the growing demand of human society.

After ending the 1st industrial revolution the second industrial revolution began. The Second Industrial Revolution lasted from 1914 until the outbreak of World War I. The second industrial revolution (1870-1914) is known as the age of rapid industrial development (Hall, 1999). That period was physically characterized by the railroad construction, use of telegraph, petroleum, machinery, steam power and so on. Moreover, economic growth during the second industrial revolution was accompanied with the automation, development of transportation sectors (railways, waterways and highways), the use of steel, iron, chemical, and fertilizers.

In history, the period between the First World War and the Second World War is called the Interwar Period (1918-1939). Although this period was confined to a limited time, but this period was very much significant for the earth. During this period, in 1929-1930, an unprecedented global economic recession was created. This Great Depression had devastating effects in both industrial and economic conditions. This interwar period has undergone major changes in industrialization. The effects of the First World War and the Great Depression fell on industrialization (Romer, 1988). Then the Second World War (1939-1945) broke out on the earth and the detrimental effects fell heavily on industrialization and the economy.

After the Second World War, there was an urgent need for reorganized the economic growth (Arndt, 1987). The economy was recommenced with the increased demand of goods and services. At that time, to solve the material well-being crisis the term economic development; considered by an increase in GDP growth (Arndt, 1981). Hence, from the year 1950 the economic development was related to the only the increase share of GDP growth means the economic growth (Arndt, 1987).During the mid-19th century, the rapid growth in productivity led to the per capita income and overall economic progress. At that time, industrialization experiences major changes and new innovations and resources were created. It plays a crucial role in utilization of resources, increase of production, employment generation, and high wages of labor, high standard of living, revenue generation and many more.

In the decades following World War II, economic growth was seen as the only solution to poverty (Marglin, 2000 pp.1). The world has already witnessed by the massive growth and this boom of economy brought detrimental changes in environmental quality. Over consumption of natural resources, air, water and soil pollution are the impacts of industrialization an economic growth. Industrialization also leads to major climatic changes, global warming, and acid rain and so on. Heavy industries emit pollutants which cause life threatening diseases. Mass production of goods and services are responsible for generating solid and hazardous wastes which harm the environment and human health as well (Mondol, 2021). Therefore, we can state that, there is a nexus between the economic growth and environmental degradation.

2.3 Nexus between economic growth and environment

Now-a-days the consequence of the economic growth on the environment is a talk about the topic as day by day environmental degradation is increasing (Yang et al., 2015). We live on a planet where the amount of total resources is constant, but the human population is steadily increasing and as a result the material demand on earth is increasing (Freedman, 2018).Therefore, to fill up these increasing demands of the human population, the world needs to continue its economic activities. But, unfortunately the consequence of all economic activity falls immediately or circuitously on the environment. So, economic development creates an ultimate pressure on the environment. Furthermore, from the first law of thermodynamics it can be claimed that, people cannot create anything from nothing; people can only transform (Schmitz, 2017).

We use natural resources as raw materials in our production process. According to this first law of Thermodynamics, what we extract from the environment must return to the environment in some other form. Thus, the waste created through the production and the waste generated through consumptions also thrown by us into the environment. The environment has its own Assimilative Process and there is a limitation to assimilate this waste which is called Assimilative Capacity. There is no problem as long as the amount of our waste thrown into the environment is not inconsistent with the assimilation capacity of the environment. But if man-made waste exceeds the assimilation capacity of the environment, then pollution occurs (Bhattacharya, 2001).

At present, more pressure is being created in the environment from human activities in the world. According to the estimation results of the global footprint network in 2019, human of the world has been used in natural capital 1.75 times as fast as the world can regenerate it. So, we need 1.75 earth, but unfortunately we have one and only earth. (Global Footprint Network, 2019). Mainly, developed countries unsustainable growths are responsible for this pressure on the earth (Jianping et al., 2014). To get rid of these problems, we need to take different measures so that we can reduce anthropogenic pollution on the environment.

Moreover, this study focuses on the country Bangladesh, which is a developing country. As a developing country Bangladesh produces very limited greenhouse gas. According to the Ministry of the Environment and Forest due to low level of pollution Bangladesh does not have any international obligatory for the climate change mitigation (Second National Communication-UNFCCC, 2012). Therefore, the climate change mitigation is not compulsory for Bangladesh in comparison with the high income OECD countries. Still govt. of the Bangladesh has taken action to reduce CO_2 emissions from different (power, transport and industrial) sectors down to 5 percent (Third National Communication-UNFCCC, 2018). Furthermore, as a developing country Bangladesh needs to focus on its economic growth and social welfare also not to jeopardize the environmental condition (Perspective Plan, 2010-2021). On the other hand, it can be argued that sustainable development may be able to reduce the amount of man-made changes in nature and help protect against environmental catastrophic damage. Because sustainable development is a process which not only helps to maintain economic growth with the social issues, but also concern about the environmental balance (Parris, 2003). Therefore, it can be argued that, to solve this unwanted environmental tension promoting sustainable development is essential.

2.4 Issues of the Sustainability

2.4.1 History of the Sustainability

The Club of Rome, a globally well recognized association of business executives, scientists, government officials and scholars, first introduced the term “sustainable” on a report called “The limits to growth” which was published in 1972 (Meadows and Donella,1972). For the first time this report explores to bring growth to the same level considerations as the past, present and as well as the future. This report also discusses about that since resources are finite, so the growth depends on resources cannot be infinite. The writers of the report “Limits of growth” relate “sustainability” (Meadows et al., 1972, pp.158). Schumacher’s “Small is beautiful” (1973) also discuss about the increasing rate of unsustainable economic growth for ensuring economic development is not correct at this finite world (Schumacher, 1973).

Moreover, in the same year 1972, the UN Conference on Human Development (UNCHD), was occupied in Stockholm in relation to the outgoing environmental pollution issues. The main purpose of the promoters of industrialization at that time was to create more wealth and increase their profits and the result was unplanned growth (UNCHD, 1972). This unplanned and unsustainable growth later created environmental catastrophe and resulted in global warming (Tim Everett and et al., 2010).

After UNCHD, in 1980; IUCN, UNEP, WWF and UNESCO, jointly published a report titled “The World Conservation Strategy”. This report further raised awareness related to the environmental conservation issues. The term "conservation" was defined in the World Conservation Strategy report. This report suggested that the natural resources needed to be used by people in such a way that the present generation would obtain the most sustainable benefits as well as the future generations' needs could be met excellently (IUCN, 1980).

Due to various man-made activities and unplanned industrialization, *greenhouse gas emissions* have been increasing day by day and as a result, the amount of global warming in the world's atmosphere has increased and for this reason, in 1983 the UN Secretary General's Office has instituted the World Commission on Environment and Development (WCED) under the chairmanship of Mr. Gro Hurlem Bruntland. After that, in the year 1987 the Bruntland Commission presented its report named "Our Common Future" and gave the definition of "*sustainability*"(Our Common Future, 1987). This report also suggested that without hampering environment, continuous economic growth can be ensured by introducing and implementing technological and organizational innovations, respectively.

After that, in 1992 the Earth Summit (UNCED) was occupied, which was a remarkable international conference in relation to three pillars of sustainable development. Among five essential documents provided by UNCED, Agenda 21 broadly describes sustainable development. Moreover, the Agenda 21 keeps the human being on the priority of this development process. Which also means that, everyone is included; nobody is excluded from the benefits of development (UNCED, 1992).

2.4.2 Sustainable Development

Sustainable development is a universally agreed and recently introduced innovative concept of development. According to the traditional concept, development refers to the progress achieved in the social and economic fields. Famous development economists Todaro and Smith state that Development is a multi-dimensional process which not only concerned about economic condition but also works for social institutions (Todaro and Smith, 2011). The environment was usually neglected on that conventional thought. In other words, even if the environmental pollution increases, if the per capita gross domestic product (GDP) increases, then the development is considered to take place according to the conventional idea. But in reality the importance of the environment is immense; there is an important relationship between the environment and the development of human life and healthy living. Therefore, proper development is not possible by polluting the environment. From this idea, the thought of sustainable development emerges. Definition of the Brundtland Commission on sustainable development was described as - it is a kind of development which not only concerns about the needs of the present generations but also conscious about the needs of the future generations (WCED, 1987). This definition of the Brundtland Commission speaks of intergenerational equality. In other words, the present and the future generations have equal rights in the field of development. Problem is, whereas the current generation is present at this moment, the future generation is yet to emerge. However, maintaining this inter-generational equality is not an easy task. It involves uncertainty as well as the complexity of implementation, just as ethics is also involved in it. Moreover, after Brundtland Commition report sustainable development becomes a vital issue for the development planners, politicians and practitioners (Burton, 1987). Furthermore, according to Agenda 21 adopted in 1992 in Rio Earth Summit and as reiterated in the outcome document (The Future We Want) of the 2012 Rio+20 Conference, SD is basically a gradual development procedure that explores economic acceleration, social welfare, and environmental safeguard by giving the full concentration towards the human being and intergenerational and intragenerational equity.

2.4.3 Three Pillars of Sustainability

The emergence of the thought of sustainable development is followed by extensive discussion and analysis in this regard. From all these discussions, three elements or pillars of sustainable development become clear. The three pillars of sustainable development are a powerful tool in providing the idea of sustainable development. These are the economic, the environmental and the social pillars. When one pillar is weak, the whole system is attacked, that is, each pillar is inextricably linked with the other (Basigo1999; Gibson2006; Boyer et al., 2016). Milne argues that basically sustainability invoking the balance among the social, economic and ecological values (Markus & Milne, 1996, p.137).

Economic sustainability is an important and essential pillar of sustainable development. A system will be economically sustainable only when it is able to produce goods and services uninterruptedly, there will be equality of consumption and distribution system, there will be efficiency in capital and labor management and the external loan will always be at a tolerable level. Sustainability is associated with economic pillar which maximizes income and also try to keep capital stock constant (Munasinghe, 1993).

Social sustainability, on the other hand, is one of the key words: equality, poverty, appropriate social facilities, political transparency and taking part in political decision-making. Each of the above issues is crucial for achieving social sustainability. Sustainability and sustainable development are involved with the social pillar which invoking equity and participation (Munasinghe 1993).Achieving growth is not the only prerequisite for sustainable development. It demands reducing inequality and welfare of all.

Moreover, one most complex of sustainable development elements is the environmental pillar. An environmentally sound system can only be sustainable if its resource base is stable. This requires moderate extraction of renewable resources, non-waste generation beyond the absorption capacity of the environment and non-renewable extraction to ensure adequate investment in alternative resources. A sustainable environment and its biodiversity have a stable atmosphere all its functions are conducted normally.

The three elements discussed as sustainable development pillars indicate that sustainable development is a multidimensional concept. Achieving sustainability conditions in all three cases is indeed a complex process. However, if sustainability is achieved in one sector, the chances of achieving sustainability increases on the other sectors as well. That is, sustainability components complement each other. On the other hand, if any, of one pillar is badly neglected, no matter how much sustainability is met in the other two hands; overall sustainability will not be achieved. Every sector must be given equal importance to ensure sustainable development (Campbell, 1996).

2.4.4 Concept of Weak and Strong Sustainability

Mainstream economists and environmental economists are having different opinions about the issue of sustainability. From the very beginning of the sustainability discussion there is a debate on the issue of weak and strong sustainability (Neumayer 2013.pp.22; Redclift 2005). Although both sides agree to keep the total capital reserves intact, they differ on the issue of natural capital reserves. Mainstream economists believe that man-made capital and natural capital are substitute able to each other and man-made capital increases when the amount of natural capital decreases. This concept of sustainability is known as weak sustainability (Whittaker & Likens, 1975). Mainly weak sustainability is associated with the thought of neo-classical growth theory, which concerted only on the capital accumulation for ensuring economic growth. To expand the economic growth weak sustainability supported using the non-renewable excludable resource as a factor of production (Dietz & Neumayer, 2007).

Environmental economists, on the other hand, place more emphasis on natural capital and speak of maintaining natural capital reserves as well as total capital reserves as a condition of sustainability. They think that man-made capital cannot be a substitute for natural capital. This concept is known as *Strong Sustainability*. According to environmental economist David Pearce (1989), it is extremely difficult to maintain the condition of strong sustainability because zero or negative depreciation rate of natural capital is actually impossible (karl-Goran, 2007, pp.72). Weak sustainability, therefore proposes trade-off with man-made capital and natural capital. If natural resources are damaged in one development project, then man-made capital must be increased through another project or natural capital increase project has to be undertaken (Neumayer 2013).

Beckerman (1994) argues that weak sustainability is sufficient because in order to achieve strong sustainability people need to sacrifice a lot, which totally impractical (Beckerman, 1994 p.191). On the other hand, the famous environmental economist Herman Daly mentioned that it is not possible to replicate the services that nature provides us. These natural capitals are not interchangeable with man-made capitals but are complementary. Realizing the global reality of natural capital, many environmental economists suggest that compensation projects be adopted. That is, if a development project harms the environment in one region, another complementary project will have to develop the environment in another region or otherwise. Environmental economists oppose the proposal (Daly, 1992). They said that any change in the environmental structure of a region is undesirable. So they talk about development that does not change the nature. Proposals from strong sustainability proponents would seem more appropriate to environmentalists in general, whereas proposals from weak sustainability proponents would appeal to economists in general. Therefore, weak sustainability thought is can be considered as illegitimate (Biely, 2018) and we need to move towards the concept of the strong sustainability thought. In the Rostow (1996) *Stage of Growth Theory* if we follow the five stage of growth then we will find that this theory allows human society to move beyond the growth. After third stage 'Take-off', the environmental policy issues come in the stage four 'Drive to Maturity' and finally human society started to think beyond the growth in the last stage namely 'Mass Consumption' (Rostow, 1996).

2.4.5 Goals of the Sustainable Development

Sustainable development have 17 universal goals and 169 targets, these goals were obtained from the United Nation State for protecting our plant and to ensure peace for all by 2030 (UNDP, 2021).

Although all of the goals are equally important and interconnected to achieve sustainable development by 2030 but this study only focuses on the SDG9 which speaks about the Industry, Innovation and Infrastructure. Sustainable Development Goals # 9 (SDG-9) focuses on the issues of the sustainable industrialization (Apendix-2). This SDG9 have five different targets, but this study only focuses on the target 9.2 which is related to the sustainable industrialization. Underpinning this economic target 9.2 are two related indicators-

- **9.2.1** Manufacturing value added as a proportion of GDP and per capita
    - 9.2.1.a Manufacturing value added as a percentage of GDP
    - 9.2.1.b Manufacturing value added per capita
- **9.2.2** Manufacturing employment as a proportion of total employment

Here, manufacturing industry represents the industries associate to the International Standard Industrial Classification (ISIC) divisions 15-37 and tabulation categories 'D'. (UN, 1990).The country Bangladesh targeted to increase Manufacturing value added as a percentage of GDP to 35% and manufacturing employment as a proportion of total employment to 25% by 2030 (BBS, 2020).

2.5 Sustainable industrialization

A *sustainable industry* is basically an industrial system that is more labor intensive and clean technology intensive than capital intensive (UNIDO, 2017, p.61). Since our resources are limited, so this is essential to ensure optimal utilization of these limited resources. That is, this is an industrial system that does not pollute, produces less waste, uses clean energy, and uses environmentally safe materials. It demands not only about using clean energy but also demands, ensuring energy-efficiency of its all production processes. All of these industries are primarily focused on ensuring the safety of workers and enhancing skills and experience to ensure the proper use of limited resources and energy. Such industries are highly conscious about the preservation of natural resources and taking care of the biosphere

The United Nation for Industrial Development Organization (UNIDO) mentioned that SID is a kind of development that needs to accomplish three dimensions, economic, social and environmental (UNIDO, 2005). First, it promotes a healthy and competitive economy, which helps to increase economic growth; second, it originates efficient and skillful employment to ensuring long-term prosperity for increasing social welfare and third, this process is related to the conservation of the environment, with industry preserving renewable resources and optimally using non-renewable resources. (Seetoh & Ong 2008, pp.113).

According to the European Commission, to establish a sustainable industrial development programme one needs to integrate three components or pillars of sustainability and it also demands environment awareness related to innovation and development in industrial sectors (EC, 1999, pp. 4). All of the three pillars are very important for the sake of the industry's sustainability performance (Elkington, 1994).

Economic performance- for the industry level the measurement of the economic performance is not only deals with financial activities but also related to the various corporate social activities (GRI, 2006). Merely improving the economy or making a profit never helps an industry to survive long. In addition to making a profit, an industry has to perform various non-financial performances such as corporate social responsibility and taking various initiatives to protect the environment to sustain an industry for a long time (Orlitzky, 2008).

Environmental performance defines how an organization manages its environment and plays a role in protecting the environmental (ISO, 1999).This presents basically the influences of the environment on the soil, water, air and ecosystem. According to Ranganathan (1998) there are four key components for environmental performance; which are: material use, energy consumption, non-product output and pollutant release. (Ranganathan, 1998, pp.3).

Social performance defines the sum of all the social responsibilities that an industry observes. Social performance basically makes an industry known as a humanitarian organization (Cooper, 2004). According to Ranganathan (1998) there are four main elements employment, community relations, ethical sourcing and social impact of product for social performance. (Ranganathan, 1998, pp.5).

However, this study mainly deals with the economic pillar of sustainable industrialization in macro level and it also deals with the environmental pillar in micro level in case of RMG and leather industry in Bangladesh but this work did not focus on social pillar.

2.5.1 Industrialization in the Bangladesh

There has been a huge economic progress in Bangladesh since its independence in 1971. There was a time when everyone called Bangladesh a 'bottomless basket' but now the Bangladesh is becoming a role model for its continued economic development (Helal & Hossain, 2014). Bangladesh averaged a real GDP growth rate 6 per cent throughout the decade (Ali et al., 2019). Bangladesh's principal productive sectors and their contributions to the GDP are: agriculture (12.65 percent), industry (28.79 per cent), and service (54.63 per cent) in FY 2019-20 (BER, 2020).

Industry is the second largest contributor in the percentage contribution to GDP, which includes RMG industry (garments & knitting sectors), leather industry, shipbuilding and ship-breaking industry, food and beverage industry, chemical industry, manufacturing industry, pharmaceuticals, etc. Since independence, Bangladesh has achieved a wonderful growth in of industrialization. The current trends of diverse indicators for measuring the industrial sector development appear to be satisfactory (Ahaduzzaman, et al., 2017).

One of the major sectors in industrial employment is the small and medium enterprise (SME) (Alauddin & Chowdhury, 2015). When we look at the history of industrialization of the Bangladesh, we can trace 177 naturally grown SME clusters. All of the clusters are based on innovations from the 2nd or 1st IR century, with slight modifications or in their original form. As a result, goods from these clusters are competing with foreign products in the same industry for established local markets (Abdin, 2019). Another major sector is the pharmaceutical industry, which has successfully developed in Bangladesh and the country's National Drug Policy established in 1982 played the role in boosting this development (Amin & Sonobe, 2013). However, this study focuses on the two emerging manufacturing sectors of the country. The Readymade garment industry and the leather industry, which are the major contributors of the country's export earnings.

2.5.1.1 The Readymade Garments (RMG) Industry:

Ready-made garments (RMG) industry is one of the quickest flourishing development sectors in the Bangladesh economy. In 2021, there were about 5000 garment factories in Bangladesh. According to the World Trade Statistical Review 2021, Bangladesh is the world's third largest exporter of readymade garments (RMG). Bangladesh was the world's second largest exporter of readymade garments, but now in 2021 Vietnam overtakes Bangladesh (Hossain, 2021). Bangladesh's RMG industry, which includes knitwear and ready-made garments sectors, is the nation's number one export earner. According to the data published by the Export Promotion Bureau (EPU) 2021, RMG is the country's highest export earner. This sector is targeted to increase its export earning around USD $50 billion by the 2021(Leahey, 2015) but due to the impact of the Covid-19 the country's export earnings continued to the negative tread from the last few months. Covid-19 pandemic caused 16.93 per cent reduction of the export in the Bangladesh (Latifee et al., 2020). As RMG is the country's top export earning sector, the export foreign currency earnings from RMG (Knitwear and woven) fell by 7.74 per cent in the FY 2019-20 (Financial Express, 2019). While its GDP contribution is about 10 per cent is mentioned by the BGMEA and the World Bank in the year 2019 (Islam, 2020). The export earnings by the sector were estimated to be about USD34.13 billion in FY 2019 (RMG Industry Outlook, 2019) but in the year 2020 the export value was approximately USD 27.95 billion. We found that the Export value is decreasing. Recently, more than 4.5 million people have been working in this sector, among them about 3.6 million are women workers (BGMEA, 2020).

Furthermore, the Bangladesh RMG sector is the shining star towards the whole world for sustainable environmental management industry. As mentioned by the BGMEA, the country has 150 green garment industries. It is also mentionable that, Bangladesh has the highest number of industries with the Leadership in Environment and Energy in Design (LEED) certification (The daily star, 2021). Among these total 150 green industries 44, 93 and 9 are in Platinum, gold and silver standard respectively and only four are just certified. Moreover, from the top 10 green industries of the world, 9 are situated in the Bangladesh which is also a matter of appreciation.

2.5.1.2 The Leather Industry

Besides garments, the leather industry of the country also has a bright future. Bangladesh has a reputation for producing good quality leather and Bangladesh ranks after India, China and Pakistan in the Asia. Around 85 percent of leather and leather products of the Bangladesh are exported in the different countries of the world. After RMG sector the leather sector was the second largest exporter, but now this sector lost its position. The Jute sector overtakes the leather sector and become second exporter of the Bangladesh economy. According to the export promotion data 2020 leather is the third largest export earner sector in the Bangladesh.

Bangladesh earned USD 1.01 billion from exports of leather and leather goods in the FY2018-19 (EPB, 2019) when it was the countries second exporter. But in the fiscal year 2019-20 the export of the leather and leather goods was USD 797.6 million thus the total export is declined by more than 21 percent (Ovi, 2020). As mentioned by the Leather goods and Footwear Manufacturers & Exporters Association of Bangladesh (LFMEAB) 2020, due to Covid-19 pandemic around USD 316 million orders were rejected by the foreign buyers. This is the one reason behind the declining of the total exports (The Daily Star, 2020). Other than this Covid-19 issue there are several challenges currently facing the leather industries. Among them most important is the non compliance around environmental issues because of delays in establishing Common Effluent Treatment Plant (CETP). Moreover, due to the lack of function of the CETP, leather manufacturers cannot achieve compliance certificate (Ovi, 2018). Thus, they are losing the opportunity to export their goods to global markets because without compliance certificate buyers are not placing orders. Bangladeshi manufacturers thought that they will find a bright future in the leather industry, particularly after policy changing in China. Due to US-China trade war, the global buyers may shift their order from China to Bangladesh. But unfortunately, the US buyers do not place orders to the Bangladeshi manufacturers because of not having compliance certificate. Furthermore, still now solid waste management is a big concerning issue in this sector. Moreover, another important issue is to maintain social compliance, which includes the workers right as well.

In addition, as a developing country Bangladesh needs to focus on its economic growth and social welfare also not to jeopardize the environmental condition. In this circumstance, to create a sustainable industry Bangladesh need to take effective strategies that may able to increase international trade and as well as national investment . However, Sustainable industrialization demands an industrial condition of balancing all of the pillars of sustainable development and also not to jeopardize the future generations as well.

2.5.2 Different strategies towards sustainable industrialization

There are several popular strategies to halt environment degradation and to promote environmental sustainability among them one of the very efficient strategies is introducing green building in Bangladesh. The establishment of the green building in the Bangladesh is a significant contribution towards achieving environmental sustainability (Alavey et al., 2017). As stated by the United Nations Industrial Development Organization (UNIDO) - Green industry is an industrial system which develops sustainable production and consumption by efficiently using the resources and minimizing the waste generation and controlling the pollution throughout the lifecycle of the production and consumption (UNIDO, 2011, pp.9). Although the govt. of Bangladesh as a whole is not active in implementing green industry aggregately but Govt. has already taken some significant steps in implementing green building in the export oriented sectors. Bangladesh bank launched Green Banking Policy Guide in 2011 and its main objective is to ensure environmental friendly production (Abedin & Azad, 2016). Not only Bangladesh government but also the World Bank and the International Finance Corporation (IFC) has emphasized on sustainable private sector development through financing (Word Bank, 2015).

However, as a developing country Bangladesh needs to focus on its economic growth and social welfare also without compromising its environmental condition. Therefore, to create a progressive economic growth Bangladesh need to adopt some fruitful strategies that may help to increase international trade and as well as national investment. Considering the issues of the global environmental problems there is a need to develop some new ways to solve environmental problem without minimizing growth, find new energy sources, decrease air pollutions, recycle wastes and to reduce water emissions. One of the recently explore idea associated with innovation is '***eco-innovation'*** (Garcia et al., 2015). According Kemp and Pearson (2008) eco-innovation is one of the most effective environmental management innovation programs. They further ascertain the innovative programs related to environmental management named eco-innovation as follows:

Eco-innovation is a process which is related to the production of goods and services, production ideas, methods, process or management of the company and it helps to minimize environmental risk and negative impacts of the energy and resource use. It can be developed by the organization or the can be adopted from the other organizations. (Pearson 2008, pp.7).

Moreover, all of the OECD countries acknowledge eco-innovation as an effective method to meet today's environmental problems (Ekins, 2010). To clear the difference between "innovation" and "eco-innovation", the OECD added to the feature that differentiates eco-innovation from innovation.

1. This is a kind of innovation, which works for reducing environmental problems.
2. This innovation is not only related to the product or process, but also conscious about social and institutional wellbeing (OECD, 2009, P.2).

Therefore, it can argue that, eco-innovation differs from traditional innovation practices due to its different features, ideas, techniques and multidimensional benefits.

2.5.2.1 Eco-innovation

The idea of the eco-innovation was first provoked by the Fussler and James in the year of the 1996 (Nicolai & Pillot, 2017). They have mentioned eco-innovation as a new way to alleviate harmful environmental consequences by introducing new products and processes to ensure economic and environmental benefits for all (Hojnik et al., 2016). Eco-innovation is one of the most effective environmental management innovation practices to reduce the environmental problems and risks (Kemp and Pearson, 2008 p.7). This method also used to reduce negative externalities related to environmental pollution. By creating new ideas, products and processes; eco-innovation helps to pay role in the sustainability goals (Rennings et al., 2000). According to Sezen et al. (2013) for the sake of sustainable development in manufacturing industries, eco-innovation can be considered as the useful strategic tools. By creating new ideas, products and processes, eco-innovations help to pay role in the sustainability goals (Rennings et. al., 2000). With the emerging importance of an environmental management technique named ***eco-innovation***, researchers started to present eco-innovation in different perspectives since the year late 1990s. At the very beginning are those works that make off factors that apply to the eco-innovation and the achievement arising from eco-innovation, with kammerer (2009) and Pujaru and Dangelico (2010) being the example of these types of studies. Another group is those that find out the dimensions of eco-innovation, with Hermosilla et al. (2010) as a best example of this category. Moreover, another important category of works is related to the measurement of eco-innovation such as, Arundael and Kemp (2009) and Cheng and Shiu (2012).

According to the Sezen and Cankaya (2013) ***eco-innovation*** (green innovation) can be divided into three main types (pp. 156).

1. *Eco-product innovation,*
2. *Eco-process innovation,*
3. *green-managerial innovation*

The ***eco-product innovation*** is basically about a process which is mainly created for the improvement of the environment by applying existing eco-products or innovating new eco-products or green products to the save environment. For reducing environmental impact on the earth eco-product implementation mainly concerns about the product’s life cycle. The main vision of this eco-product innovation is minimizing environmental consequences (Cheng et al., 2012) by ensuring resource efficiency and upgrading environmental performance (Dong et. al, 2014).

The ***eco-process innovation,*** mainly deals with the production processes of the industry. Its implementation involves the betterment of current production processes for minimizing environmental problems. It also deals with the introduction of new processes for minimizing negative externalities or bad impact on environment generated due to the production processes in the industry level (Cheng et al. 2012). This innovation basically demands clean production system, minimum waste and emission generation and optimal use of the resources (Sehnem et al., 2016). Furthermore, this eco-process innovation helps to reduce greenhouse gas emission without minimizing the level of productivity (Kemp & Arundel, 2014).

The ***green-organization or eco-organization*** implementation involves the development of eco-innovation management, business methods and processes reorganizations (Rennings et al., 2006). This technique deals about the organizational member's skills and willingness to apply the eco-innovation management. That means the awareness of organizational member's related with environment friendly management techniques. Moreover, this type of innovation creates technological changes of the company for minimizing environmental problems (Frondel et al., 2007).

This study, examined both the eco-product innovation and eco-process innovation. This study did not cover eco-organization implementation because according to Murphy and Gouldson (2000) eco-organization is not in a position to reduce environmental impact directly. Therefore, this study covered eco-product innovation and eco-process innovation in environmental sustainability perspective in the case of RMG and leather industries in Bangladesh.

2.6 Some study related to the eco-innovation

Ramadan (2019) conducted a study on technological innovation in the agricultural sector in Spain. The goals of this study were to find out the impact of eco-innovation strategy of cooperation strategy on performance. Data was collected from 277 agricultural food companies. The findings of the study have shown that R&D and technological innovation are helpful for increasing sales and profitability of the company and also reduce the cost of production. Moreover, eco-innovation is also effective for small companies.

Aboelmaged (2018) have done a study to examine the impacts of eco-innovation, environmental orientation and suppliers' collaboration on performance in the United Arab Emirates. Data were collected from 182 hotel managers and finding of this study revealed that, both eco-innovation and environmental orientation have an impact on performance.

Costantini (2017) did a work on eco-innovation to examine the influence of equation on environmental performance. This paper collected data from 27 EU countries and 13 other major countries' environmental performances. The findings of the study have shown that eco-innovation have direct impact on environmental performance.

Chean & Shiu (2012), conducted a study on the eco-innovation in the China. The objective of this study was to create an instrument to measure eco-innovation. This paper collected information from 298 managers and created a very dependable and effective eco-innovation application scale.

Lee & Min (2015) have conducted a study to estimate the impact of eco-innovation on environmental and financial performance in the manufacturing sector of the Japan. This study found that it has a direct relation on environmental performance and financial performance.

Cheng et al. (2014) conducted a study on eco- innovation (eco- product innovation, eco-process innovation and eco-organizational innovation) to determine the every innovation types effects on the performance of the business in Taiwan. From the 121 senior managers of the environmental Management Association in Taiwan were surveyed by the study. The result of these is study have shown that, all of these innovations are having its direct or indirect effects on performance of the business.

Dong et al. (2014) did a study to find out the impacts of economic recession types and environmental rules on environmental performance in the Chinese enterprise. The outcome of this study has shown that eco-innovation, eco-product and environmental rules has significantly effected on environmental and financial performance of the Chinese enterprises.

Habach (2012), conducted a study on the eco-innovation. The main goal of the paper was to learn about the dynamics of equation types. The paper use questionnaire method to collect the data from community survey of the European Commission. The finding of the paper can be present as eco-innovation is an effective trigger for ensuring cost advantage and eco-innovation also helpful for the minimization of the energy use and pollution level.

Hellstrom (2007) conducted a study on eco-innovation mode and types. Data was collected from annual Swedish eco-innovation companies. From the study it found that there was several attractive modes of eco-innovation are available but there were some biasness in the process.

Pujari (2006) have done a work on eco-product innovation in North America. The objective of this study was to investigate the effect of emerging new eco-products on the market performance. To conduct the survey this study collected data from 68 product managers. From the outcome of this work it can be revealed that Eco product innovation, influence the market performance very effectively.

Rennings et al. (2006) conducted study on eco-product and eco-process innovation in the German manufacturing sector. The main aim of this study was to identify the effects of EMAS on technical environmental innovation and economic performance. This study used a questionnaire method and 12 case studies. Data were gathered from 1277 managers. The outcome of this study indicates that eco- process innovation is important for both economic and environmental performance.

2.7 Some Study Related to the Sustainable Industrialization

After describing about some study related to eco-innovation, in this part of the literature review, this paper presents some of the works related to the sustainable as well as green industry.

Chen et al. (2017) did a study on green industry in the China. This study used grey correlation and elastic coefficient analysis to find out the importance of the green industry to the national economic growth. Considering data from the period of 2008-2012 this work found a positive relationship between green industry and GDP growth. This study also finds a positive relationship with increase in green product exports and GDP in China. According to the outcome of this paper a 1 percent raise in green product exports ensures 0.04 per cent increase in GDP but the effect of green industry was insignificant on employment generation.

Ali et al. (2016) studied for identifying the level of use of the green initiatives and its way of using in the construction industry in Kota Kinabalu, Malaysia. They mainly focused on green technologies which were used by the economic development activities. It is also mentionable that only a green technology is not enough for sustainable development. For making actual change different relevant training and awareness creation activities are needed.

Deng and Liu (2011) conducted a study on oil industry to analyze the different problems in the supply chain in China. This study suggested green supply chain to solve the problem related to the supply chain.

Theyel (2000) undertook an empirical survey on the chemical industry in the USA. The objective of this work was to learn about the industry's adoption of environmental management activities and to identify the relationships between environmental management activities with environmental performances and innovations. The study finds that chemical firms are practicing various types of environmental innovation methods. In addition, some of the firms switch their production processes to the cleaner production.

2.8 Research Gap Identified From Literature Review

There are different types of studies are done by the researchers on the several aspects of the eco-innovation. Most of the work focuses on eco-product, eco-process and eco-organization (Garcia et al., 2018). Some of the work also investigate on the eco-marketing also. But most of the studies have been conducted in the perspective of the developed countries. Only few number of the research has been conducted in the case of the developing countries. In addition, to my best knowledge, this is maybe first work conducted in the context of eco-innovation (eco-product and eco-process) and environmental sustainability performance index in the Bangladesh.

2.9 Conclusion

At last it is very much clear from the review that eco-innovation is one of the relatively new but effective technique for improving environmental sustainability performance. From these reviews it is found that most of the studies were conducted under the perspective of developed countries, few of the studies were conducted under the perspective of developing countries. The literature review shows that despite its limitation, the impact of eco-innovation needs to be analysis in developing countries like Bangladesh to make decisions related to sustainable industrialization. This chapter also presents some research gap, which are identified from the literature review.

Chapter Three

Methodology

3.1 Introduction

This chapter gives a description of the methodological part which has applied for this study. It presents the theoretical background and hypothesis development, conceptual development, sample size, sampling technique, data sources, data collection procedure and questionnaire design. After that econometric model are discussed. The main objective of the study is to find out the prospects of Bangladesh to promote sustainable industrialization by 2030, and this study was also presented the relationship between eco-innovation and environmental sustainability performance to formulate long term policy for sustainable industrialization program. Under this main goal, there are three specific objectives, considering the macro and the micro issue.

3.2 Theoretical background and hypotheses development

3.2.1 Theoretical background

3.2.1.1 Sustainable Industrialization Theory Sustainable industrialization refers to the process of industrial growth that is environmentally sustainable, economically viable, and socially inclusive. This concept aligns with the Sustainable Development Goals (SDGs), particularly Goal 9, which emphasizes building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. For the sake of the sustainable industrialization selecting workable industrial production methods are essential (Hirvilammi and Koch, 2020). Recently, Eco-innovation has been considered as one of the efficient strategic tools for sustainable development (Weng et al., 2015). Eco-innovation plays a pivotal role in this context by enabling industries to grow while minimizing their environmental footprint (Hojnik et al., 2023).

3.2.1.2 Eco-Innovation Theory The notion of Eco-innovation is come up from the principle of a circular economy and highly integrated with the concept of the sustainable development

(OECD/ Eurostat, 2005; Hirvilammi et al., 2023). Eco-innovation has emerged as a crucial component in addressing global environmental challenges and fostering sustainable development. Eco-innovation is the development of new products, processes, technologies, or business models that lead to environmental benefits or reduce negative environmental impacts. It can be seen as an extension of traditional innovation theories, such as Schumpeter's theory of innovation, with a specific focus on environmental sustainability (Sanni and Verdalini, 2022). Eco-innovation encompasses various dimensions, including technological innovation, organizational innovation, and systemic innovation, each of which contributes to improving environmental performance in industry. By creating new ideas, products and processes; eco-innovation helps to pay role in the sustainability goals (Rennings et al., 2000). According to Sezen et al. (2013) for the sake of sustainable development in manufacturing industries, eco-innovation can be considered as the useful strategic tools. With the emerging importance of an environmental management technique named ***eco-innovation***, researchers started to present eco-innovation in different perspectives since the year late 1990s. Eco-innovation plays a vital role in achieving this balance by offering solutions that promote economic growth while minimizing environmental harm (Pujaru and Dangelico, 2010).

Moreover, both eco-product and eco-process innovation are two critical aspects of environmental sustainability (Hang and Chem, 2021). Eco-product innovation refers to the development of new or significantly improved products that are designed to reduce environmental impact throughout their life cycle. This includes using sustainable materials, increasing energy efficiency, reducing waste, and enhancing recyclability (Cooke, 2011). By creating products that are less harmful to the environment, companies can help reduce resource consumption and minimize pollution. Eco-process innovation involves improving the processes used to produce goods and services in a way that reduces environmental harm.

This can include adopting cleaner technologies, optimizing resource use, reducing emissions, and minimizing waste in manufacturing and operations. By focusing on eco-process innovation, companies can lower their environmental footprint and contribute to more sustainable production practices (Demirel and Kesidos, 2019). According to the recent literature both types of innovation are essential for achieving long-term environmental sustainability, as they help mitigate the negative impacts of industrial activity on the planet (Chaparro-Banegas et al., 2023). According to the Behnam and Cagliano (2016) eco-innovation undertakes all the activities and tasks adopted by the stakeholders originating and appling new concepts, activities, products and processes that lead to halt environmental degradation and helps to fulfill sustainable development goals (Behnam and Caliano, 2016).

3.2.2 Hypotheses Development

Based on the theoretical background, the following hypotheses were developed to examine the relationship between eco-innovation and environmental performance in the context of sustainable industrialization:

Hypothesis 1: Hypothesis 1: Bangladesh will be able to achieve the target of SDG 9.2 by 2030 for making its industry more sustainable.

Rationale: Sustainable Development Goal (SDG) 9.2 aims to promote inclusive and sustainable industrialization by significantly raising industry's share of employment and GDP in line with national circumstances and doubling its share in least developed countries by 2030. For Bangladesh, achieving SDG 9.2 is crucial as the country transitions from a developing to a middle-income economy.

Hypothesis 2: Eco-product innovation will have a positive relationship with industrial environmental sustainability performance in the Bangladesh.

Rationale: Product eco-innovation directly reduces the environmental impact of products throughout their lifecycle, leading to measurable improvements in environmental performance indicators.

Hypothesis 3: Eco-process innovation will have a positive relationship with industrial environmental sustainability performance in the Bangladesh.

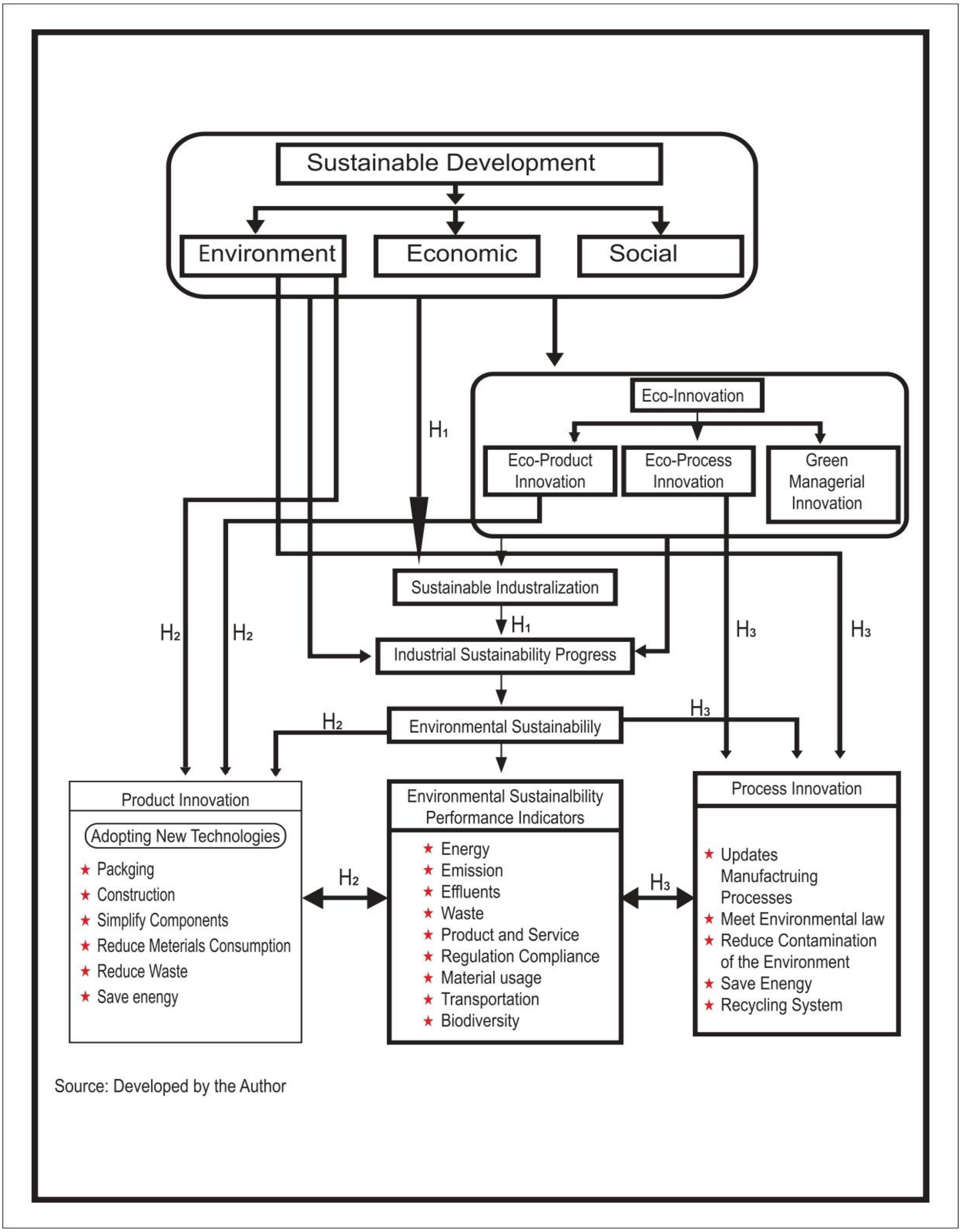
Rationale: Process eco-innovations optimize the use of resources and minimize waste and emissions, thereby enhancing the environmental efficiency of industrial operations.

The theoretical background and hypotheses outlined above provide a comprehensive framework for understanding the relationship between eco-innovation and environmental performance in the context of sustainable industrialization. By testing these hypotheses, researchers can gain insights into the mechanisms through which eco-innovation contributes to environmental sustainability and identify the conditions under which it is most effective. This framework also highlights the importance of institutional pressures and dynamic capabilities in shaping the impact of eco-innovation, offering valuable guidance for policymakers and industry leaders aiming to promote sustainable industrial practices.

3.2.3 Conceptual Framework:

This framework provides a foundation for further empirical research and practical applications aimed at enhancing the role of eco-innovation in promoting environmental sustainability and ensuring long-term sustainable development.

Figure 3.1 Conceptual Framework



The interplay between eco-innovation and environmental sustainability is complex and multifaceted. By understanding the theoretical underpinnings and conceptual framework outlined above, stakeholders can better design policies and strategies that leverage eco-innovation to achieve sustainable development goals. The transition towards a more sustainable future depends on the widespread adoption and diffusion of eco-innovations across industries and regions, driven by supportive regulatory environments, market demand, and technological advances.

3.3 Study Area

To meet the second specific objective of this thesis, the data were collected from manufacturing industries of the Bangladesh. The manufacturing sector was selected based on the issues, that this sector uses maximum energy and resources (Blair and Hitchcock, 2011), moreover, this sector is also responsible for carbon dioxide emission (IPCC, 2014), harmful waste generation for the environment and greenhouse gas emission. The two manufacturing sectors have been selected for the survey and analyses, RMG and Leather sectors that are among the sectors which are the major contributor to the industrial development of the Bangladesh (Ferdous, 2015; Rahman, 2004). This study explores the ready-made garments and leather industries which are situated in Dhaka division to examine the influences of eco-innovation on sustainability performance, especially in case of environmental performance of the selected industries related to the issue of sustainable industrialization in Bangladesh. Dhaka is the capital city of the Bangladesh and most of the leather industries are situated in the Dhaka, based on these issues Dhaka is selected as the study area for this study.

3.4 Research Design

The study undertook an exploratory cross sectional survey. Industries were selected using simple random sampling to avoid selection bias.

3.5 Data Source, Sample Size and Sampling Techniques

The nature of the work demands the collection and analysis of both primary and secondary data. Hence, to obtain first hand information, to project how close the Bangladesh to achieve the target of SDG9.2, this study considered only one indicator 9.2.1Manufacturing value added as a proportion of GDP and per capita to find out the country's prospects for sustainable industrial development. 9.2.1.a Manufacturing value added as a proportion of GDP data was taken from the World Bank data set indicators 2020 and 9.2.1.b Manufacturing value added per capita data were collected from the UNIDO-Competitive Industrial Performance Index, 2020. Another indicator manufacturing employment as a proportion of total employment is also related, but due to unavailability of long time data series this indicator is not considered for this study.

Moreover, this study employed primary survey-based data to examine the influences of eco-innovation on sustainability performance, especially in case of environmental performance of the selected industries related to the issues of sustainable industrialization in Bangladesh. A primary survey conducted to collect the data from the export oriented industry. To meet the second specific objective of this study, the data were collected from Bangladesh's 50 manufacturing companies. Considering the data collection problem (during Covid-19 pandemic), the study has collected information from only 50 units of RMG (30 units) and leather (20 units) companies based on purposive sampling.

According to the BGMEA list there are four categories of the RMG sector (Knit, Woven, Sweater and others). Based on the information of the BGMEA list, from all of the categories of the RMG companies was selected by using a simple random sampling technique to avoid statistical biasness.

Furthermore, the leather industry, mainly divided into two sectors. The Tannery industry and the Footwear and leather factory are the two broad sectors of the leather industry in the

Bangladesh. From these two sectors we purposively select the tannery companies. We took tannery considering the issue, that this sector is more responsible for environmental pollution because it process the raw hide to finished leather. The leather (tannery) companies were also selected by using a simple random sampling technique.

Furthermore, in this study, Key Informant Interviews (KIIs) were conducted to gain in-depth insights from individuals with specialized knowledge on Eco-innovation. Purposive sampling was employed to select 15 key informants who met predefined criteria, including having widespread knowledge on the impacts of the eco-innovation in the environmental sustainability. These informants were chosen based on their expertise, professional role, and experience relevant to the study's objectives. Initial contact was made via email/phone, where the purpose of the study was explained, and consent was sought for participation. In cases where key informants were unable to participate, they were asked to recommend other suitable candidates, following a snowball sampling technique to ensure a diverse range of perspectives. The sample size was determined based on the principle of data saturation.

3.6 Method of Data collection

Primary data on these eco-innovation measurement comprising industries current green innovation and greening initiative and the benefit of undertaking sustainable industrialization in case of one of the pillars of sustainable development (environment) was collected through a structure questionnaire and by adopting a face-to-face interview technique. Senior management and owners of the selected industrial units was chosen for data collection. Besides, data on environmental issues, sustainable production procedure, technology, energy use and level of awareness was collected using the structured questionnaire. The time period of the data collection was January 2021 to June 2021.

Qualitative data were collected through by KII for this study. All key informants were informed of the study's objectives, the voluntary nature of their participation, and their right to confidentiality. Informed consent was obtained from each participant before the interviews commenced. The interviews were conducted in a manner that respected the informants' time and expertise, typically lasting between 30 minutes to 45 minutes.

3.7 Designing the Questionnaire and Administering the Interview

The questionnaire was collected and complied from different important documents from the literature reviewed, but considering the data collection problem (during this Covid-19 pandemic), the study conveniently used only 50 units of RMG and leather industries for collection of primary data.

The Eco-innovation scale was adopted from Arundal and Kemp (2009) and Cheng and Shiu (2012). Few shuffles were formed to working to suit the context of this work. According to most of the scholars and consultants there are no common standard measurements of industrial sustainability (Leonordo Academy, 2008). Sustainability scale applied in this thesis was taken from GRI (2002). GRI Guidelines have got approval by the companies for sustainability reporting. In 2010, GRI website listed 1,973 companies that adopted the GRI Guidelines in preparing their sustainability reports (Hsiang et al. 2014). A total of 10 items were included for measuring eco-product implementation and 6 items were considered for measuring eco-process process implementation for this survey as suggested by the Cheng and Shiu (2012). Moreover, to measure environmental performance indicators this study used 10 items as suggested by the Sustainability Report Guideline, Global Reporting Initiative (GRI), Environmental Performance Indicator, 2002.

The study first used to identify whether the industry applies any eco-innovation measurement techniques. If the answer was yes, then what type of innovation they have adopted? The questionnaire was parted into five main sections (attached in the Appendix 1). The initial part was described about eco-innovation and few questions were asked to learn about that whether their industry applies or initiate any innovation activities during 2018-2020. If their answer showed that their firm is eligible for this survey then we proceed to our next part of the questionnaire. The second and third parts cover eco-product (good or service) and eco-process innovations as suggested by the literature review. In the second part, firstly it describes about eco-product innovation and ask them whether their enterprise introduce any eco-product innovation during the year 2018-2020. If their answer is no, then we moved to the third part of the questionnaire. If their answer is yes, then we proceed to measure eco-product implementation. For measuring eco-product implementation, we used 10 items as suggested by the cheng and shiu (2012). In the third section of this questionnaire, this paper discusses eco-process innovation and tries to measure eco-process implementation by using six items. The Likert scales measure was used in this questionnaire to rate industries unit over the last three years. The 4 point Likert scale, ranging from Applies fully (4), Applies Partly (3), Does Not Apply (2) and Not Relevant (1) were used in this questionnaire to measure both eco-product and eco-process innovation. At the forth part of the questionnaire, we describe innovation with environmental benefits. This paper tried to learn about the environmental benefits of the eco-innovation by the different performances of the specific industries. Finally, in the last part of the questionnaire, we explore the 10 items to measure environmental performance indicators as suggested by the GRI, Environmental Performance indicators, 2002. Here to measure environmental performance indicators again we used 4 point Likert scale, ranging from High (4), Medium (3), Low (2), Not Relevant (1).

Furthermore, a pilot survey was conducted on a random sample of total 6 (3 RMG and 3 Leather) industries, which were situated in the Dhaka city. The respondents were encouraged to give their observations or comments on any topics or issues they felt ambiguous. Based on their observation a very little modification was done. The final version of the survey questionnaire which is used for this study is attached in the Appendix 2.

Furthermore, The KII questionnaire was developed to collect detailed and context-specific information from experts and stakeholders on the issues of the eco-innovation. The primary aim of the questionnaire was to explore experts' considerations on eco-innovation in the industrial sectors of the Bangladesh, gather insights on sustainable industrializations. The questionnaire was designed to be semi-structured, allowing for flexibility in the interviews while ensuring that all relevant topics were covered. The questions were developed based on a thorough review of existing literature related to eco-innovation.

3.8 Method of Data Analysis

3.8.1 Secondary data were analyzed using statistical technique and econometric model:

The study employed time series analysis techniques to find out the current trends of the proposed indicators and this study also did forecasting (ARIMA) to project progress across the SDG9.2 in case of Bangladesh; to showing if current trends continue then what will be the Bangladesh conditions in 2030.

3.8.1.1ARIMA Model

In the year 1970, the Auto Regression Investigate Moving Average (ARIMA) model was introduced by Box-Jenkins. This model is basically well fitted for the time series analysis of medium to long length (George, et. al., 2008). The Variables are examined by adopting auto-regression (P) and moving average (Q) to explore data.

The simple Box- Jenkins (Auto Regression Investigate Moving Average) model:

$$\boldsymbol{Wt = \O 1Wt - 1 + \O 2Wt - 2 + \cdots + \O pWt - p + at - \Theta 1at - 2 - \cdots - \Theta qat - q(1)}$$

Where,

Ø and θ = unknown parameters

a= independent and identically distributed normal errors with zero mean,

P = the number of lagged value of W_t, it represents the order of autoregressive (AR) dimensions,

I = the number of times w is differed,

Q = the number of lagged values of the error terms representing the order of moving average (MA) dimension of the model.

This integrated term presents that to get a forecast for W, it is essential to integrate the forecast W_t. (George, et. al., 2008).

3.8.2 Primary data was analyzed using statistical technique and econometric model:

The collected data from the questionnaire survey was analyzed both by factor analysis to form an index for environmental performance under sustainability performance, eco-innovation and eco-process innovation. The regression analysis was used to prove the hypothetical relationship of the work.

The regression model was assumed the following model:

$$y_i = \beta_0 + X_{1i}\beta_1 + X_{2i}\beta_2 + \cdots + X_{ni}\beta_n + \varepsilon$$

Where,

Y_i = the explained variable

X_i = vector of explanatory variable

β = vector of explanatory to be estimated and

ε = error term

$$y_i espi = \beta_0 + \beta_1 eproci + \beta_2 eprodi + \varepsilon$$

Where,

$espi$ = Environmental sustainability performance index

$eproci$= Eco- process innovation index

$epordi$= Eco-product innovation index

ε = Error term

Based on the above regression analysis, the influences of eco-innovation on sustainability performance will identify. Here eco-product innovation and eco-process innovation will explanatory (independent) variable and environmental performance will explained (dependent) variables.

3.8.2.1Testing assumptions of regression analysis

This study tests different assumptions for applying regression analysis.

Residual

This study applied residual to identify the difference between the observed value from the scatter plot and the predicted value from the regression equation line.

Multicollinearity test

In the linear regression, multicollinearity test is applied to learn the extent to which independent variables are linearly related to the other independent variables. This paper used variance inflation factor (VIF) to test for multicollinearity. Mainly VIF determines the correlation between Independent variables.

Omitted variable test

This study applied omitted variable test to fit the values of dependent variables and to identify that omitted variables are not influencing model misspecification.

Heteroscedasticity test

This test is used in a linear regression model. This study applied the white heteroscedasticity test to identify that whether the variance of the error from of the regression model is constant.

3.8.2.2 Factor analysis

Factor analysis is a well-established statistical method which helps to create a data set more manageable and intangible. Basically, it is a very useful data reduction technique which helps to investigate concepts more specifically and accurately. Factor analysis is one of the best ways to solidify the data from the large number of variables into a small number of the variables (Garson, 2013).

3.8.2.2.1Types of factor analysis

Broadly, factor analysis can be classified into two types

-Exploratory factor analysis (EFA) and

-Confirmatory factor analysis (CFA).

EFA is a statistical method where it helps in fixing variables and creating a hypothesis about the underlying processes that play a role in clustering of the variables. This EFA method is applied in the primary stage of the analysis and it helps to test the internal reliability of the measure.

CFA is a special form of statistical technique which helps to verify the factor set from a set of observed variables. It helps to examine the hypothesis that a relationship between observed variables and underlying processes. This study used EFA due to the uncertainty of the underlying structure of the exploratory research work.

Exploratory factor analysis has two ways of conducting the factor analysis. These ways are- the principle component factor analysis and the common factor analysis.

According to the Hair et al., 2010 the selection of correct processes depends on two things. Firstly, it depends on the objective of the factor analysis and secondly, it depends on the previous idea on the variance (Hair et al., 2010).

CFA is basically applied in confirmatory research and applied when the investigators do not have any knowledge on the factor. Moreover, the principal component method is applied in exploratory research and applied when the investigators required to run the lowest number of factors and to explain the largest portion of variance in the actual variable (Salkind, 2010). Therefore, for this study component factor analysis was applied for accomplishing data analysis.

3.8.2.2.2Testing assumption for factor analysis

There are various assumptions are available for factor analysis. They are linearity, normality, homoscedasticity and adequate sample size. But the statistical assumptions of linearity, normality and homoscedasticity do not need to be fulfilled, if the data matrix has a sufficient correlation to support the appropriateness of factor analysis (Hair et. al., 2010). The process for justifying the adequate correlation for factor analysis is discussed in the following section.

3.8.2.2.3 Appropriateness of factor analysis

One of the most troublesome works for the statistician is to check the appropriateness of the data. Furthermore, reliability of factor analysis is completely associated with the appropriateness of the data. There are different methods of the appropriateness of the factor analysis are discussed below.

Examination of the correlation matrix

One of the easiest ways to ascertain the appropriateness of data is testing the correlation matrix, the plotting of the latent roots and inquisition of the commonalities estimates. The values of the correlation coefficient are associated with the appropriateness of factor analysis. If the values of the correlation coefficient are small, then it means that using factor analysis is inappropriate. Thus investigative should select the correlation matrix which has various values greater than 0.3; because it shows the appropriateness of the factor analysis (Hair et al, 2010).

Inspection of the Anti Image Correlation matrix

This method is used to identify the appropriateness of correlation matrix. It helps to find out the unique variables which are not being identified from other variables. The variables which have minimum significant level of point 0.5 are only acceptable for this analysis (Garson, 2013).

Batlett's taste of sphericity

Another procedure of the statistical test of data appropriateness is the Batlett's taste of sphericity. This test mainly gives the statistical probability and used to test the null hypothesis.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA)

MSA is a test for checking the appropriateness of data and it gives a measure of the extent to which the variables belong together.

$$MSA = \frac{\sum_{j\neq k}\sum r^2 jk}{\sum_{j\neq k}\sum r^2 jk + \sum_{j\neq k}\sum q^2 jk}$$

Where,

MSA= A measure of the extent to which the variables belong together.

r^2jk= the square of the off-diagonal elements of the original correlation.

q^2jk = the square of the off-diagonal elements of the anti image correlation

The calibration of the MSA; as suggested by the Kaisa and Rice (1974) is presented in the following table.

Table 3.2: Kaiser-Meyer-Olkin Measure of Sampling Adequacy Value

KMO	Interpretation
0.90 and +ve	Marvelous
0.80 and +ve	Meritorious
0.70 and +ve	Middling
0.60 and +ve	Mediocre
0.50 and +ve	Miserable
Below 0.50	Unacceptable

3.8.2.2.4 Criteria for the number of factors to extract in principle component analysis

Latent root criterion

One of the mostly used analyses is the latent root criterion. By using this technique investigator can be deducted those factors whose eigenvalues (latent root) are less than one.

Thus, the choice of eigenvalues value is one for this analysis. This analysis is good to use when the number of variables are more than 20 but less than 50 (Pandey et al., 2015).

Scree test criterion

This test is used to determine, how many factors should keep in any specific factor analysis. This method is used to make a judgment for the elimination of factors. This test is depending on the relationship between both latent roots and covariance matrix, in opposition to the number of factors in their order of squeezing out.

3.8.2.2.5 Factor rotation

Factor rotation helps to create the structure simpler to interpret by reducing the complexity of the factor loadings (Garson, 2010). Vector rotation is necessary if the investigators retain two or more factors, but retain only one factor then rotation is not relevant. Broadly, there are two types of factor rotation- Orthogonal rotation and Oblique rotation.

Orthogonal factor rotation

Orthogonal factor rotation is a transformation system used where latent variables are required to be correlated or remain individual from one another.

Varimax

Varimax is one of the most familiar and useful orthogonal rotation method which helps to facilitate the factors. By the use of the extracted factors this rotation can differentiate the original variables. If the variable factor is near to +1 it can be illustrated as a positive association where is the variable factor is near to -1 can be clarified as a negative association (Hair et al., 2010). Moreover, when correlation is near to 0, then the rotation presents a lack of association.

The Varimax Orthogonal factor rotation was applied in this study.

Quartimax

Quartimax MAX is another form of orthogonal rotation, which helps to simplify the structure by transforming factors associated with principal component analysis. But the limitation of this method is to generate large general factors (Pandey et. al., 2015).

Equimax

Equimax is a kind of rotation, which helps to compromise between Varimax and Quartimax.

Oblique factor rotation

Oblique factor rotation is a transformation system used on latent variables, or two or more factors are correlated. It helps to make the factors closer to clusters of vectors. According to Garson, 2010 a factor correlation matrix is created when an oblique is demanded.

Promax

Promax is used to find out the best least-squares fit between the app like factor- pattern or factor-structure. Matrix and a target matrix promax rotation is appropriate for large data set, atlist <150. In which state has small data set then oblimin is the best method (Pandey et. al., 2015).

Oblimin

Oblimin is another form of transformation system, applied to transform the factors connected with principal component analysis (Garson, 2013).

3.9 Conclusion

The main aim of this chapter was to discuss the methodological part. Required data for this study, data sources, data collection procedure, data analysis method all of the essential issues were presented in this chapter. Different statistical techniques and econometric model were used in this study was also discussed in this chapter.

Chapter Four

Results and Discussion

4.1. Introduction

This is a very important chapter of this study because the result obtained from the secondary data analysis and the sample industries are discussed here in brief. The first part of this chapter deals with secondary data related to the **target 9.2** for promoting inclusive and sustainable industrialization by 2030. To forecast the country's overall progress related to sustainable industrialization this study used ARIMA model and the outcome is discussed in this chapter .The second section provides the analysis of the identifying the relationship between eco-innovation and environmental sustainability in the case of RMG and leather industry in Bangladesh. To identify this relation this study used several statistical techniques. The outcome of the analysis, are discussed in this chapter. Lastly, this chapter also tried to generate some overall policy inputs. All the individual objectives are discussed severally in this chapter.

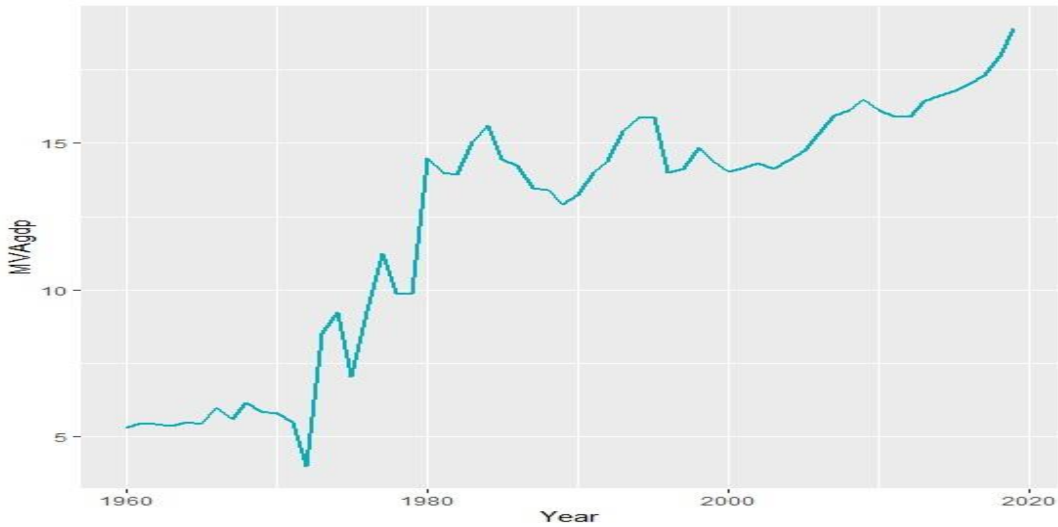
4.2 Results Relating to Research Objective One

To forecast the country's overall progress related to sustainable industrialization and to check the related hypothesis this thesis work Auto Regressive Integrated Moving Average (ARIMA) Model was used. Indicators 9.2.1 demand the data of manufacturing value added percentage of GDP. In Table 3.1 (Appendix 3) presents the data of manufacturing value added percentage of GDP in Bangladesh (in percent) during the period of 1960-2019. The data were collected from the World Bank data set indicators, 2020. Moreover, the indicator 9.2.1 also connected to the manufacturing value added per capita and the data were presented in the table 3.2 (Appendix 3). The annual data of manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014 were collected from UNIDO-Competitive Industrial Performance Index.

4.2.1 Forecasting the values of the Manufacturing value added (percentage of GDP) in Bangladesh (in percent)

Figure 4.1 presents the variables used in the analysis, which is the annual data of the manufacturing value added percentage of GDP in Bangladesh (in percent) represent a sample size 60 observations from 1960-2019. These 60 observations were used for estimation of the forecasted values.

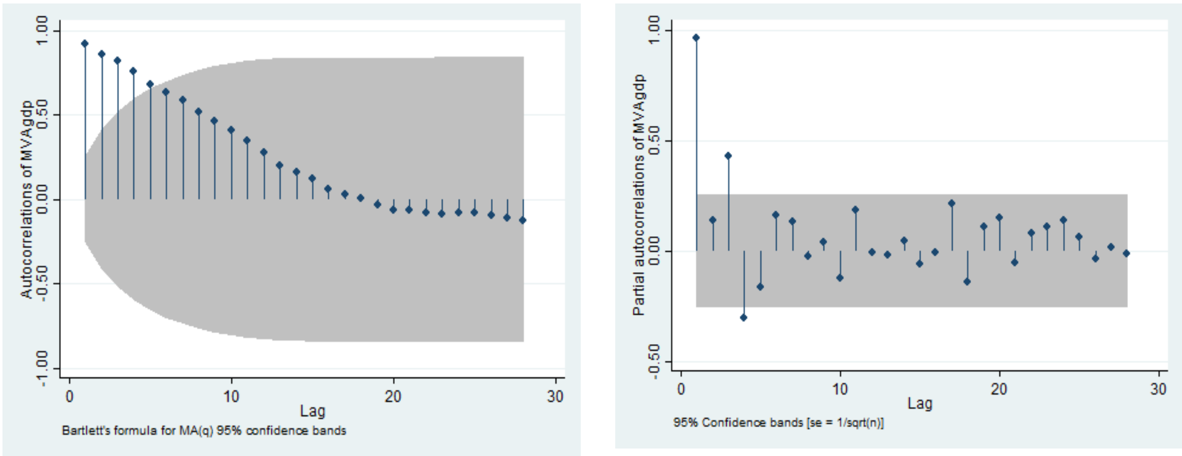
Figure 4.1: The annually data of Manufacturing value added percentage of GDP (in percent) in Bangladesh during the period of 1960-2019



Source: Compiled by the author from the secondary data

Figure 4.1 shows increasing trend and which represent that the used time series data is non-stationary. After that for defining the distribution of sample data autocorrelation functions (ACF) and partial autocorrelation functions (PACF) were applied in this study. The values of the ACF are gradually declining from auto correlation coefficient to the end. Here the PAF represents a large peak at lag 1 with a quick decline thereafter, which represents a highly persistent autoregressive structure in the series.

Figure 4.2 ACF and PACF of Manufacturing value added percentage of GDP (in percent) in Bangladesh during the period of 1960-2019 from left to right



Source: Compiled by the author

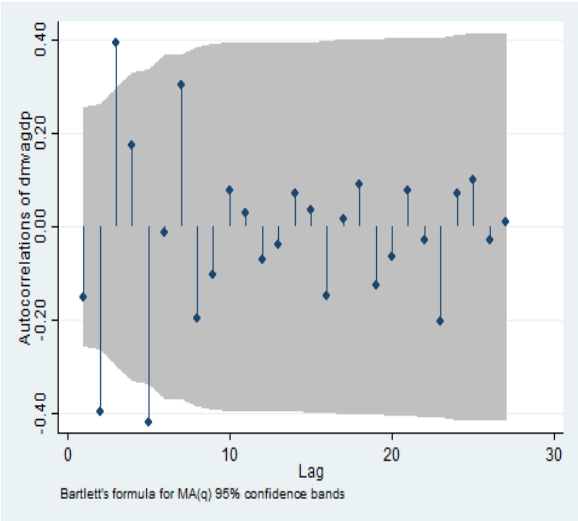
Table 4.1 Dickey-Fuller test for unit root of the annually data of Manufacturing value added percentage of GDP (in percent) in Bangladesh during the period of 1960-2019

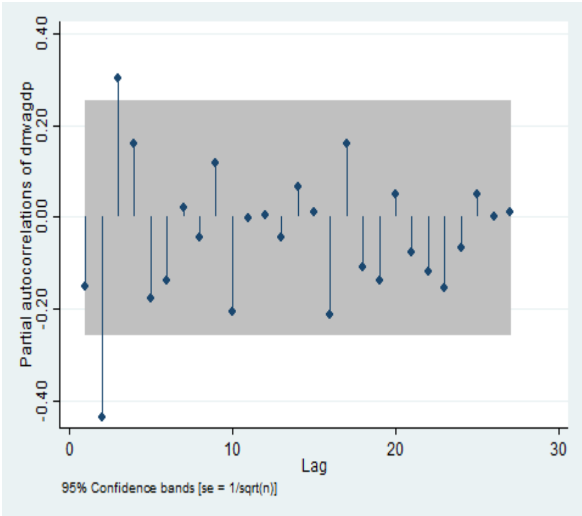
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.107	-3.567	-2.923	-2.596
MacKinnon approximate p-value for Z(t)=0.7125				

Source: Compiled by the author

Then the stationary unit root test is done and for this data Dickey Fuller test is used. Table 4.1 presents the p value=0.7125; fail to reject the null hypothesis (H_0), the data have a unit root and is non-stationary. Figure 4.3 presents ACF and PACF the transformed series. To taste stationary we applied Dickey Fuller test (unit root).Table 4.2 presents the p-value=0.0000 and while the p value was statistically significant and reject the null hypothesis (H_0), the data does not have a unit root and is stationary.

Figure 4.3 ACF and PACF of Manufacturing value added percentage of GDP (in percent) in Bangladesh after 1st differencing 1960-2019 from left to right





Source: Compiled by the author

Table 4.2 Dickey-Fuller test for unit root of the annually data of Manufacturing value added percentage of GDP after 1st differencing

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-8.689	-3.569	-2.924	-2.597
MacKinnon approximate p-value for Z(t)=0.0000				

Source: Compiled by the author

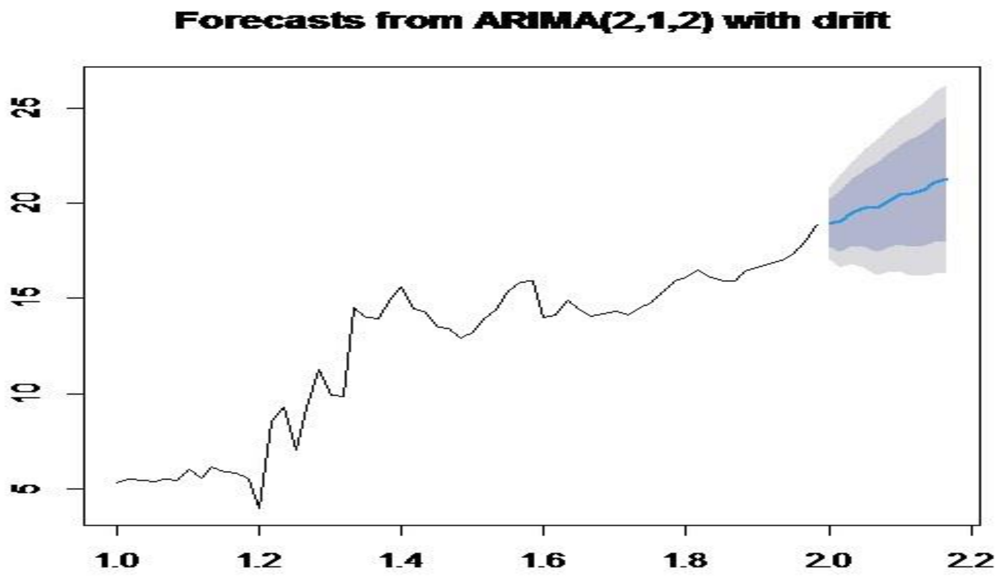
After receiving stationary, this study applied Auto ARIMA to get the forecasted value of the annual data of manufacturing value added percentage of GDP. Then, the AIC values (170.67) BIC values (183.14) were generated for identifying the approximate combination of parameters (Appendix 3). The model with lowest AIC and BIC values are chosen from the set of approximated results. After selecting the appropriate model, this study used it to make forecasts. Table 4.3 shows that forecasting for the next eleven years of the annual data of manufacturing value added percentage of GDP.

Table 4.3 Forecasted values with ARIMA of the annually data of manufacturing value added percentage of GDP from the 2020-2030

Year	**F_value**	**Lower limit 95%**	**Upper limit 95%**
2020	18.94	17.05	20.83
2021	19.04	16.59	21.50
2022	19.5	16.83	22.18
2023	19.72	16.62	22.82
2024	19.77	16.22	23.31
2025	20.09	16.33	23.85
2026	20.42	16.43	24.41
2027	20.52	16.19	24.86
2028	20.73	16.16	25.30
2029	21.07	16.32	25.81
2030	21.26	16.27	26.25

Source: Compiled by the author

Figure 4.4 Forecasted values with ARIMA of the annually data of manufacturing value added percentage of GDP from the 2020-2030



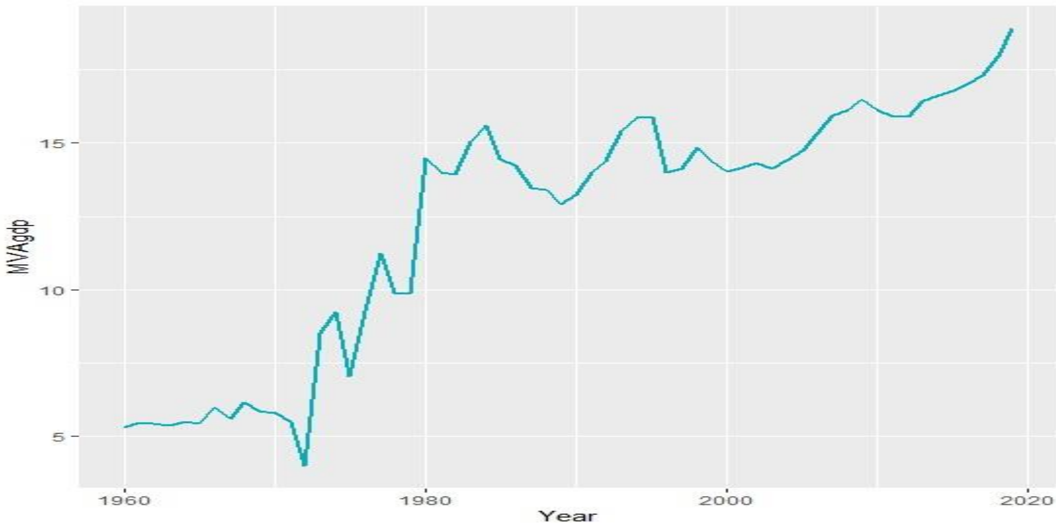
Source: Compiled by the author

Table 4.3 represents that the predicted value of manufacturing value added percentage of GDP for the year 2030 is 21.26 percent. The target for 2030 is to have a share of manufacturing GDP, which is double that of the level of 2015. Considering this target of the SDG 9.2, Bangladesh needs to achieve manufacturing share of GDP 33.57 percent by 2030. Moreover, According to Bangladesh Bureau of Statistics, 2020 the country targeted to increase manufacturing value added as a percentage of GDP to 35 percent by 2030 (BBS, 2020) but after forecasting the value this paper found that the manufacturing value added as a percentage of GDP in Bangladesh will be 21.26 percent by 2030.

4.2.2 Forecasting the values of the Manufacturing value added per capita (in USD) in Bangladesh

Figure 4.5 presents the variable used in the analysis, which is the annually data of manufacturing value added per capita (in USD) in Bangladesh. This shows a sample size of 25 observations from 1990-2014. This 25 observations were used for estimations of the forecasting values for the manufacturing value added per capita from 2015-2030.

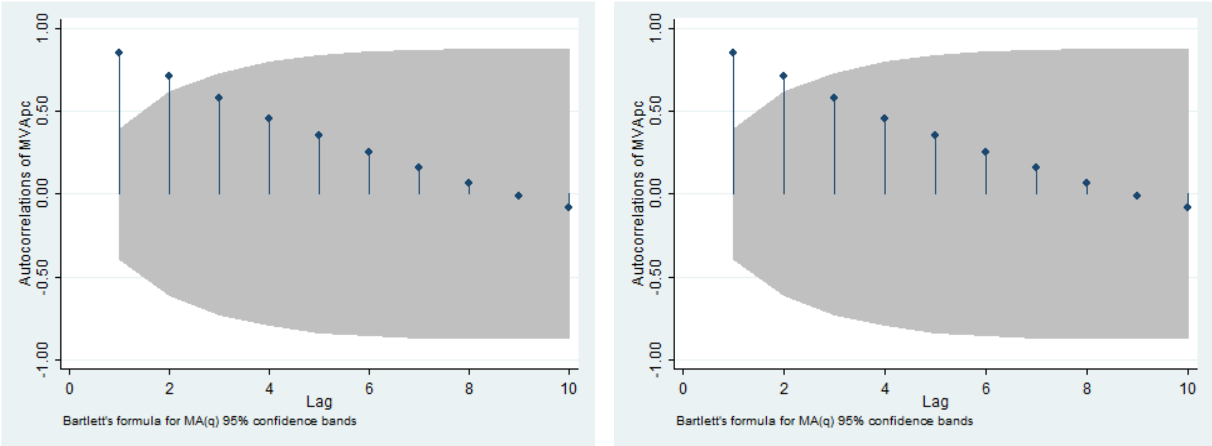
Figure 4.5: The annually data of Manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014



Source: Compiled by the author from the secondary data

Figure 4.5 represents an increasing trend and indicates that the used time series is non-stationary. After that, for defining the distribution of sample data, autocorrelation functions (ACF) and partial autocorrelation functions (PACF) were applied, which is presented in the figure 4.6.

Figure 4.6 ACF and PACF of Manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014 from left to right



Source: Compiled by the authors

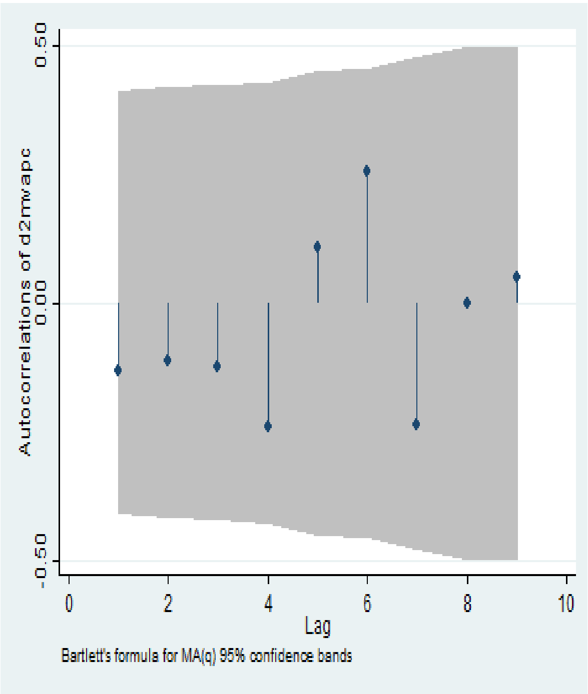
Table 4.4 Dickey-Fuller test for unit root of the annually data of Manufacturing value added in per capita (in USD) in Bangladesh during the period of 1990-2014

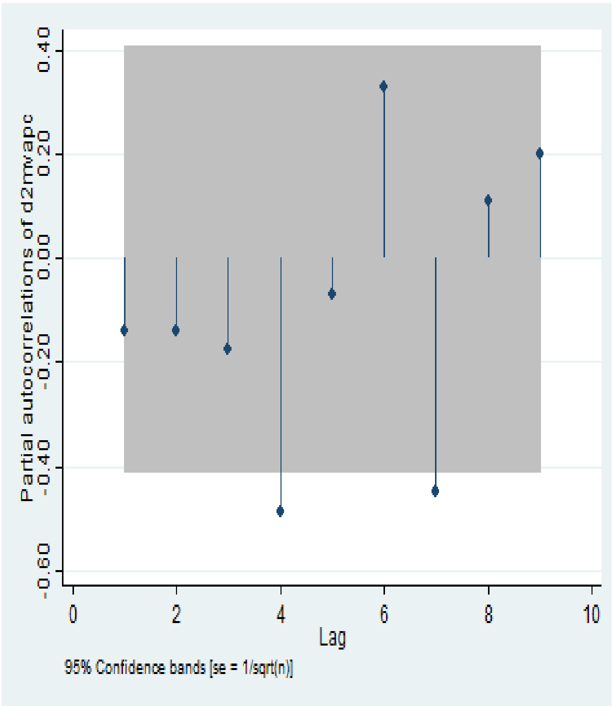
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	10.125	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t)=1.000				

Source: Compiled by the authors

The Dickey Fuller test is applied to check the stationary of the data. Table 4.4 presents the p value=1.000; which fails to reject the null hypothesis (H_0), the data has a unit root and is non-stationary. To taste stationary this paper again applied Dickey Fuller test (unit root). Table 4.5 presents that the p-value=0.7837 and the value also fails to reject the null hypothesis (H0). The data have a unit root and is non-stationary. So, this paper again applied 2nd differencing and table 4.6 presents the p-value=0.0000 and while the p value reject the null hypothesis (H_0), the data does not have a unit root and is stationary. Figure 4.7 presents ACF and PACF the transformed series after 2nd differencing.

Figure 4.7ACF and PACF of Manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014 from 2nd differencing from left to right





Source: Compiled by the authors

Table 4.5 Dickey-Fuller test for unit root of the annually data of Manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014 after 1^{st} differencing

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-0.913	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t)=0.7837				

Source: Compiled by the authors

Table 4.6 Dickey-Fuller test for unit root of the annually data of Manufacturing value added per capita (in USD) in Bangladesh during the period of 1990-2014 after 2^{nd} differencing

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.112	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t)=0.0000				

Source: Compiled by the authors

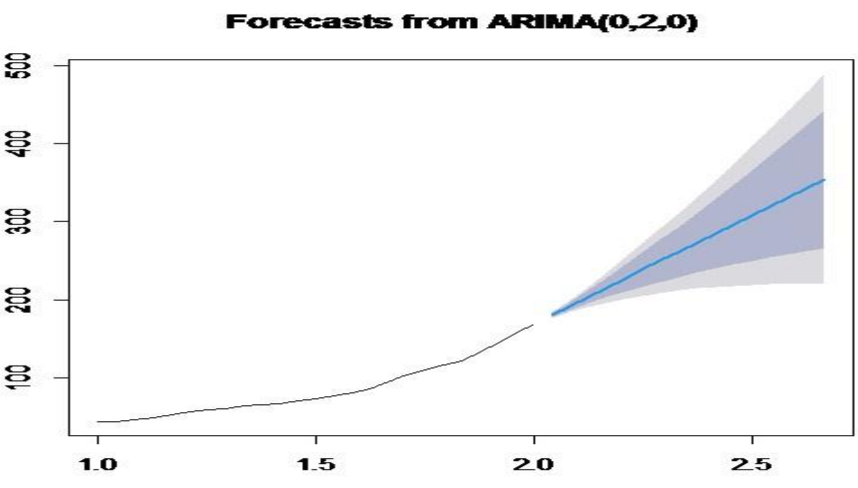
After receiving stationary of the data, this study applied the Auto ARIMA model to get furcated value of the annually data of manufacturing value added in per capita (in USD) in Bangladesh. Furthermore, the AIC (93.76) and BIC (94.9) values were generated for identifying the approximate combination of parameters. The models with lowest AIC and BIC values were chosen. Then this study forecasted for its future values. Table 4.7 shows that forecasting for the next sixteen years of the annually data of manufacturing value added percentage of GDP.

Table 4.7 Forecasted values with ARIMA of the annually data of manufacturing value added per capita (in USD) in Bangladesh for the period of 2015-2030

Year	F_value	Lower limit 95%	Upper limit 95%
2015	180.48	176.99	183.96
2016	192.07	184.27	199.86
2017	203.66	190.61	216.70
2018	215.25	196.155	234.34
2019	226.84	200.98	252.69
2020	238.43	205.17	271.68
2021	250.02	208.77	291.26
2022	261.61	211.81	311.40
2023	273.20	214.34	332.05
2024	284.79	216.38	353.19
2025	296.38	217.95	374.80
2026	307.97	219.08	396.85
2027	319.56	219.79	419.32
2028	331.15	220.08	442.21
2029	342.74	219.97	465.50
2030	354.33	219.48	489.17

Source: Compiled by the authors

Figure 4.8 Forecasted values with ARIMA of the annually data of manufacturing value added in per capita (in USD) in Bangladesh from the 2015



Source: Compiled by the author

From the table 4.7 we found that, the predicted value of Manufacturing value added per capita (in USD) in Bangladesh for the year 2030 is 354.33 USD. According to target SDG 9.2 the country targeted to double its manufacturing value added per capita by 2030 as of the year 2015 when the SDG targets were decided for the country and the forecasted value is almost very close to double value (360.69).

4.3 Descriptive Statistics Relating to Research Objective Two

To collect the data for measuring the impact of eco-innovation in environmental performance this study used manufacturing sectors. The descriptive statistics for the industry types were gained from the frequency analysis. Among the total 50 manufacturing industry, 60 percent data were collected from readymade garment industry and 40 percent data were collected from Leather industry. Moreover, from the RMG sector this study collects data from all the sectors, but from the Leather industry this study chooses only on tannery sectors (See Appendix-5, section 5.1). Among the total 30 RMG industry data were collected 24 percent, 26 percent and 10 percent from Knit, Woven and Sweater sectors respectively. However, to learn about the impact of eco-innovation in the environmental performance this study need to select the industries which have already adopted any eco-product and eco-process method. Thus, finally in total the 50 industry, we consider in the data analysis, all of them have initiated some kind of eco-product or eco-process initiatives or both initiatives. This study collected data from the industries about three issues- Eco-product, Eco-process and Environmental performance. Although to identify the impact of eco-innovation on environmental performance, firstly this study selects variables; secondly, used factoring and finally calculate indexing, but to learn about overall condition some questions were asked about these three issues, which are discussed in the following.

4.3.1 Eco product innovation

In case of the Eco product innovation, from the total industries almost 98 percent or 49 industries have mentioned that, during the three years 2018-2020 their industry introduce new or significantly improved goods and only 2 percent or 1 industry did not. Moreover, in case of service, 94 percent or 47 industries have mentioned that, during the three years 2018-2020 their industry introduces new or significantly improve services and the rest of the 6 percent or 3 industries does not introduce any new or significantly improve services. Furthermore, 28 or 56 percent industries introduce a new or significantly improved goods and services in the market before their competitors; whereas, 22 or 44 percent industries did not introduce. However, 66 percent or 33 industries claimed that, the new or significantly improved goods and services are only new to their industry and that was already available from their competitors in the market. But 34 percent or 17 industries said that, the goods and services introduced by them not only new to them but also new for their market.

As we know that Eco product innovation need to new for the industries but, not need necessarily to be new for the market. Product innovation could have been introduced by their industry or the others. So in this survey, we tried to learn from the industry that, who developed this product innovation which they have adopted. 86 percent or 43 industries mentioned that mainly other enterprises or institutions are the developer of these innovations. Only 12 percent or 6 industries claim that their industry together with other industries and only 2 percent or one industry claim that they are the pioneer or developer of the innovations

(See Appendix-5, section 5.2).Therefore, from the data collected by, survey it can be claimed that, there is a high rate of adaptation of the new or significantly improved products by the industries but mostly the product they initiated are developed by the others.

4.3.2 Eco process innovation

This study also explores about process innovation which is the implementation of a new or significantly improved production process for support activities. This process must need to be new in their industry but not to be new to the market and the innovation could have been originally developed by their own industry or others.

From the survey this study found that, 90 percent or 45 industries have mentioned that during the three years 2018-2020 the industries introduce new or improved methods of manufacturing or producing goods and services and the rest of the 10 percent or 5 industries said that they do not have introduced. Furthermore, 72 percent or 36 industries and 84 percent or 42 industries also claim that, during the three years 2018-2020 their industry introduced the new or significantly improved logistics, delivery or distribution methods for their inputs, goods and services and also introduced new or significantly improved supporting activities for their processes, such maintenance systems or operations for purchasing accounting or computing. Whereas, only 28 percent or 14 industries and 16 percent or 8 industries does not introduced this process. This data indicates that most of the industries have adopted different kinds of process during these three years. ((See Appendix-5, section 5.3)

After that, this survey tried to learn who developed these process innovations. From the data analysis this study found that, 84 percent or 42 industries have mentioned that other enterprises have developed these process innovations. Whereas, 12 percent or six industries claim that their industry together with other industries developed these process innovations and only 2 industries or 4 percent industries have claimed that, the process what they have been adopted, they are the developer of these innovations. Thus, it can be argued from the collected data that, most of the industries have adopted the eco-process innovations, which are developed by the other industries. Among them, 42 percent or 26 industries claim that during these three years the processes which have been introduced by them are new to their market. 42 percent or 21 industries said that, the process innovations which have been initiated by them are not new in the market and the rest of the 6 percent or 3 industries claimed that they do not know about this issue (See Appendix-5, section 5.3).

4.3.3 Innovation with Environmental Benefits

The main objective of this paper was to identify the impact of eco-innovation on the environmental sustainability index. Therefore, this survey tried to find the several environmental benefits related issues adopted by the industries during 2018 to 2020.

Table 4.8: The information of the environmental benefits from the production of goods or services of the different industries

Environmental benefits from the production of goods or services within industry	Yes (percent)	No (percent)	Total (percent)
Minimize the use of material use per unit of output	64	36	100
Decrease the level of energy use per unit of output	94	06	100
Decrease the level of energy use per unit of input	90	10	100
Replaced less polluting backstop	88	12	100
Reduced pollution	94	6	100
Recycled waste, water, or materials	26	74	100

Source: Compiled by the authors

Table 4.8 presents the information of the environmental benefits from the production of goods or services of the different industries. From these information presented in the table it can be claimed that, eco-innovation helps to minimize the level of materials use, reduction of energy use, reduction of pollution and replacing of materials with less polluting substitutes. Furthermore, this study also investigates about the environmental benefit from the after sale use of a goods and services by the end user. Table 4.9 presents the information about environmental benefit from the after sales, use of a goods and services by the end user. 96 percent industry claim that their goods and service helps to minimize the level of energy use, reduce pollution and rest of the 4 percent claim that their goods and services do not provide these kinds of after sale environmental benefits. Whereas, only 38 percent claim that, they ensure advanced recycling of product after use and 62 percent mentioned that they do not ensure advanced recycling of product after use. From both parts, environmental benefits with production and after sale end user this paper found that, the recycling sector is one of weakest part in the case of the manufacturing industry of the Bangladesh.

Table 4.9: Environmental benefits from the after sales use of a good or service by the end user

Environmental benefits from the after sales use of a good or service by the end user	Yes (percent)	No (percent)	Total
Minimize the level of energy use	96	4	100
Reduced pollution level	96	4	100
Advanced recycling of product after use	38	62	100

Source: Compiled by the authors

Table 4.10: Industries inaugurated an environmental innovation for the sake of several environmental issues during 2018-2020

Industry introduce an environmental innovation in response to:	Yes (percent)	No (percent)	Total (percent)
Existing environmental regulations or taxes on pollution	96	4	100
Environmental regulations or taxes that expected to be introduced in the future	82	18	100
Availability of government grants, subsidies or other financial incentives for environmental innovation	76	24	100
Current or expected market demand from targeted customers for environmental innovations	98	2	100
Voluntary codes or agreements for environmental good practice	98	2	100

Source: Compiled by the authors

This table 4.10 presents that manufacturing industries of the Bangladesh has introduce different environmental actions in response to existing environmental regulations or taxes on pollution (96 percent); environmental regulations or taxes that expected to be introduced in the future (82 percent); availability of government grants, subsidies or other financial incentives for environmental innovation (76 percent); current or expected market demand from targeted customers for environmental innovations (98 percent) and voluntary codes or agreements for environmental good practice (98 percent). Thus, from this information it can be argued that eco-innovation have direct or indirect relation to environmental innovation.

4.4 Results Relating to Research Objective Two

The result analysis part of this thesis for the object two can be divided in three parts. Firstly, this paper tried to examine the impact of the eco-innovation in environmental sustainability performance in the case of the manufacturing industry sector and selects two manufacturing sectors RMG and lather industry. Then this paper attempted to learn about both of the sectors (RMG and Leather) individual situations about the same issue of the impact of the eco-innovation on environmental sustainability performance. The analysis is discussed in the following part of this chapter.

4.4.1 Impact of the eco-innovation on environmental sustainability performance in manufacturing industry

4.4.1.1 To create environmental sustainability performance index

To create environmental sustainability performance index this study used factor analysis and to check the appropriateness of the data this paper applied the Bartlett's Test of Sphericity. The result of the test was significant ($P<0.00$), showing that correlations existed between some of the response categories. So, this shown that the data was appropriate for factor analysis (Stewart, 1981; Balen et al., 2010).The KMO index measures values from 0 to 1.0, reaching 1.0 individual variable is exactly predicted without error by the other variables (Hair et al., 2010). In this study, The KMO measure sampling adequacy for the environmental sustainability performance was 0.6581 (Appendix 6, section 6.1) is *mediocre*. So, the data were considered perfect for factor analysis.

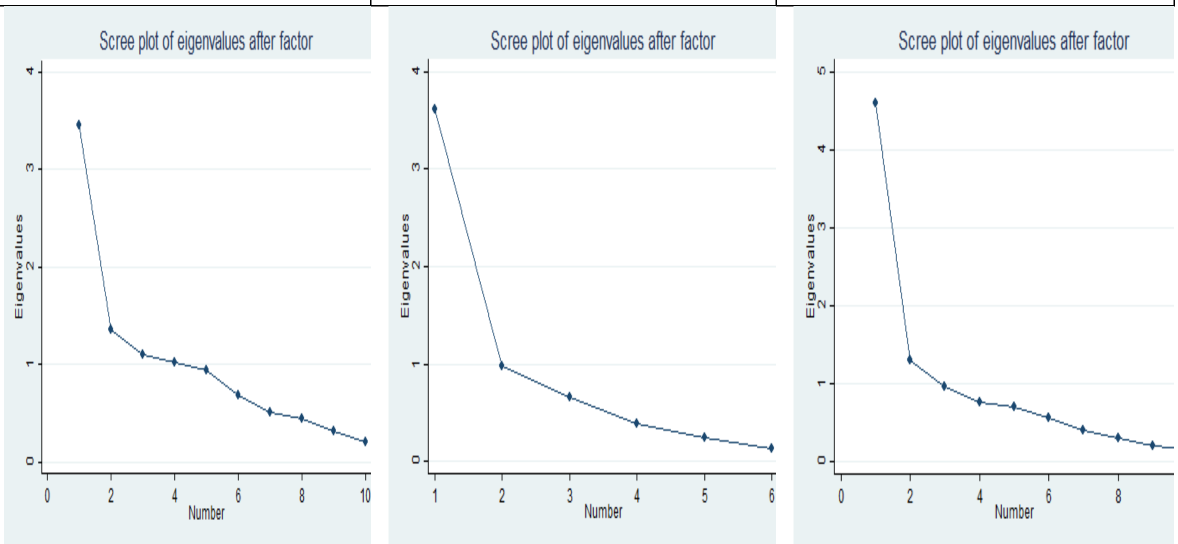
Factor was extracted using principle component factor, followed by a varimax rotation, as suggested by the literature review (Cheng & Shiu, 2012).The result of the latent root criterion shows that the 10 variable submitted for factor analysis could be extracted to form four dimensions. These four dimensions explain 69.27 percent of the variation in the data. Figure 4.9 presents that by laying a straight edge across the bottom portion of the roots, there are four factors before the curve turned a straight line. So, from the scree test it can be claimed that extracted four factors is perfect for this analysis. Then it generates factor scores for four factors (appendix 6). From the factor scores, by averaging the values of the scores, it calculates the value of the environmental sustainability performance index.

4.4.1.2 To create eco-process index

By using the similar process to calculate eco-process index first, this study selects 6 different variables from the literature and after that used factor analysis. Before doing factor analysis to check the appropriateness of the data we performed Bartlett's test of Sphericity and measure Kaiser-Meyer-Olkin (KMO) index. The Bartlett's Test of Sphericity was significant ($P<0.00$), showing that correlations existed between some of the response categories. The KMO measure results from eco-process was 0.8407, is *meritorious*. Therefore, the results of KMO show that the data is appropriate for factor analysis. Factors were extracted for the eco-innovation process by applying the principal component, followed by varimax rotation. Again for eco-process innovation the result of the latent root criterion presents that the six variables submitted for factor analysis could be extracted to from one dimension. This dimension explains 93.87 percent of the variation in the data. Figure 4.9 shows the scree test it can be argued from the scree test that, this one factor is accurate for this analysis. Then, this study generates factor scores and also calculates the eco-process index.

Figure 4.9 The Scree Plot of eigenvalues after factoring of the environmental sustainability performance, eco-process index and eco-product index for the manufacturing sector from left to right

Scree Plot of eigenvalues after factoring of the environmental sustainability performance	Scree Plot of eigenvalues after factoring of the eco-process index	Scree Plot of eigenvalues after factoring of the eco-product index



Source: Compiled from the primary survey

4.4.1.3 To create eco-product index

Again, using the similar process to create eco-product index, we choose 10 different variables as suggested by the literature and after that used factor analysis to create eco-process index. Before doing factor analysis to check the appropriateness of the data this study performed Bartlett's test of Sphericity and found that the result is significant (P<0.00). The KMO measure results from eco-process was 0.7751, is *middling*.

Therefore, the results of KMO show that the data is appropriate for factor analysis. Factors were extracted for the eco-product innovation by adopting the principal component, followed by varimax rotation. Again for eco-product innovation the result of the latent root criterion presents that the 10 variables submitted for factor analysis could be extracted to from two dimensions. This dimension explains 58.91 percent of the variation in the data. Again, from the scree test it can be argued that, the extracted three factors are perfect for this analysis. Then, this study generates factor scores and also generates the eco-process index.

4.4.1.4 Use of Classical Linear Regression Model in case of the manufacturing sector

Finally, after getting the all index values by using factor analysis this study used the classical linear regression model to identify the impacts of eco-innovation (eco-product and eco-process) on environmental sustainability performance index.

Different statistical tests were used in this study to determine that the assumptions of the regression analysis were satisfied. The distribution of the residuals was normal for the data. The Multicollinearity test was done by using VIF. The value of Multicollinearity test by VIF was less than 5, so no perfect multicollinrarity exceed. Thus, no Multicollinearity problems exist in the regression model used in this study (Hair et al. 2010). After that, form the omitted variable test the result shows that, the model has no omitted variables. Then this study applied White's Pure Heteroscedasticity test and found that the model was free from the problem of heteroscedasticity.

Table 4.11: Anova Test (Manufacturing Sector)

Source	SS	Df	MS
Model	1.5722	2	.7861
Residual	10.6777	47	.2271
Total	12.25	49	.2500
Number of obs	50		
Prob>F	0.039**		
R^2	0.1283		
Adj. R^2	0.0913		

Note: ** denote statistically significant at the 0.05 level of significance

Source: Compiled from the primary survey

In addition, ANOVA test was used to estimate the impact of eco-innovations in the environmental sustainability performance. According to the regression model result shows that the overall model is significant at the 5 percent level, i.e. $H_0=\beta_0= \beta_1=\beta_2 \neq 0$; while the p value is 0.0396.

Table 4.12: Effect of the eco-innovation on environmental sustainability performance in case of the manufacturing industries

Environmental Sustainability performance	Co-eff	Std.error	t value	P-value p>|t|	95% CI
Eco-process	0.0135	.0785	0.17	0.864	-.1444 .1714
Eco-product	.2432	.1110	2.19	0.033**	.0198 .4666
_Constant	7.71e-12	.0674	0.00	1.000	.1356 .1356

Note: ** denote statistically significant at the 0.05 level of significance

Source: Compiled from the primary survey

Table 4.12 shows that, eco-product have a positive and highly significant effect on environmental sustainability performance (P-value=0.033). But the eco-process was not found to have a significant effect on environmental sustainability performance (P-value=0.864). Thus, the regression analysis result supports the hypotheses 2 but does not support the hypotheses 3.

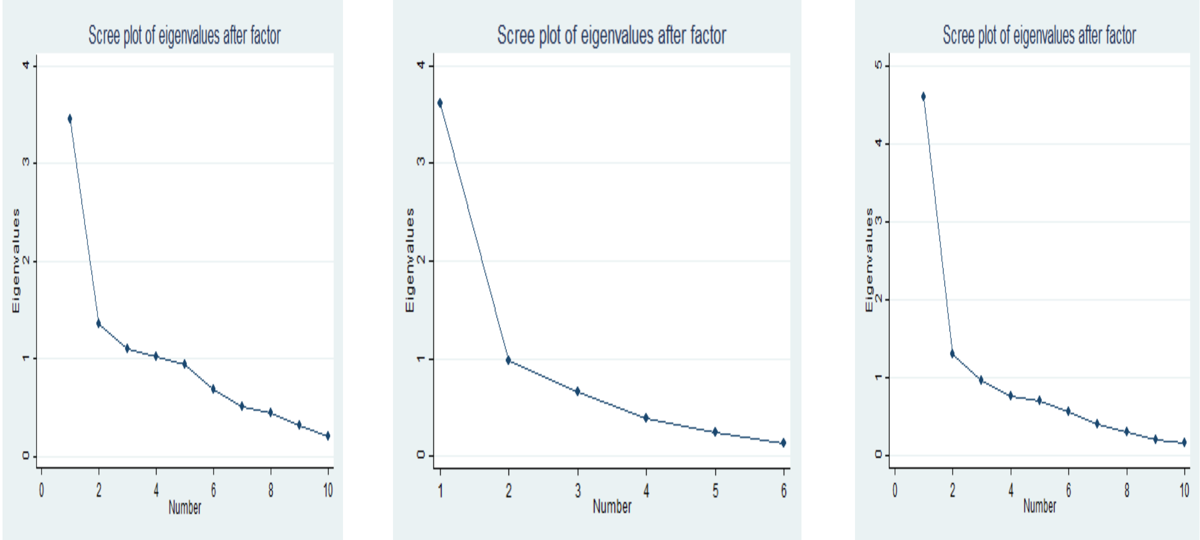
4.4.2 Impact of the eco-innovation on environmental sustainability performance in RMG industry

This study also tried to examine the impact of the eco-innovation in environmental sustainability performance in the case of RMG industry of the Bangladesh. From the same data, again to assure the appropriateness of the data collected from the RMG industry for factor analysis, different kinds of statistical assumptions were applied in this study.

The KMO measure results from environmental sustainability performance was 0.6310, is *mediocre*, the eco-process was 0.8382, is *meritorious* and eco-product was 0.7248 is *middling*, as presented in the Kaiser and Rice's definition (1974). Therefore, the results of KMO show that the data are perfect for factor analysis (See Appendix-6, section 6.2)

Figure 4.10 The Scree Plot of eigenvalues after factoring of the environmental sustainability performance, eco-process index and eco-product index in the case of the RMG sector

Scree Plot of eigenvalues after factoring of the environmental sustainability performance	Scree Plot of eigenvalues after factoring of the eco-process index	Scree Plot of eigenvalues after factoring of the eco-product index



Source: Compiled by the authors

Factors were extracted by adopting the principal component, followed by varimax rotation. The result of the latent root criterion presents that; four, one and three factors could be extracted from the given variables for environmental sustainability performance, eco-process and eco-product innovation respectively. Again, figure 4.10 presents the Scree test and showing that, the extracted factors are perfect for this analysis. Then, this study generates factor scores and also calculates index by averaging the values.

4.4.2.1 Use of the Classical Linear Regression Model in the case of the RMG sector

Regression analysis was used to test the hypothesis and to identify the impacts of eco-innovation in environmental sustainability performance index in the case of the RMG sector of the Bangladesh.

Different statistical tests were applied in this study to determine that the assumptions of the regression analysis were satisfied. The error distribution was normal for the data set. The Multicollinearity test was done by using VIF. The value of multicollinearity test by VIF was less than 5, so perfect multicollinearity exceed. After that, form the omitted variable test the result shows that, the model has no omitted variables. White's Pure Heteroscedasticity test was applied and found that the model was free from the Heteroscedasticity. Furthermore, ANOVA and t-test were used to estimate the impact of eco-innovations on the environmental sustainability performance in RMG industry.

Table 4.13: Anova Test (RMG industry)

Source	SS	Df	MS
Model	3.1039	2	1.5519
Residual	4.1460	27	.1535
Total	7.2499	29	.2499
Number of obs 30 Prob>F 0.005*** R^2 0.4281 Adj. R^2 0.3858			

Note: *** denote statistically significant at the 0.01 level of significance

Source: Compiled from the primary survey

According to the regression model result shows that the overall model is significant at 5% level, i.e. $H_0=\beta_0= \beta_1=\beta_2 \neq 0$; while the p value is 0.0005.

Table 4.14: Effect of the eco-innovation on environmental sustainability performance in case of the RMG industries

Environmental Sustainability performance	Co-eff	Std.error	t value	P-value p>|t|	95% CI
Eco-process	.0520	.0787	0.66	0.515	-.1096 .2136
Eco-product	.5259	.1364	3.85	0.001***	.2459 .8059
_Constant	1.24e-09	.0715	0.00	1.000	-.1467 .1467

Note: *** denote statistically significant at the 0.01 level of significance

Source: Compiled from the primary survey

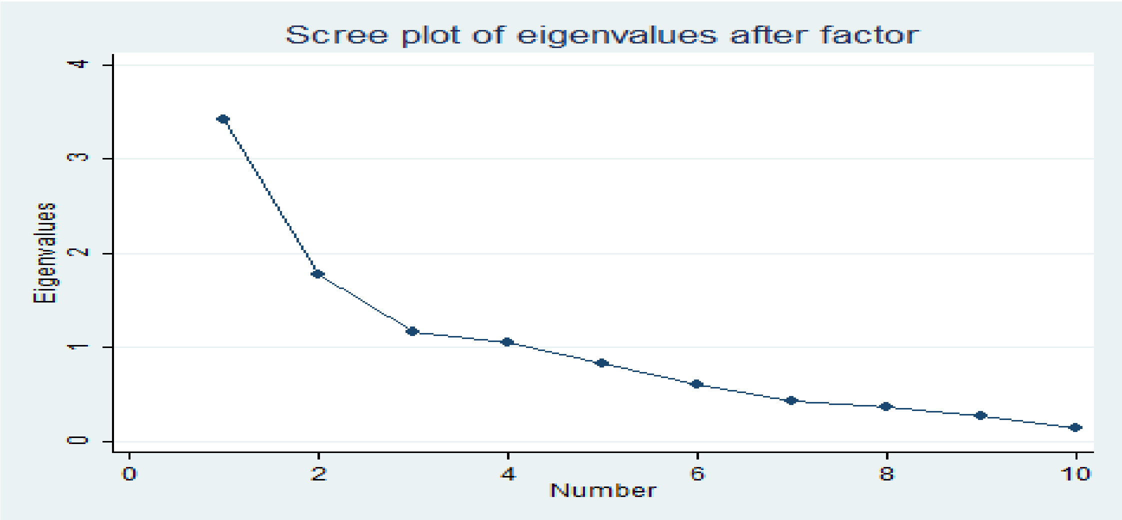
Table 4.14 shows that, eco-product have a positive and highly significant effect on environmental sustainability performance (P-value=0.001). But the eco-process was not found to have a significant effect on environmental sustainability performance (P-value=0.515). Thus, the regression analysis result supports the hypotheses 2a and does not support the hypotheses 3a.

4.4.3 Impact of the eco-innovation on environmental sustainability performance in the Leather industry

Leather industry was another manufacturing sector selected for this survey. This study collects data from 20 tannery industries for this survey and tried to learn about the impact of the eco-innovation on environmental sustainability performance in Leather industry as well.

To determine the impact of the eco-innovation on environmental sustainability performance in Leather industry of the Bangladesh this paper analyzes the data from the same data, which has been used for the overall manufacturing industries. Furthermore, this study tried to analyze the data by using the same procedures which have already used for the other sectors and suggested by the literatures. For doing factor analysis, we check the appropriateness of the data. We performed Bartlett's test of Sphericity and measure Kaiser-Meyer-Olkin (KMO) index. The Bartlett's Test of Sphericity was significant ($P<0.04$) for the data of environmental sustainability performance and showing that correlations existed between some of the response categories. The KMO measure results from environmental sustainability performance was 0.6151, is *mediocre*. Therefore, the results of KMO show that the data are perfect for factor analysis. Factor was extracted using the principle component factor analysis, followed by a varimax rotation. The result of the latent root criterion shows that the 10 variable submitted for factor analysis could be extracted to form 4 dimensions. Figure 4.11 presents that by laying a straight edge across the bottom portion of the roots, there are four factors before the curve turned a straight line. Figure 4.11 presents the Scree test and it can be claimed that extracted the four factors is perfect for this analysis. Then it generates factor scores for 4 factors (appendix 6, section 6.3) after getting factor scores by averaging the values, it calculates the value of the environmental sustainability performance index.

Figure 4.11: Scree Plot of eigenvalues after factoring of the environmental sustainability performance in leather industry



Source: Compiled from the primary survey

This paper checks the data appropriateness for eco-process and eco-product innovation for factor analysis by using the KMO. But The KMO measure results from the eco-process was 0.3851 and eco-product was 0.3209.Therefore, the results of KMO show that data were not appropriate for factor analysis as mentioned in the Kaiser and Rice's definition (1974). So for the inappropriateness of the data we cannot able to make factor analysis. Thus, this study could not able to generate any results related to this issue. Therefore, the hypotheses 2b and 3b could not be tested for this study.

4.5 Summary of Key Informant Interviews (KIIs) on Eco-Innovation in the case of the Bangladesh's Industrial Sector

The Key Informant Interviews (KIIs) conducted with industry experts, policymakers, and environmental consultants provided valuable insights into the role and impact of eco-innovation on the environmental sustainability of Bangladesh's industrial sector. The following summary captures the main themes and findings from these interviews:

Respondents defined eco-innovation as the development and implementation of new products, processes, and practices designed to reduce environmental impacts, improve resource efficiency, and support sustainable development within the industrial sector. In the context of Bangladesh, this includes the adoption of cleaner production technologies, the integration of renewable energy sources, the implementation of waste reduction practices, and the use of innovative materials with lower carbon footprints.

The interviews revealed that eco-innovations have led to significant improvements in environmental sustainability within Bangladesh's industries. Key outcomes include reductions in energy and water consumption, lower greenhouse gas emissions, enhanced waste management practices, and improved compliance with international environmental standards. These eco-innovative practices have also enhanced the global competitiveness of Bangladeshi industries by attracting customers and investors who prioritize sustainability.

Respondents provided several examples of successful eco-innovations within Bangladesh's industrial sector. Notable examples include the widespread adoption of solar energy in textile manufacturing, the use of biodegradable materials in packaging, the implementation of water recycling systems in factories, and the development of energy-efficient machinery. These innovations have not only contributed to environmental sustainability but have also bolstered the competitiveness of these industries in international markets.

Eco-innovation was identified as a critical driver of sustainable industrialization, aligning with the objectives of SDG 9. By reducing environmental impacts, improving resource efficiency, and supporting the transition to a low-carbon economy, eco-innovation helps industries achieve both economic viability and environmental sustainability. This, in turn, promotes inclusive and sustainable industrial growth, a core focus of SDG 9.

To further scale up eco-innovation across Bangladesh's industrial sector, respondents emphasized the need for several priority measures. These include enhancing policy frameworks to support green innovation, providing financial incentives for adopting eco-friendly practices, investing in research and development (R&D), fostering public-private partnerships, and developing infrastructure for sustainable industrial zones. Specially, some of the respondents mentioned that, the adoption of a proper and powerful Central Effluent Treatment Plant (CETP) in the leather industry is must for trading with European buyers. Additionally, raising awareness among industry leaders about the long-term benefits of eco-innovation is considered crucial for driving widespread adoption.

4.6 Discussion

After adopting sustainable development goals by the 25th September in 2015, Bangladesh has been working actively for implementing its SDGs. The government of Bangladesh has taken different initiative for implementing SDGs for the country. This study focuses only one target 9.2 of SDG. The target for 2030 is to have a share of manufacturing GDP and manufacturing value added per capital and which is double that of the level of 2015. Considering this target Bangladesh needs to achieve manufacturing share of GDP 33.576 and manufacturing value added per capital USD 360.96 percent by 2030.

But after forecasting this study found that, the manufacturing share of GDP will be 21.26 and manufacturing value added per capital will be USD 354.33 percent in the Bangladesh if current trends continue. However, forecasting considered that only past trends will continue in the future; but it does not consider future uncertainties and as well as opportunities.

Therefore, from the outcome of this study it can be argued that, this 9.2 target will require special intervention to be achieved by the 2030. Because from the indicator 9.2.1a this study found that the country will be still far from achieving the target of manufacturing share of GDP by 2030. However, from the forecasting value of indicator 9.2.1.b this paper can claim that, the forecasted value USD 354.33 is very close to the targeted value USD 360.96. This indicates that manufacturing value added per capital of the Bangladesh will be able to achieve the target, if current trends continue.

Considering the forecasted value of SDG target 9.2 achieved by this study it can be claimed that, it is essential to speed up the SDG related programs at all manufacturing industry levels, because we do not have much time left to the deadline of the 2030. Without a potential project considering SDG target 9.2 a successful outcome from the manufacturing sector related to the share of GDP in Bangladesh will be critical.

The second objective of this study was to determine the impacts of Eco innovation on environmental sustainability performance. The analysis conducted for the objective two can be illustrated the three important outcomes.

First, from the outcome of the result, it can be claimed that, there is a positive relationship between the eco-innovation and environmental sustainability performance. Outcomes of the empirical result were supported by other research findings. Dong et. al. (2014), have proven that eco-innovation has significantly effected on upgrading the environmental activities. Doran & Ryan, (2012) have mentioned that for improving a company's performance, it is very much effective. Contantin et al. (2017), have presented that eco-innovation helps to reduce environmental problems. Moreover, Lee & Min, (2015) have also found that a conversion is very effective for reducing carbon emission. Moreover, from the empirical results it was found that eco-product innovation has a positive impact on environmental sustainability performance, but eco-process innovation does not have any positive impact on environmental sustainability performance. This means that Eco process innovation is less important than eco-product innovation for better manufacturing industry's performance of the Bangladesh.

Second, this study has found that eco-innovation has a positive impact on environmental performance in the case of the RMG industry. Which indicate that eco-innovation is an important factor for improving the RMG industries' environmental sustainability performance. The research done by the Ferado & Wah, (2017) has also revealed that for improving environmental performance eco-innovation is an important process. We found that eco-product has a highly significant relationship with environmental sustainability performance but the eco-process does not have a significant relationship with environmental sustainability performance. This also means that eco-process innovation is not as effective as eco-product innovation for improving RMG industry performance. Therefore, it can be revealed that, RMG industries of the Bangladesh must need to adopt eco-product innovation in their major activities to ensure a sustainable industry.

Third, this work also tried to determine the impacts of the eco-innovation in the case of the leather industry in the Bangladesh. But due to the inappropriateness of the data for doing factor analysis; this study cannot able to generate factored scores and further analysis. Thus, it was not possible to generate any outcomes for the leather industry of the Bangladesh.

Finally, the insights gained from the KIIs underscore the vital role of eco-innovation in improving environmental sustainability and advancing sustainable industrialization in Bangladesh. The findings suggest that with the right policy support, financial incentives, and industry engagement, eco-innovation can play a transformative role in achieving the goals of SDG 9 and fostering a more sustainable industrial sector in Bangladesh. These insights will inform the analysis and recommendations presented in this thesis, highlighting the pathways for scaling up eco-innovation to ensure long-term environmental and economic sustainability in Bangladesh's industrial sector.

4.7 Conclusion

The aim of this chapter was to forecast the country's overall progress related to sustainable industrialization and to identify the impact of eco-innovation in environmental sustainability performance. The result of the forecasted value shows that, indicator 9.2.1a will not be able to reach its target by 2030 whereas; indicator 9.2.1b will be able to reach near to its target if current trends continue. The results have shown that eco-product innovation have significant impact on the overall manufacturing sector and also in the RMG sector of the Bangladesh.

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

The industrial sector in Bangladesh is the lifeline of its economy. The ready-made garments and leather (tanneries) industries in the country play a critical role in employment creation, higher economic growth and export earnings. Despite that, the levels of industrial environmental hazards in these sectors are comparatively higher. These hazards have high social costs and there is thus a need to minimize those environmental consequences and make the industry sustainable in the long run. This may not only help in improving the local environment, but also attracts international markets with higher demand for such products. With these objectives in mind, the study is developed hoping that the inputs may serve to be useful in designing a sustainable industrial development pathway for Bangladesh.

This paper was conducted to find out the prospects of Bangladesh to promote sustainable industrialization by 2030, and to examine the impact of the eco-innovation in the environmental sustainability performance to formulate long term policy for sustainable industrialization program. This study aims to find out macro scenario perspectives towards sustainable industrialization in Bangladesh. To identify overall countries prospects towards sustainable industrial development this study analyzed the research question "what will be the situation of Bangladesh for the target of SDG-9.2 by 2030?" Only one indicator 9.2.1 was used in this study to find out the country's prospects for sustainable industrial development. The target for 2030 is to have a share of manufacturing GDP and manufacturing value added per capital and which is double that of the level of 2015. Considering this target Bangladesh needs to achieve manufacturing share of GDP 33.576 Percent and manufacturing value added per capital USD 360.96 by 2030. To learn about the country's prospects of the sustainable industrialization related to SDG target 9.2; this study forecasted the value by using ARIMA. However, after forecasting this study found that, the manufacturing share of GDP will be 21.26 percent and manufacturing value added per capital will be USD 354.33 in the

Bangladesh if current trends continue. From the analysis of this paper, it is found that the SDG indicator 9.2.1a the manufacturing share of GDP will not be able to achieve the target. Thus, considering this outcome, it can be claimed that, government of the Bangladesh should initiate some special program or project for ensuring SDG target 9.2. Without some dynamic program considering the issues of the SDG indicator 9.2.1a; a successful outcome from the manufacturing sector related to the share of the GDP in Bangladesh will be hard. The study findings can help to generate special policy to speed up the SDG target 9.2 related programs in the Bangladesh.

Moreover, from the forecasting value of indicator 9.2.1.b this paper found that, the forecasted value USD 354.33 is very near to the targeted value USD 360.96. This indicates that manufacturing value added per capital of the Bangladesh will be able to achieve the target, if current trends continue.

This study also examined the impacts of eco-innovation (eco-product and eco-process) in environmental sustainability performance to formulate long-term policy towards sustainable industrialization in Bangladesh. The two manufacturing sectors (RMG and Leather) were selected for the data collection.

Different literature Porter & Linde (1995), Lee & Min, (2015) presented that to solve the unlimited environmental problems we can consider eco-innovation as an ultimate solution. The analysis of Bangladesh's manufacturing industries covered in this study also supports this outcome. From the descriptive analyses of the study it is found that, eco-innovation focused on the minimization of materials use, reduction of energy use, reduction of pollution and replacing of materials with less polluting substitutes. We can argue with the empirical results of this study that; eco-innovation is helpful to improve the environmental sustainability performance of the manufacturing industry of the Bangladesh. Specifically, from the empirical results it was found that eco-product innovation has a positive impact, but the eco-process innovation does not have any positive impact on environmental sustainability performance in the case of overall manufacturing industry and as well as RMG industry. From the outcome of this paper, it can claim that, eco-product innovation is more effective for improving manufacturing industry's performance of the Bangladesh. Thus, it can be revealed that, manufacturing industries in the Bangladesh, especially the RMG sector must adopt eco-product innovation in their major activities for upgrading of the environmental performance. However, this paper also tried to analyze the impact of eco-innovation in environmental performance in the case of the leather industry in the Bangladesh. But due to inappropriateness of the data for factor analysis this paper cannot able to generate any results.

5.2 Recommendations

-The result of the study has shown that, the manufacturing value added share of GDP will not be able to achieve its target. It is essential to design a manufacturing industry related project or policy with special initiatives to help to achieve the target 9.2. Implementation of policies that support export-oriented manufacturing, including trade facilitation, export incentives, and the removal of trade barriers is essential for ensuring SDG 9.2. Targeted support to industries with high export potential should be provided. Expanding export markets will increase demand for Bangladeshi manufactured goods, driving up production and value addition in the sector. Establishment of the innovation hubs and technology parks to foster research and development (R&D) in new manufacturing processes and products can help to achieve the target 9.2. Upgrading technology will increase productivity, improve product quality, and enhance competitiveness, leading to higher value-added manufacturing.

-The result of this study has shown that there is a positive impact of the eco-product innovation on the environmental sustainability performance in the case of the manufacturing sector of the Bangladesh. Hence, for designing a sustainable industrialization project or policy for manufacturing sector eco-product innovation can be considered for effective environmental performance. By promoting eco-product innovation, manufacturers will be encouraged to develop and produce goods that have a reduced environmental footprint, leading to overall better environmental performance in the sector. Should implement some policies which will be encouraged the development and adoption of eco-products within the manufacturing sector. This could include providing R&D grants, tax incentives, and subsidies for companies that invest in eco-product innovation. Creating a robust market for eco-products will stimulate demand and incentivize manufacturers to innovate, thus enhancing the sector's contribution to environmental sustainability. Should support the creation of markets for eco-products through public procurement policies, consumer awareness campaigns, and export promotion strategies. Embedding eco-product innovation into industrial policy will create a long-term commitment to sustainability, ensuring that environmental performance improvements are sustained and scaled across the manufacturing sector. Thus, integrate eco-product innovation as a core component of the national industrial policy will be highly appropriate initiative. This integration should focus on aligning industrial growth objectives with environmental sustainability goals, ensuring that eco-product innovation is prioritized in policy-making.

-The result of the study also has found that the Eco product innovation has a highly positive relationship with environmental sustainability performance in case of RMG sector. Thus, for designing a sustainable industry related project or policy for the RMG sector in the Bangladesh; eco-product innovations need to be considered for dynamic environmental sustainability performance. By integrating eco-innovation into policy, the government can create a supportive environment for the RMG sector to thrive sustainably, leading to improved environmental outcomes and enhanced global competitiveness. It can be assumed that incorporate eco-product innovation into the broader policy framework for the RMG sector, ensuring that sustainability is a key priority in industrial policy, trade policy, and export promotion strategies will be help for the long run industrial sustainability.

-From the descriptive analyses of the thesis it is found that, eco-innovation focuses on the minimization of materials use, reduction of energy use, reduction of pollution and replacing of materials with less polluting substitutes. Thus, for designing a sustainable industrialization related project or policy in the Bangladesh; eco-innovations need to be considered. By embedding eco-innovation into industrial policy, the government can ensure that sustainability is a key consideration in all industrial development efforts, leading to long-term environmental and economic benefits.

-This study only analyses the economic pillar of sustainable development at the macro level. It is expected that the findings from the present study may serve as a basis for any possible study in the future, in the other pillars (environment and social) of the sustainable development at the macro level of the Bangladesh. Sustainable development is inherently multidisciplinary. Combining insights from various fields will enhance the depth and relevance of future research, leading to more effective solutions for sustainable development challenges.

-This study only examines the impact of eco-innovation in environmental sustainability performance, but it is also expected that the outcome of this work may encourage possible future study on the impact of the eco-innovation in the economic sustainability performance and also social sustainability performance.

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Appendix 1

Survey Questionnaire

&

Key Informant Interview Questionnaire

University of Dhaka

Questionnaire Survey Cover letter

Dated:

Subject: You are invited to a research survey (Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries)

Dear Participant,

My name is Sadia Islam and I am a Master of Philosophy (Mphil) student under the supervision of Syed Naimul Wadood, Ph.D., Associate Professor at the University of Dhaka. For our study purpose, we are estimating the influence of eco-innovation on environmental performance in RMG and the leather industry of the Bangladesh.

Because you are working for RMG/leather industry, we are cordially inviting you to participate in this research study by completing the following questions. This work is completely done for academic purpose and your participation is voluntary, you may refuse to participate at any time.

Thank you for giving the time to help me in my academic endeavors. Your participation is appreciated.

Sincerely,
Sadia Islam
Mphil Student &
Naimul Wadood, Ph.D.,
Professor,
Department of Economics,
University of Dhaka

Dated:

CERTIFICATE

This is to certify that the dissertation titled: "**Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries**" surveyed by Sadia Islam for the fulfillment of the requirements for the degree of Master of Philosophy in Economics is her own independent and original research work carried out at Dhaka University under my supervision. This work is for academic purpose only. I, therefore, request you to assist/help her for the fulfillments of her degree. Your participation is highly appreciated. Thanks in advance.

………………………………………..

(**Syed NaimulWadood, Ph.D.**)
Professor, Department of Economics,
University of Dhaka.

Eco-innovation measurement questionnaire for estimating influence of eco-innovation on environmental performance in RMG and leather industry of the Bangladesh

Confidential (*for research use only*)

This survey collects information on your enterprise's innovations and innovation activities between 2018 and 2020 inclusive.

An innovation is the introduction of a new or significantly improved product, process, organizational method, or marketing method by your enterprise. The innovation must be new to your enterprise, although it could have been originally developed by other enterprises. This question on innovation activities only refer to product and process innovations. Please complete all questions, unless otherwise instructed.

Person we should contact if there are any queries regarding the form:

Name: ______________________________________

Job title: ______________________________________

Organisation: ______________________________________

Phone: ______________________________________

Fax: ______________________________________

E-mail: _____________________________

1. General information about the enterprise

1.1 Name of enterprise: _____________________________

1.2 Address: _____________________________

1.3 Main activity: _____________________________

1.4 In the last three years, did your establishment introduce any **pollution control** technologies?

Yes ☐

No ☐

1.5 In the last three years, did your establishment introduce any **recycling** programmes?

Yes ☐

No ☐

1.6 In the last three years, did your establishment introduce any new or improved **products or services** that are more **environmentally-friendly** than those already on the market?

Yes ☐

No ☐

1.7 In the last three years, did your establishment introduce any new or improved **processes** with environmental benefits?

Yes ☐

No ☐

FILTER: IF RESPONDENT ANSWERS NO TO ALL CATEGORIES, END INTERVIEW

Otherwise Read Out:

Your answers show that your firm is eligible for this survey, which will take up to 20 minutes. If you agree, we will send you a copy of the study report. Can we proceed?

2. Eco-product (good or service) innovation

A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems.

- ➢ Product innovations (new or improved) must be new to your enterprise, but they do not need to be new to your market.
- ➢ Product innovations could have been originally developed by your enterprise or by other enterprises.

2.1 During the three years 2018 to 2020, did your enterprise introduce:

- New or significantly improved goods. (Exclude the simple resale of new goods purchased from other enterprises and changes of a solely aesthetic nature) Yes ☐ No ☐
- New or significantly improve services Yes ☐ No ☐

If no to both options, go to section 3, otherwise:

2.2 Who developed these product innovations? Select the most appropriate option only

- Mainly your enterprise or enterprise group Yes ☐ No ☐
- Mainly your enterprise together with other enterprises or institutions Yes ☐ No ☐
- Mainly other enterprises or institutions Yes ☐ No ☐

2.3 Were any of your product innovations during the three years 2018 to 2020

- **New to your market?** Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets) Yes ☐ No ☐
- **Only new to your firm?** Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market Yes ☐ No ☐

2.4 Items for measuring eco-innovation (Eco-product) implementation

Rate your unit over the last three years on the extent to which……

Eco-product implementation

Item No	Items for measuring eco-product implementation	Applies Fully	Applies Partly	Does not apply	Not Relevant
1	Our unit often emphasizes developing new eco-products through new technologies to simplify their packaging	☐	☐	☐	☐
2	Our unit often emphasizes developing new eco-products through new technologies to simplify their construction	☐	☐	☐	☐
3	Our unit often emphasizes developing new eco-products through new technologies to simplify their components	☐	☐	☐	☐
4	Our unit often emphasizes developing new eco-products through new technologies to easily recycle their components	☐	☐	☐	☐
5	Our unit often emphasizes developing new eco-products through new technologies to easily decompose their materials	☐	☐	☐	☐
6	Our unit often emphasizes developing new eco-products through new technologies to rarely use processed materials	☐	☐	☐	☐
7	Our unit often emphasizes developing new eco-products through new technologies to use natural materials	☐	☐	☐	☐
8	Our unit often emphasizes developing new eco-products through new technologies to reduce waste as much as possible	☐	☐	☐	☐
9	Our unit often emphasizes developing new eco-products through new technologies to reduce damage by waste as much as possible	☐	☐	☐	☐
10	Our unit often emphasizes developing new eco-products through new technologies to use as little energy as possible	☐	☐	☐	☐

Source: C.C. Cheng, E.C. Shiu/ Technovation 32 (2012) 329-344

3. Eco-process innovation

A process innovation is the implementation of a **new** or **significantly** improved production process, distribution method, or support activity for your goods or services.

- Process innovations must be new to your enterprise, but they do not need to be new to your market.
- The innovation could have been originally developed by your enterprise

3.1 During the three years 2018 to 2020, did your enterprise introduce:

- New or significantly improved methods of manufacturing or producing goods or services Yes ☐ No ☐
- New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services Yes ☐ No ☐
- New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing Yes ☐ No ☐

If no to all options, go to section 4, otherwise:

3.2 Who developed these process innovations? Select the most appropriate option only

- Mainly your enterprise or enterprise group Yes ☐ No ☐
- Mainly your enterprise together with other enterprises or institutions Yes ☐ No ☐
- Mainly other enterprises or institutions Yes ☐ No ☐

3.3 Were any of your process innovations introduced between 2018and 2020 new to your market?

- Yes ☐
- No ☐
- Do not know ☐

3.4 Items for measuring eco-innovation (Eco-process) implementation

Rate your unit over the last three years on the extent to which…….

Eco-process implementation

Item No	**Items for measuring eco-product implementation**	**Applies Fully**	**Applies Partly**	**Does not apply**	**Not Relevant**
1	Your unit often updates manufacturing processes to protect against contamination	☐	☐	☐	☐
2	Your unit often updates manufacturing processes to meet standards of environmental law	☐	☐	☐	☐
3	Your unit often employs manufacturing processes so as not to contaminate the environment	☐	☐	☐	☐
4	Your unit often introduces new technologies into manufacturing processes to save energy	☐	☐	☐	☐
5	Your unit often updates equipment in manufacturing processes to save energy	☐	☐	☐	☐
6	Your unit often establishes recycling system manufacturing processes	☐	☐	☐	☐

Source: C.C. Cheng, E.C. Shiu/ Technovation 32 (2012) 329-344

4. Innovations with environmental benefits

An environmental innovation is a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives.

- The environmental benefits can be the primary objective of the innovation or the result of other innovation objectives.
- The environmental benefits of an innovation can occur during the production of a good or service, or during the after sales use of a good or service by the end user

4.1 During the three years 2018 to 2020, did your enterprise introduce a product (good or service), process, with any of the following environmental benefits?

Environmental benefits from the production of goods or services within your enterprise	Yes	No
Reduced material use per unit of output	☐	☐
Reduced energy use per unit of output	☐	☐
Reduced energy use per unit of output	☐	☐
Replaced materials with less polluting or hazardous substitutes	☐	☐
Reduced soil, water, noise, or air pollution	☐	☐
Recycled waste, water, or materials	☐	☐

4.2 Environmental benefits from the after sales use of a good or service by the end user

Reduced energy use Yes ☐ No ☐

Reduced air, water, soil or noise pollution Yes ☐ No ☐

Improved recycling of product after use Yes ☐ No ☐

4.3 During 2018 to 2020, did your enterprise introduce an environmental innovation in response to:

- Existing environmental regulations or taxes on pollution Yes ☐ No ☐
- Environmental regulations or taxes that you expected to be introduced in the future Yes ☐ No ☐
- Availability of government grants, subsidies or other financial incentives for environmental innovation Yes ☐ No ☐
- Current or expected market demand from your customers for environmental innovations Yes ☐ No ☐
- Voluntary codes or agreements for environmental good practice within your sector Yes ☐ No ☐

4.4 Does your enterprise have procedures in place to regularly identify and reduce your enterprise's environmental impacts? (For example preparing environmental audits, setting environmental performance goals, ISO 14001 certification, LEED certification, etc).

- Yes: implemented before January 2018
- Yes: Implemented or significantly improved after January 2015
- No

Source: Eurostat, Final harmonized CIS-2008 questionnaire

Ref: EUROSTAT (2007): Draft Compilation guide on environmental sector version 5.1, Luxemburg,

5. Items for measuring environmental performance indicators

Rate your unit over the last three years on the extent to which……

Item No	**Items for measuring environmental performance indicators**	**High**	**Medium**	**Low**	**Not relevant**
1	Energy (direct consumption; indirect consumption; energy saved due to conservation and efficiency improvements)	☐	☐	☐	☐
2	Emission (total direct and indirect greenhose gas emissions by weight; NOx (Nitrogen Oxide), Sox (Sulfur Oxide), and other significant air emissions by type and weight)	☐	☐	☐	☐
3	Effluents (total water discharged by quality and destination)	☐	☐	☐	☐
4	Waste (total weight of waste by type and disposal method)	☐	☐	☐	☐
5	Water (total amount withdrawal; percentage and total volume of water recycled and reused)	☐	☐	☐	☐
6	Product and Services (initiatives to mitigate environmental impacts of products and services; percentage of products sold and their packaging materials that are reclaimed)	☐	☐	☐	☐

7	Regulation compliance (Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations)	☐	☐	☐	☐
8	Material usage (by weight or volume, percentage of materials used are from recycled materials)	☐	☐	☐	☐
9	Transportation (Significant environmental impacts to transporting product)	☐	☐	☐	☐
10	Biodiversity of company sites (location and land of company in protected areas; significant impacts of activities, products, and services on biodiversity in protected areas; habitats protected or restored)	☐	☐	☐	☐

Source: Sustainability Reporting Guideline, Global Reporting Initiative (GRI), *Environmental Performance Indicators, 2002.*

Thanks a lot for your cooperation!

Key Informant Interview Questionnaire Cover letter

University of Dhaka

Dated:

Subject: You are requested to attain a KII

Dear Participant,

My name is Sadia Islam and I am a Master of Philosophy (Mphil) student under the supervision of Syed Naimul Wadood, Ph.D., Professor at the University of Dhaka**.** For our study purpose, we are estimating the influence of eco-innovation on environmental performance in RMG and the leather industry of the Bangladesh.

We are cordially requesting you to participate in this research KII by completing the following questions. This work is completely done for academic purpose and your participation is voluntary, you may refuse to participate at any time.
Thank you for giving the time to help me in my academic endeavors. Your participation is appreciated.

Sincerely,
Sadia Islam
Mphil Student &
Naimul Wadood, Ph.D.,
Professor, Department of Economics,
University of Dhaka

Dated:

CERTIFICATE

This is to certify that the dissertation titled: "**Sustainable Industrialization in Bangladesh: A Case Study of the Ready-Made Garments and the Leather Industries**" KII done by Sadia Islam for the fulfillment of the requirements for the degree of Master of Philosophy in Economics is her own independent and original research work carried out at Dhaka University under my supervision. This work is for academic purpose only. I, therefore, request you to assist/help her for the fulfillments of her degree. Your participation is highly appreciated. Thanks in advance.

………………………………………..

(**Syed NaimulWadood, Ph.D.**)
Professor, Department of Economics,
University of Dhaka.

Key Informant Interview (KII) Questionnaire

Questionnaire for the Key Informant Interview (KII) to Learn About Expert Opinion on the Impacts of Eco-Innovation on Environmental Sustainability Performance in the Bangladesh's Industrial Sectors

Section 1: Background Information

1. Name of Respondent:
2. Position/Role:
3. Organization:

Section 2: Expert Opinion

1. How would you define eco-innovation in the context of Bangladesh's industrial sector?

2. How have eco-innovations affected the environmental sustainability performance of industries in Bangladesh?

3. Can you provide examples of successful eco-innovations in Bangladesh's industrial sector?

4. How does eco-innovation contribute to the overall goal of sustainable industrialization as outlined in SDG 9?

5. In your opinion, what measures should be prioritized to scale up eco-innovation across Bangladesh's industrial sector?

6. Do you have any other insights or comments on the role of eco-innovation in promoting environmental sustainability in Bangladesh's industrial sectors?

Appendix 2

Table 2.1: Targets and Indicators of Sustainable Development Goals # 9 (SDG-9) and relationship with sustainability pillar

Target	Indicators	Sustainability pillar
9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	**9.1.1** Proportion of the rural population who live within 2 km of an all-season road **9.1.2** Passenger and freight volumes, by mode of transport	Social
9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries	**9.2.1** Manufacturing value added as a proportion of GDP and per capita **9.2.2** Manufacturing employment as a proportion of total employment	Economic
9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets	**9.3.1** Proportion of small-scale industries in total industry value added **9.3.2** Proportion of small-scale industries with a loan or line of credit	Economic

9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	**9.4.1** CO2 emission per unit of value added	Environment
9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	**9.5.1** Research and development expenditure as a proportion of GDP 9.5.2 Researchers (in full-time equivalent) per million inhabitants **9.5.2** Researchers (in full-time equivalent) per million inhabitants	Economic and Environment

Source: Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (E/CN.3/2016/2/Rev.1), Annex IV, pp. 12-13).

Appendix 3

Table 3.1: The annually data of Manufacturing value added percentage of GDP (in percent) in Bangladesh during the period of 1960-2019

Year	Manufacturing value added as a percentage of GDP	Year	Manufacturing value added as a percentage of GDP
1960	5.3099	1990	13.2392
1961	5.4706	1991	13.9871
1962	5.4487	1992	14.3975
1963	5.4487	1993	15.4125
1964	5.5140	1994	15.8695
1965	5.4455	1995	15.9000
1966	5.9981	1996	14.0026
1967	5.5829	1997	14.1198
1968	6.1534	1998	14.8598
1969	5.8511	1999	14.3891
1970	5.8047	2000	14.0353
1971	5.4852	2001	14.1784
1972	3.9838	2002	14.3174
1973	8.5218	2003	14.1455
1974	9.2513	2004	14.4421
1975	7.0423	2005	14.7440
1976	9.2839	2006	15.3076
1977	11.2262	2007	15.9341
1978	9.9110	2008	16.1244
1979	9.8615	2009	16.4802
1980	14.4875	2010	16.1212
1981	13.9821	2011	15.9967
1982	13.9391	2012	15.9142
1983	15.0437	2013	16.4420
1984	15.6039	2014	16.6127
1985	14.4581	2015	16.7887
1986	14.2232	2016	17.0302
1987	13.4738	2017	17.3006
1988	13.4220	2018	17.9581
1989	12.9056	2019	18.9326

Source: The World Bank data set indicators, 2020.

Table 3.2: The annually data of Manufacturing value added in per capita (in USD) in Bangladesh during the period of 1990-2014

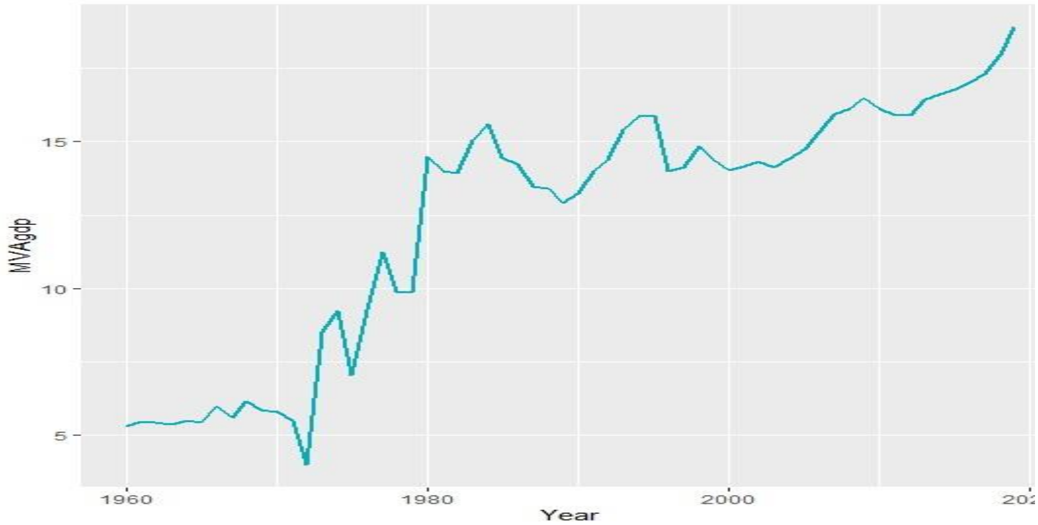
Year	Manufacturing Value Added Per Capita	Year	Manufacturing Value Added Per Capita
1990	44.13	2003	76.5
1991	44.13	2004	80.74
1992	46.31	2005	86.19
1993	49.22	2006	94.33
1994	52.11	2007	103.49
1995	56.11	2008	109.81
1996	58.74	2009	115.94
1997	60.45	2010	122.15
1998	64.31	2011	132.86
1999	65.1	2012	144.35
2000	66.95	2013	157.3
2001	70.18	2014	168.89
2002	72.8		

Source: UNIDO- Competitive Industrial Performance Index, 2020.

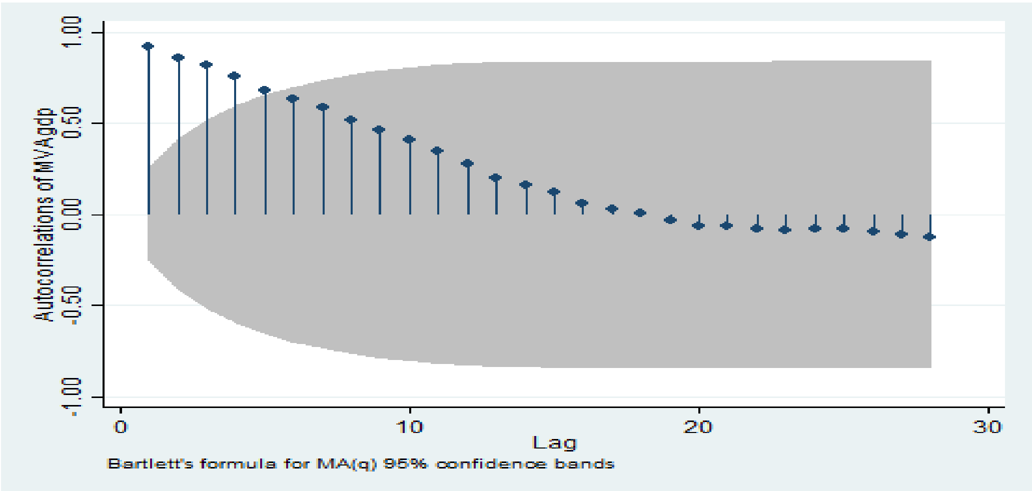
Appendix 4

Section 4.1: Forecasted result for the annually data of Manufacturing value added percentage of GDP (in percent) (MVAgdp) from the Bangladesh the period of 2020-2030

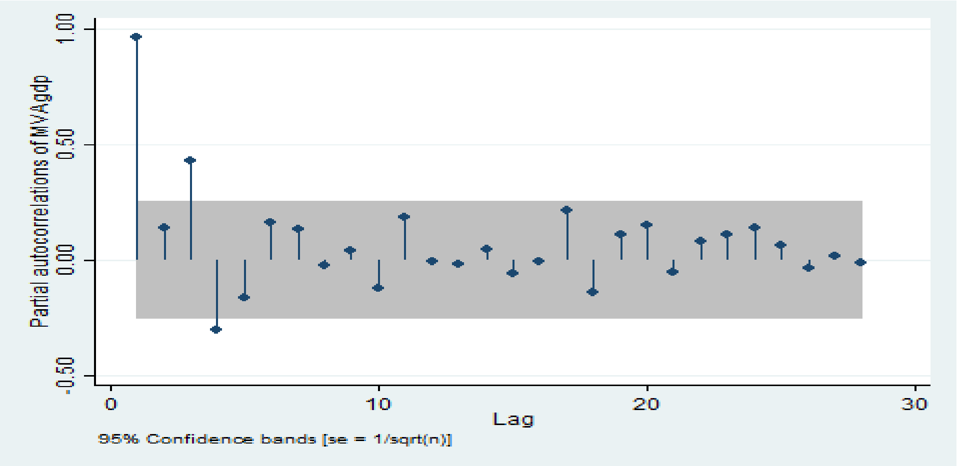
Time series plot



ACF_ MVAgdp



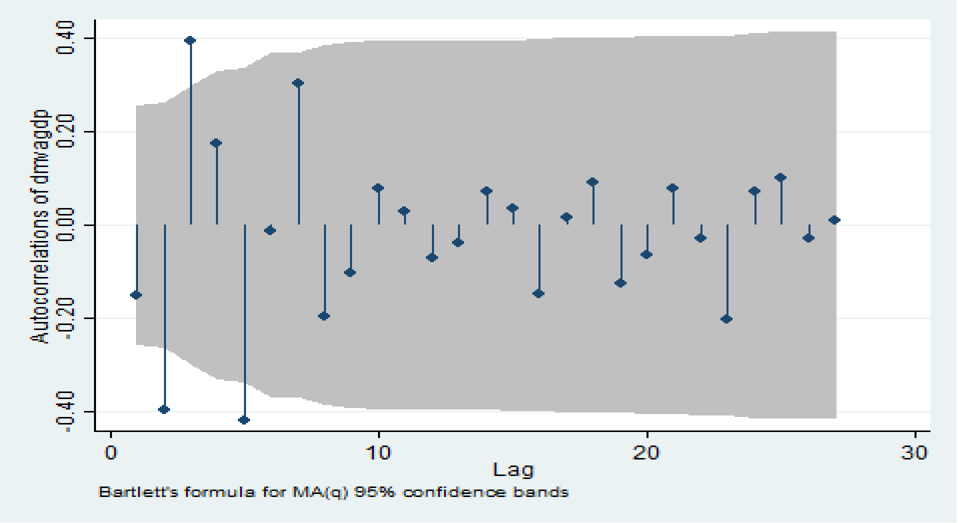
PACF_ MVAgdp



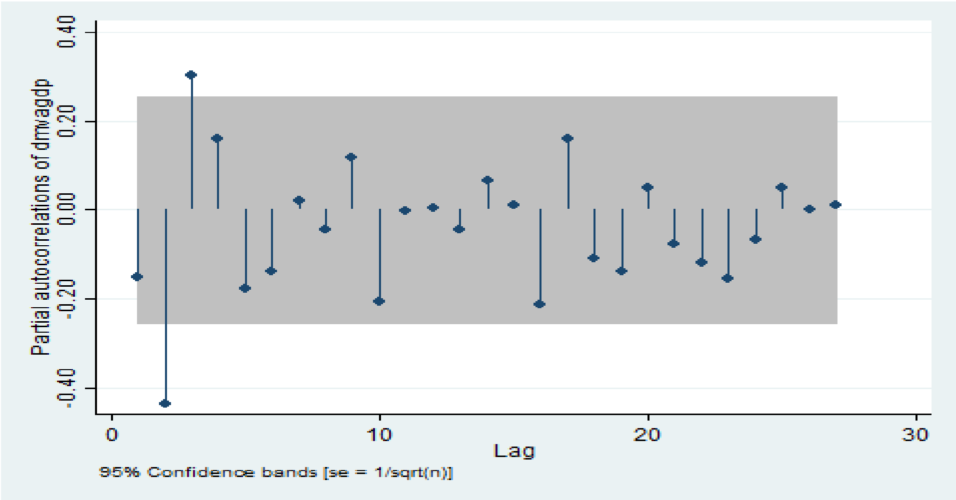
Df test_ MVAgdp

```
. dfuller MVAgdp

Dickey-Fuller test for unit root                   Number of obs   =        59

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.107            -3.567            -2.923            -2.596
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7125
```

ACF_ DMVAgdp



PACF_ DMVAgdp



Df test_ DMVAgdp

```
. dfuller dmvagdp

Dickey-Fuller test for unit root                   Number of obs   =        58

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -8.689            -3.569            -2.924            -2.597
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

Auto ARIMA: ARIMA(2,1,2)

AIC, BIC:

ARIMA(2,1,2) with drift					
Coefficients:					
	ar1	ar2	ma1	ma2	drift
	-0.4691	-0.8054	0.2995	0.4566	0.2279
s.e.	0.1604	0.1126	0.2599	0.1914	0.0931

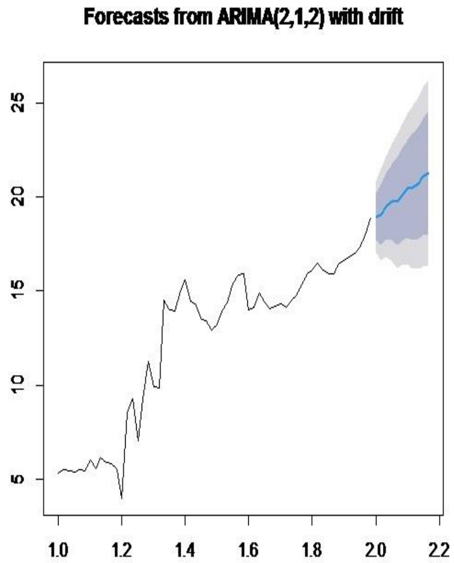
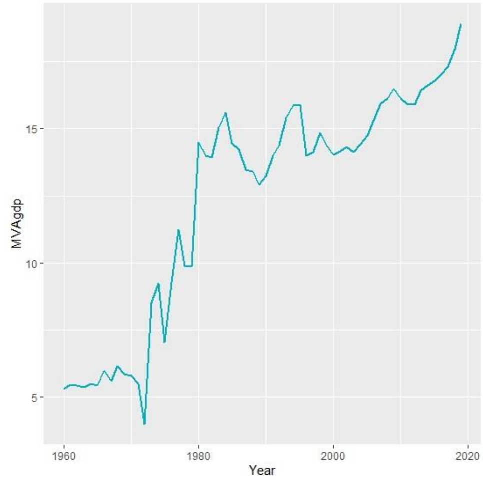
sigma^2 estimated as 0.9301: log likelihood=-79.34

AIC=170.67 AICc=172.29 BIC=183.14

Forecasted values with ARIMA(2, 1,2)

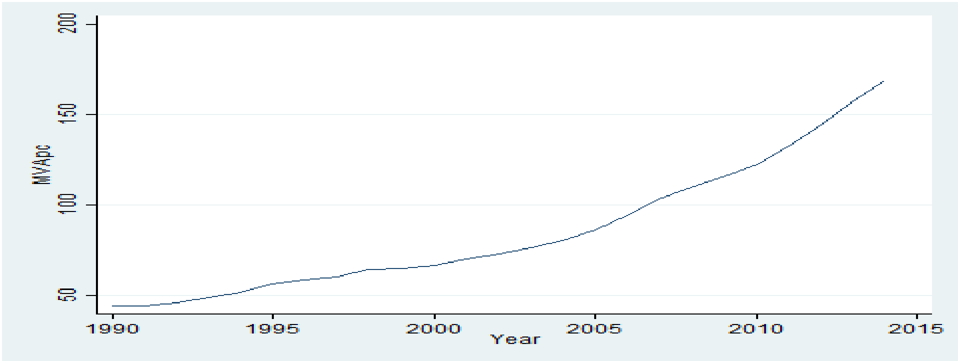
Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
18.94078	17.70486	20.17670	17.05060	20.83096
19.04801	17.44154	20.65447	16.59113	21.50488
19.50973	17.75999	21.25946	16.83374	22.18571
19.72504	17.70049	21.74959	16.62876	22.82132
19.77043	17.44990	22.09096	16.22149	23.31938
20.09400	17.63351	22.55450	16.33100	23.85701
20.42394	17.81310	23.03477	16.43100	24.41687
20.52683	17.69301	23.36064	16.19288	24.86077
20.73110	17.74224	23.71997	16.16003	25.30218
21.07069	17.96680	24.17457	16.32370	25.81767
21.26513	18.00034	24.52993	16.27206	26.25821

Year	F_value	95% CI
2020	18.94	
2021	19.04	
2022	19.5	
2023	19.72	
2024	19.77	
2025	20.09	
2026	20.42	
2027	20.52	
2028	20.73	
2029	21.07	
2030	21.26	

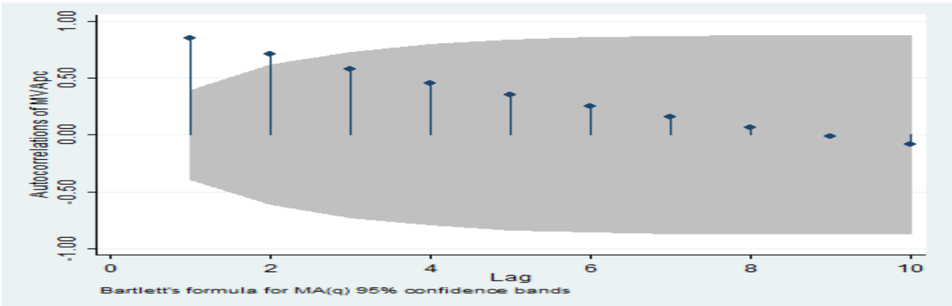
F_graph	Forecasted	Actual
		

Section 4.2: Forecasted result for the annually data of Manufacturing value added per Capita (in USD) (MVApc) from the Bangladesh the period of 2015-2030

Time series plot

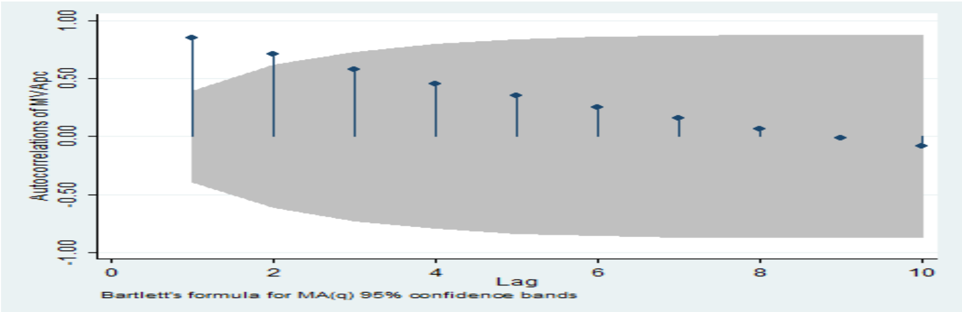


ACF_ MVApc



PACF_

MVApc



Df test_

MVApc

```
Dickey-Fuller test for unit root                   Number of obs   =        24

                          ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             10.125            -3.750            -3.000            -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 1.0000
```

Df

Test_DM

VApc

```
. dfuller dmvapc

Dickey-Fuller test for unit root                   Number of obs   =        23

                          ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.913            -3.750            -3.000            -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7837
```

Df

Test_D2

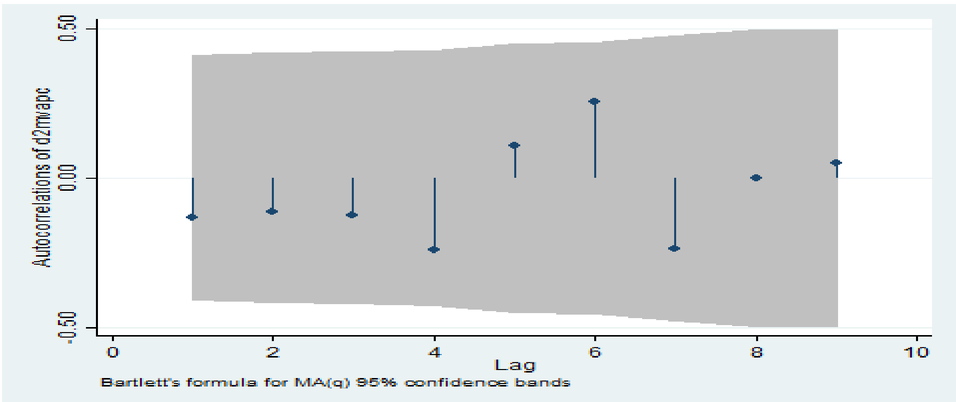
MVApc

```
. dfuller d2mvapc

Dickey-Fuller test for unit root                   Number of obs   =        22

                          ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -5.112            -3.750            -3.000            -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

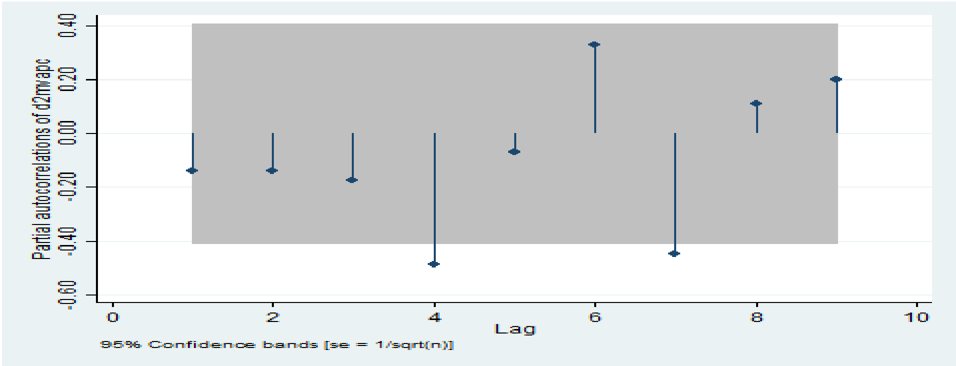
ACF_

D2MVAp

c



PACF_ D2MVApc



Auto ARIMA

ARIMA(0,2,0)

AIC, BIC

autoarima1

Series: y

ARIMA(0,2,0)

sigma^2 estimated as 3.164: log likelihood=-45.88

AIC=93.76   AICc=93.95   BIC=94.9

Forecasted values with ARIMA(0,2,0)

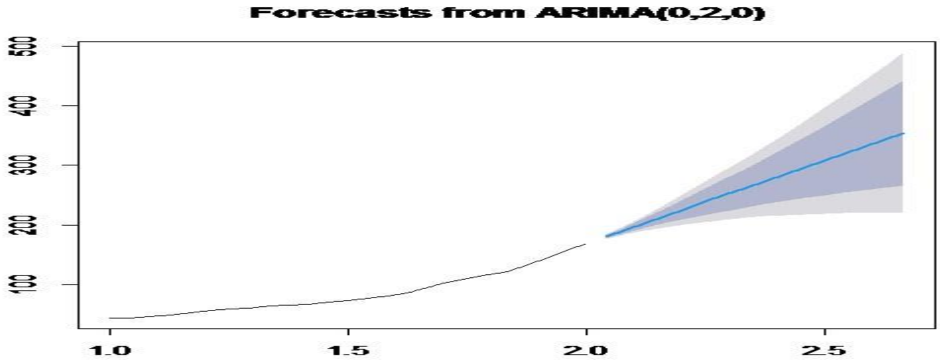
		Lo 80	Hi 80	Lo 95	Hi 95
2.041667	180.48	178.2005	182.7595	176.9938	183.9662
2.083333	192.07	186.9729	197.1671	184.2746	199.8654
2.125000	203.66	195.1308	212.1892	190.6158	216.7042
2.166667	215.25	202.7646	227.7354	196.1552	234.3448
2.208333	226.84	209.9347	243.7453	200.9855	252.6945
2.250000	238.43	216.6848	260.1752	205.1736	271.6864

2.291667	250.02 223.0484 276.9916 208.7705 291.2695
2.333333	261.61 229.0520 294.1680 211.8169 311.4031
2.375000	273.20 234.7174 311.6826 214.3459 332.0541
2.416667	284.79 240.0627 329.5173 216.3855 353.1945
2.458333	296.38 245.1036 347.6564 217.9595 374.8005
2.500000	307.97 249.8536 366.0864 219.0886 396.8514
2.541667	319.56 254.3245 384.7955 219.7908 419.3292
2.583333	331.15 258.5268 403.7732 220.0824 442.2176
2.625000	342.74 262.4700 423.0100 219.9776 465.5024
2.666667	354.33 266.1626 442.4974 219.4896 489.1704

Year	F_value	95% CI	
		low	Hi
2015	180.48		
2016	192.07		
2017	203.66		
2018	215.25		
2019	226.84		
2020	238.43		
2021	250.02		

2022	261.61		
2023	273.20		
2024	284.79		
2025	296.38		
2026	307.97		
2027	319.56		
2028	331.15		
2029	342.74		
2030	354.33		

F_graph



Appendix 5

Section 5.1 Frequency of the industries main activity

Main activity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	RMG	30	60.0	60.0	60.0
	Leather	20	40.0	40.0	100.0
	Total	50	100.0	100.0	

Section 5.2 Frequencies related to Eco-product innovation

Did your enterprise introduce new or significantly improved goods					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	2.0	2.0	2.0
	Yes	49	98.0	98.0	100.0
	Total	50	100.0	100.0	

Did your enterprise introduce new or significantly improved services					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	6.0	6.0	6.0
	yes	47	94.0	94.0	100.0
	Total	50	100.0	100.0	

Were any of your product innovation only new to your firm					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	17	34.0	34.0	34.0
	yes	33	66.0	66.0	100.0
	Total	50	100.0	100.0	

Who developed these product innovations					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mainly your enterprise or enterprise group	1	2.0	2.0	2.0
	your enterprise together with other enterprises or institutions	6	12.0	12.0	14.0
	Mainly other enterprises	43	86.0	86.0	100.0
	Total	50	100.0	100.0	

Section 5.3 Frequencies related to Eco-process innovation

Your enterprise introduce new or significantly improved methods of manufacturing producing goods and services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	5	10.0	10.0	10.0
	yes	45	90.0	90.0	100.0
	Total	50	100.0	100.0	

Your enterprise introduce new or significantly improved supporting activities for your processes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	8	16.0	16.0	16.0
	yes	42	84.0	84.0	100.0
	Total	50	100.0	100.0	

Your enterprise introduce new or significantly improved logistics, delivery or distribution methods for your inputs, goods or services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	13	26.0	26.0	26.0
	yes	36	72.0	72.0	98.0
	2	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Who developed these process innovations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mainly your enterprise or enterprise group	2	4.0	4.0	4.0
	your enterprise together with other enterprises or institutions	6	12.0	12.0	16.0
	Mainly other enterprises or institutions	42	84.0	84.0	100.0
	Total	50	100.0	100.0	

your process innovations introduced between 2018and 2020 new to your market

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	26	52.0	52.0	52.0
	No	21	42.0	42.0	94.0
	do not know	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Appendix 6

Section 6.1: Factor Analysis and Regression Analysis for Manufacturing Sector

Exploratory FA

To create Environmental Sustainability Performance Index

```
. factor env_per_indi1 env_per_indi2 env_per_indi3 env_per_indi4 env_per_indi5 env_
> per_indi6 env_per_indi7 env_per_indi8 env_per_indi9 env_per_indi10, pcf
(obs=50)

Factor analysis/correlation                        Number of obs    =        50
    Method: principal-component factors           Retained factors =         4
    Rotation: (unrotated)                          Number of params =        34
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.44220	2.08240	0.3442	0.3442
Factor2	1.35980	0.25468	0.1360	0.4802
Factor3	1.10512	0.08496	0.1105	0.5907
Factor4	1.02016	0.08225	0.1020	0.6927
Factor5	0.93791	0.26326	0.0938	0.7865
Factor6	0.67465	0.16590	0.0675	0.8540
Factor7	0.50875	0.06515	0.0509	0.9049
Factor8	0.44360	0.13378	0.0444	0.9492
Factor9	0.30982	0.11182	0.0310	0.9802
Factor10	0.19800	.	0.0198	1.0000

```
    LR test: independent vs. saturated:  chi2(45) =  140.90 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
env_per_in~1	0.7481	0.0111	-0.2453	0.1894	0.3441
env_per_in~2	0.7038	0.3016	-0.0135	-0.3621	0.2823
env_per_in~3	0.6730	-0.4444	-0.0090	0.1075	0.3380
env_per_in~4	0.6225	-0.3489	0.0562	0.1898	0.4516
env_per_in~5	0.8184	-0.0852	-0.3421	-0.0783	0.1998
env_per_in~6	0.1843	0.4450	-0.1660	0.7999	0.1006
env_per_in~7	0.5905	-0.0456	0.4624	-0.1875	0.4003
env_per_in~8	0.6634	0.2374	0.1082	-0.0977	0.4823
env_per_in~9	0.2092	0.3673	0.7647	0.2031	0.1953
env_per_i~10	0.1023	0.7422	-0.2942	-0.2714	0.2784

Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy:

Without proper checking of the **appropriateness of the data**, the factor analysis is misleading and inappropriate.

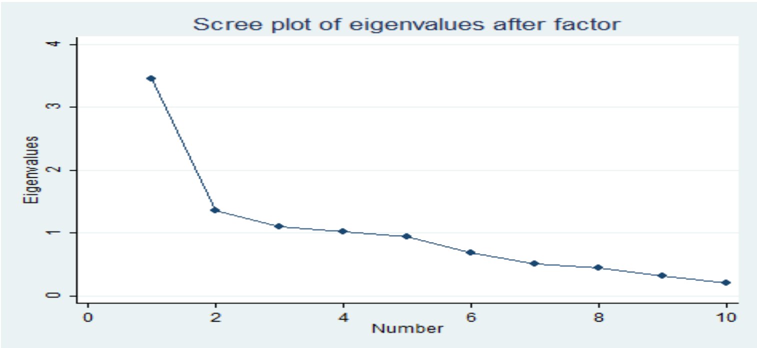
```
. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
env_per_in~1	0.8285
env_per_in~2	0.6733
env_per_in~3	0.7834
env_per_in~4	0.6040
env_per_in~5	0.6881
env_per_in~6	0.5143
env_per_in~7	0.6212
env_per_in~8	0.6162
env_per_in~9	0.3522
env_per_i~10	0.3459
Overall	0.6581

KMO	Interpretation
0.90 and + ve	*marvelous*
0.80 and + ve	*meritorious*
0.70 and + ve	*middling*
0.60 and + ve	*mediocre*
0.50 and + ve	*miserable*
below 0.50	*unacceptable*

Latent root criteria:

screeplot



Rotation Results

Orthogonal

```
. rotate

Factor analysis/correlation                        Number of obs    =       50
    Method: principal-component factors            Retained factors =        4
    Rotation: orthogonal varimax (Kaiser off)      Number of params =       34
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	3.18344	1.83475	0.3183	0.3183
Factor2	1.34869	0.04942	0.1349	0.4532
Factor3	1.29927	0.20339	0.1299	0.5831
Factor4	1.09588	.	0.1096	0.6927

LR test: independent vs. saturated: chi2(45) = 140.90 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

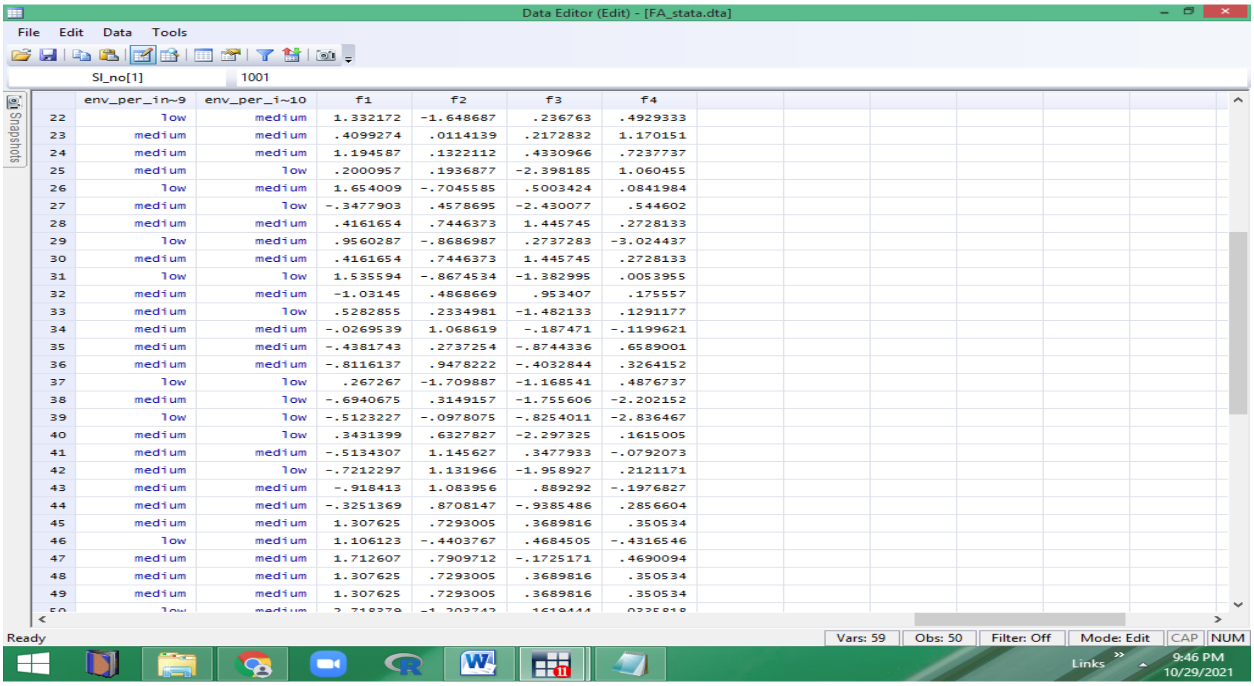
Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
env_per_in~1	0.7518	0.0231	0.0912	0.2862	0.3441
env_per_in~2	0.5999	0.2757	0.5127	-0.1378	0.2823
env_per_in~3	0.7419	0.0679	-0.3258	-0.0295	0.3380
env_per_in~4	0.6530	0.1451	-0.3113	0.0634	0.4516
env_per_in~5	0.8723	-0.0872	0.1742	0.0379	0.1998
env_per_in~6	0.0775	0.0897	0.0677	0.9385	0.1006
env_per_in~7	0.4636	0.5721	-0.0105	-0.2394	0.4003
env_per_in~8	0.5417	0.3681	0.2953	0.0393	0.4823
env_per_in~9	-0.0795	0.8761	0.0086	0.1753	0.1953
env_per_i~10	-0.0122	-0.0205	0.8383	0.1352	0.2784

Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.9394	0.3067	0.1303	0.0802
Factor2	-0.2492	0.3073	0.8238	0.4059
Factor3	-0.2334	0.8990	-0.2965	-0.2222
Factor4	-0.0295	0.0571	-0.4652	0.8829

Generation of factor scores

predict f1 f2 f3 f4 (regression scoring assumed)



Data Editor (Edit) - [FA_stata.dta]

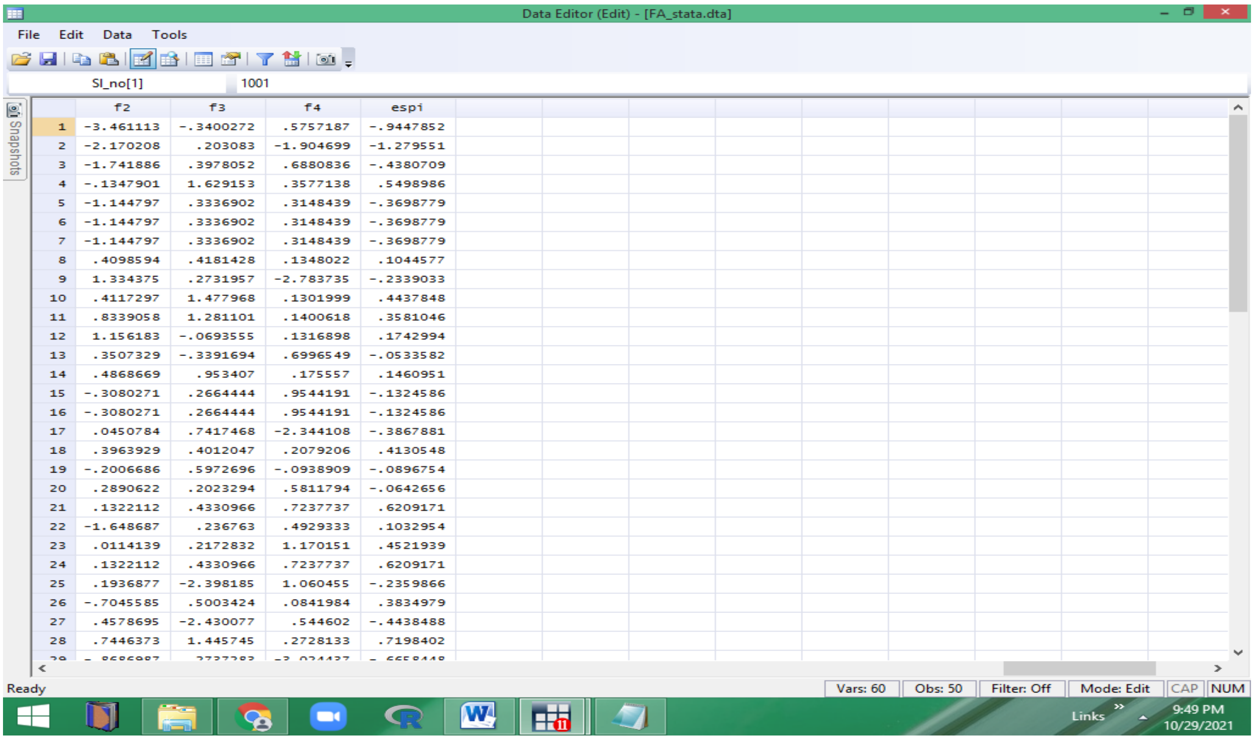
Sl_no[1] 1001

	env_per_in~9	env_per_i~10	f1	f2	f3	f4
22	low	medium	1.332172	-1.648687	.236763	.4929333
23	medium	medium	.4099274	.0114139	.2172832	1.170151
24	medium	medium	1.194587	.1322112	.4330966	.7237737
25	medium	low	.2000957	.1936877	-2.398185	1.060455
26	low	medium	1.654009	-.7045585	.5003424	.0841984
27	medium	low	-.3477903	.4578695	-2.430077	.544602
28	medium	medium	.4161654	.7446373	1.445745	.2728133
29	low	medium	.9560287	-.8686987	.2737283	-3.024437
30	medium	medium	.4161654	.7446373	1.445745	.2728133
31	low	low	1.535594	-.8674534	-1.382995	.0053955
32	medium	medium	-1.03145	.4868669	.953407	.175557
33	medium	low	.5282855	.2334981	-1.482133	.1291177
34	medium	medium	-.0269539	1.068619	-.187471	-.1199621
35	medium	medium	-.4381743	.2737254	-.8744336	.6589001
36	medium	medium	-.8116137	.9478222	-.4032844	.3264152
37	low	low	.267267	-1.709887	-1.168541	.4876737
38	medium	low	-.6940675	.3149157	-1.755606	-2.202152
39	low	low	-.5123227	-.0978075	-.8254011	-2.836467
40	medium	low	.3431399	.6327827	-2.297325	.1615005
41	medium	medium	-.5134307	1.145627	.3477933	-.0792073
42	medium	low	-.7212297	1.131966	-1.958927	.2121171
43	medium	medium	-.918413	1.083956	.889292	-.1976827
44	medium	medium	-.3251369	.8708147	-.9385486	.2856604
45	medium	medium	1.307625	.7293005	.3689816	.350534
46	low	medium	1.106123	-.4403767	.4684505	-.4316546
47	medium	medium	1.712607	.7909712	-.1725171	.4690094
48	medium	medium	1.307625	.7293005	.3689816	.350534
49	medium	medium	1.307625	.7293005	.3689816	.350534

Ready | Vars: 59 | Obs: 50 | Filter: Off | Mode: Edit | CAP | NUM

Generation of ESPI

Gen espi=(f1+f2+f3+f4)/4



Data Editor (Edit) - [FA_stata.dta]

Sl_no[1] 1001

	f2	f3	f4	espi
1	-3.461113	-.3400272	.5757187	-.9447852
2	-2.170208	.203083	-1.904699	-1.279551
3	-1.741886	.3978052	.6880836	-.4380709
4	-.1347901	1.629153	.3577138	.5498986
5	-1.144797	.3336902	.3148439	-.3698779
6	-1.144797	.3336902	.3148439	-.3698779
7	-1.144797	.3336902	.3148439	-.3698779
8	.4098594	.4181428	.1348022	.1044577
9	1.334375	.2731957	-2.783735	-.2339033
10	.4117297	1.477968	.1301999	.4437848
11	.8339058	1.281101	.1400618	.3581046
12	1.156183	-.0693555	.1316898	.1742994
13	.3507329	-.3391694	.6996549	-.0533582
14	.4868669	.953407	.175557	.1460951
15	-.3080271	.2664444	.9544191	-.1324586
16	-.3080271	.2664444	.9544191	-.1324586
17	.0450784	.7417468	-2.344108	-.3867881
18	.3963929	.4012047	.2079206	.4130548
19	-.2006686	.5972696	-.0938909	-.0896754
20	.2890622	.2023294	.5811794	-.0642656
21	.1322112	.4330966	.7237737	.6209171
22	-1.648687	.236763	.4929333	.1032954
23	.0114139	.2172832	1.170151	.4521939
24	.1322112	.4330966	.7237737	.6209171
25	.1936877	-2.398185	1.060455	-.2359866
26	-.7045585	.5003424	.0841984	.3834979
27	.4578695	-2.430077	.544602	-.4438488
28	.7446373	1.445745	.2728133	.7198402

Ready | Vars: 60 | Obs: 50 | Filter: Off | Mode: Edit | CAP | NUM

To create Eco process Index

```
. factor eco_peocess_1 eco_process_2 eco_process_3 eco_process_4 eco_process_5 eco_process_6, pcf
(obs=50)

Factor analysis/correlation                    Number of obs    =        50
    Method: principal-component factors        Retained factors =         1
    Rotation: (unrotated)                      Number of params =         6
```

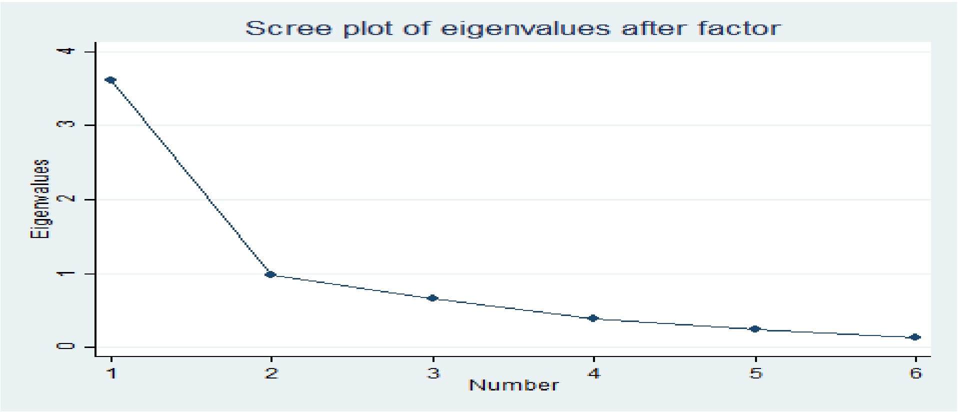
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.60666	2.62944	0.6011	0.6011
Factor2	0.97722	0.32060	0.1629	0.7640
Factor3	0.65663	0.26512	0.1094	0.8734
Factor4	0.39151	0.15089	0.0653	0.9387
Factor5	0.24062	0.11325	0.0401	0.9788
Factor6	0.12736	.	0.0212	1.0000

```
    LR test: independent vs. saturated:  chi2(15) =  169.04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Uniqueness
eco_peoces~1	0.6777	0.5407
eco_proces~2	0.8154	0.3351
eco_proces~3	0.9266	0.1415
eco_proces~4	0.8752	0.2340
eco_proces~5	0.8648	0.2522
eco_proces~6	0.3319	0.8899

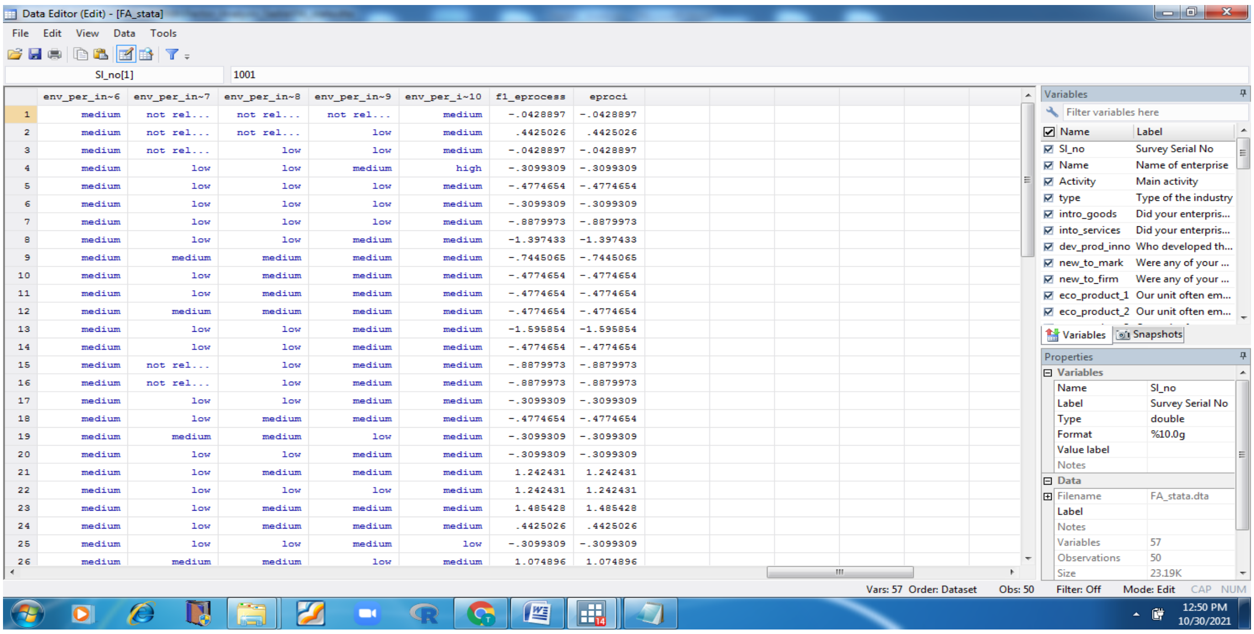
```
.

. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
eco_peoces~1	0.8859
eco_proces~2	0.8888
eco_proces~3	0.7875
eco_proces~4	0.8095
eco_proces~5	0.8882
eco_proces~6	0.7924
Overall	0.8407



```
. rotate

Factor analysis/correlation                        Number of obs    =         50
    Method: principal-component factors           Retained factors =          1
    Rotation: orthogonal varimax (Kaiser off)      Number of params =          6

    --------------------------------------------------------------------------
         Factor  |     Variance   Difference        Proportion   Cumulative
    -------------+------------------------------------------------------------
        Factor1  |      3.60666            .            0.6011       0.6011
    --------------------------------------------------------------------------
    LR test: independent vs. saturated:  chi2(15)  =  169.04 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

    -------------------------------------------
        Variable |  Factor1 |   Uniqueness
    -------------+----------+------------------
    eco_peoces~1 |   0.6777 |      0.5407
    eco_proces~2 |   0.8154 |      0.3351
    eco_proces~3 |   0.9266 |      0.1415
    eco_proces~4 |   0.8752 |      0.2340
    eco_proces~5 |   0.8648 |      0.2522
    eco_proces~6 |   0.3319 |      0.8899
    -------------------------------------------

Factor rotation matrix

    ----------------------------
                 |  Factor1
    -------------+--------------
         Factor1 |   1.0000
    ----------------------------

. predict f1_eprocess
(regression scoring assumed)

Scoring coefficients (method = regression; based on varimax rotated factors)

    ----------------------------
        Variable |  Factor1
    -------------+--------------
    eco_peoces~1 |  0.24882
    eco_proces~2 |  0.28563
    eco_proces~3 |  0.31073
    eco_proces~4 |  0.29172
    eco_proces~6 |  0.12773
    ----------------------------
```

gen eproci=f1_eprocess



	env_per_in~6	env_per_in~7	env_per_in~8	env_per_in~9	env_per_i~10	f1_eprocess	eproci
1	medium	not rel...	not rel...	not rel...	medium	-.0428897	-.0428897
2	medium	not rel...	not rel...	low	medium	.4425026	.4425026
3	medium	not rel...	low	low	medium	-.0428897	-.0428897
4	medium	low	low	medium	high	-.3099309	-.3099309
5	medium	low	low	low	medium	-.4774654	-.4774654
6	medium	low	low	low	medium	-.3099309	-.3099309
7	medium	low	low	low	medium	-.8879973	-.8879973
8	medium	low	low	medium	medium	-1.397433	-1.397433
9	medium	medium	medium	medium	medium	-.7445065	-.7445065
10	medium	low	medium	medium	medium	-.4774654	-.4774654
11	medium	low	medium	medium	medium	-.4774654	-.4774654
12	medium	medium	medium	medium	medium	-.4774654	-.4774654
13	medium	low	low	medium	medium	-1.595854	-1.595854
14	medium	low	low	medium	medium	-.4774654	-.4774654
15	medium	not rel...	low	medium	medium	-.8879973	-.8879973
16	medium	not rel...	low	medium	medium	-.8879973	-.8879973
17	medium	low	low	medium	medium	-.3099309	-.3099309
18	medium	low	medium	medium	medium	-.4774654	-.4774654
19	medium	medium	medium	low	medium	-.3099309	-.3099309
20	medium	low	low	medium	medium	-.3099309	-.3099309
21	medium	low	medium	medium	medium	1.242431	1.242431
22	medium	low	low	low	medium	1.242431	1.242431
23	medium	low	medium	medium	medium	1.485428	1.485428
24	medium	low	medium	medium	medium	.4425026	.4425026
25	medium	low	low	medium	low	-.3099309	-.3099309
26	medium	medium	medium	low	medium	1.074896	1.074896

To create Eco product Index

```
. factor eco_product_1 eco_product_2 eco_product_3 eco_product_4 eco_product_5 eco_product_6 eco_product_7 eco_product_8 eco_product_9
> eco_product_10, pcf
(obs=50)

Factor analysis/correlation                    Number of obs    =        50
    Method: principal-component factors        Retained factors =         2
    Rotation: (unrotated)                      Number of params =        19
```

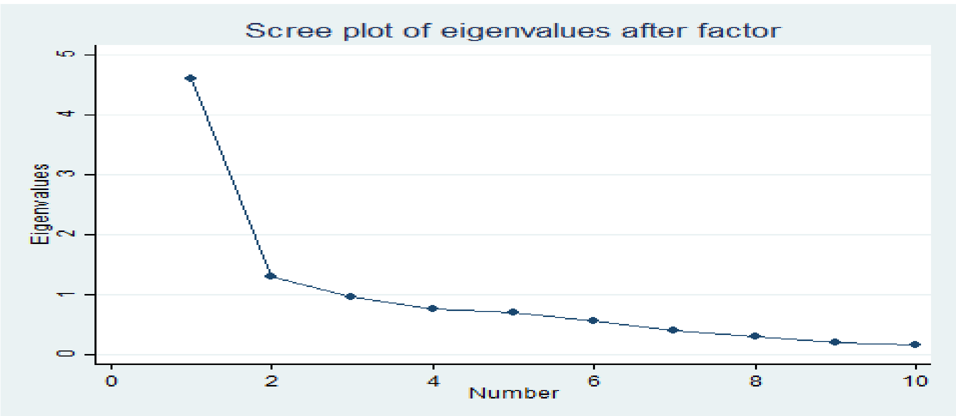
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.59367	3.29656	0.4594	0.4594
Factor2	1.29711	0.33740	0.1297	0.5891
Factor3	0.95971	0.18582	0.0960	0.6850
Factor4	0.77389	0.05890	0.0774	0.7624
Factor5	0.71499	0.14166	0.0715	0.8339
Factor6	0.57333	0.16532	0.0573	0.8913
Factor7	0.40802	0.10470	0.0408	0.9321
Factor8	0.30332	0.08750	0.0303	0.9624
Factor9	0.21582	0.05568	0.0216	0.9840
Factor10	0.16014	.	0.0160	1.0000

```
LR test: independent vs. saturated:  chi2(45) =  222.70 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Uniqueness
eco_produc~1	0.7843	0.2706	0.3117
eco_produc~2	0.5824	0.6543	0.2327
eco_produc~3	0.2644	0.7298	0.3975
eco_produc~4	0.6317	-0.1277	0.5846
eco_produc~5	0.5833	-0.0592	0.6562
eco_produc~6	0.7537	-0.3100	0.3359
eco_produc~7	0.7750	-0.2804	0.3207
eco_produc~8	0.7273	-0.2573	0.4049
eco_produc~9	0.7239	0.0082	0.4758
eco_produ~10	0.7800	-0.0498	0.3891

```
. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
eco_produc~1	0.7998
eco_produc~2	0.6449
eco_produc~3	0.6252
eco_produc~4	0.8370
eco_produc~5	0.7406
eco_produc~6	0.7211
eco_produc~7	0.7740
eco_produc~8	0.8345
eco_produc~9	0.8458
eco_produ~10	0.8152
Overall	0.7751



```
. rotate

Factor analysis/correlation                        Number of obs    =        50
    Method: principal-component factors           Retained factors =         2
    Rotation: orthogonal varimax (Kaiser off)      Number of params =        19
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	3.93073	1.97067	0.3931	0.3931
Factor2	1.96005	.	0.1960	0.5891

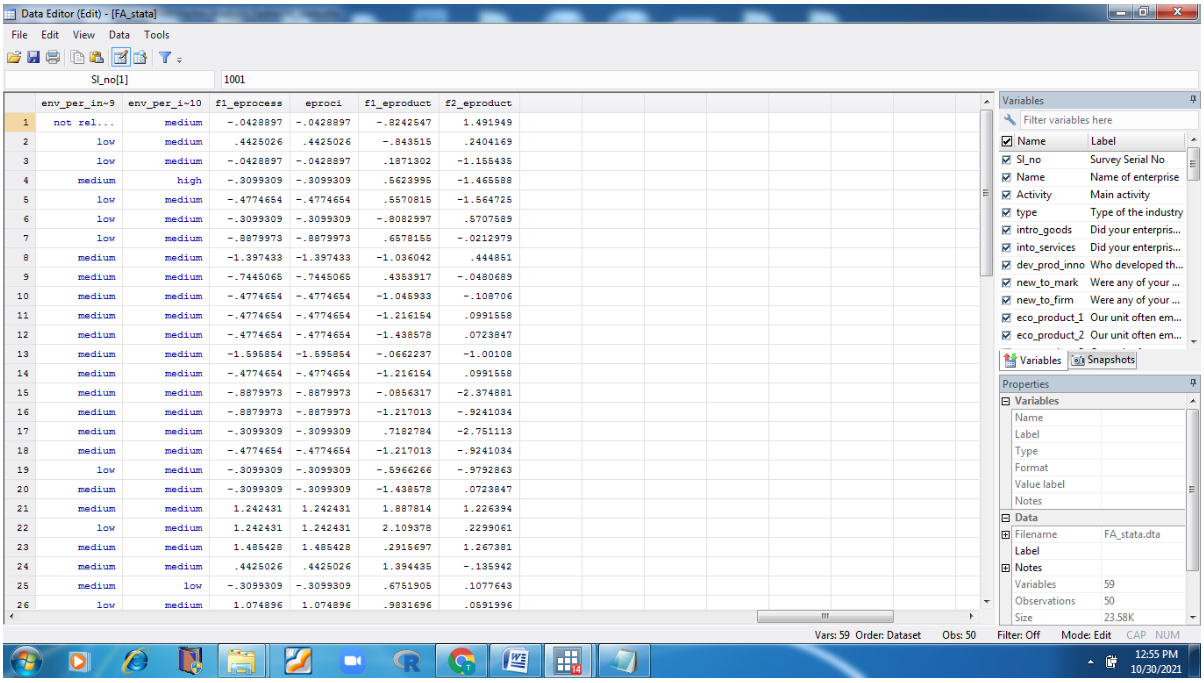
```
    LR test: independent vs. saturated:  chi2(45) =  222.70 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Uniqueness
eco_produc~1	0.5797	0.5935	0.3117
eco_produc~2	0.2271	0.8460	0.2327
eco_produc~3	-0.0909	0.7708	0.3975
eco_produc~4	0.6219	0.1691	0.5846
eco_produc~5	0.5480	0.2086	0.6562
eco_produc~6	0.8126	0.0609	0.3359
eco_produc~7	0.8185	0.0969	0.3207
eco_produc~8	0.7654	0.0962	0.4049
eco_produc~9	0.6434	0.3320	0.4758
eco_produ~10	0.7195	0.3053	0.3891

```
Factor rotation matrix
```

	Factor1	Factor2
Factor1	0.8938	0.4484
Factor2	-0.4484	0.8938

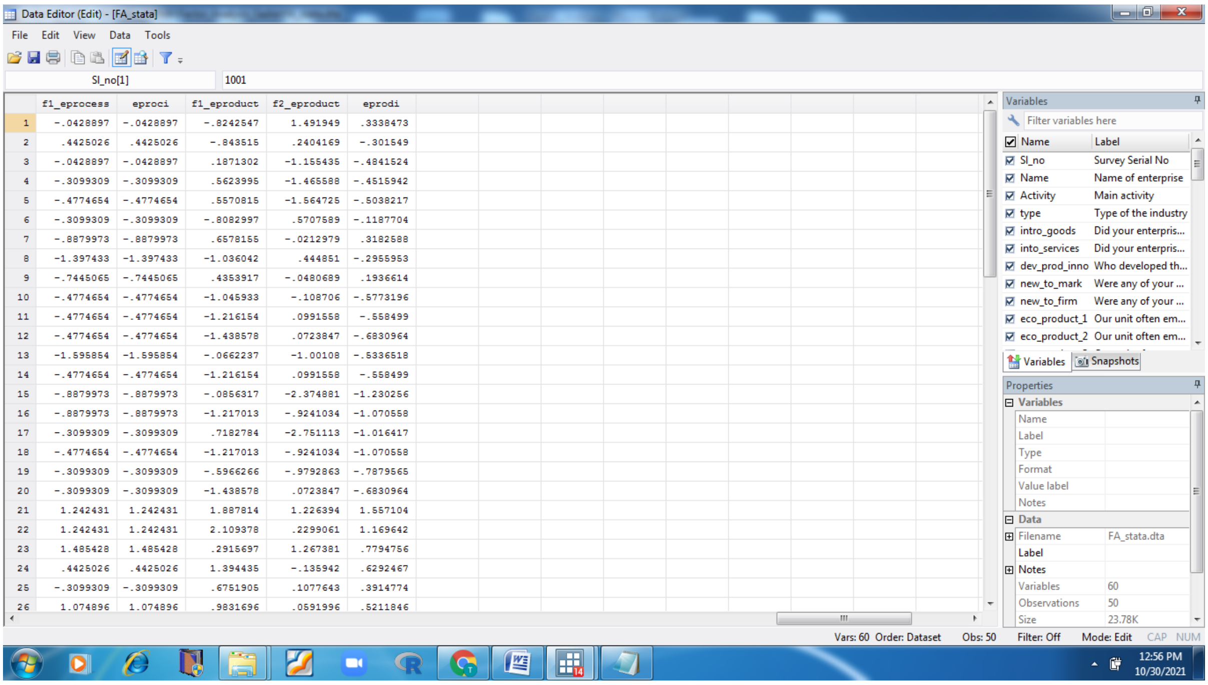
```
. predict f1_eproduct f2_eproduct
(regression scoring assumed)
```



Data Editor (Edit) - [FA_stata]

	env_per_in~9	env_per_i~10	f1_eprocess	eproci	f1_eproduct	f2_eproduct
1	not rel...	medium	-.0428897	-.0428897	-.8242547	1.491949
2	low	medium	.4425026	.4425026	-.843515	.2404169
3	low	medium	-.0428897	-.0428897	.1871302	-1.155435
4	medium	high	-.3099309	-.3099309	.5623995	-1.465588
5	low	medium	-.4774654	-.4774654	.5570815	-1.564725
6	low	medium	-.3099309	-.3099309	-.8082997	.5707589
7	low	medium	-.8879973	-.8879973	.6578155	-.0212979
8	medium	medium	-1.397433	-1.397433	-1.036042	.444851
9	medium	medium	-.7445065	-.7445065	.4353917	-.0480689
10	medium	medium	-.4774654	-.4774654	-1.045933	-.108706
11	medium	medium	-.4774654	-.4774654	-1.216154	.0991558
12	medium	medium	-.4774654	-.4774654	-1.438578	.0723847
13	medium	medium	-1.595854	-1.595854	-.0662237	-1.00108
14	medium	medium	-.4774654	-.4774654	-1.216154	.0991558
15	medium	medium	-.8879973	-.8879973	-.0856317	-2.374881
16	medium	medium	-.8879973	-.8879973	-1.217013	-.9241034
17	medium	medium	-.3099309	-.3099309	.7182784	-2.751113
18	medium	medium	-.4774654	-.4774654	-1.217013	-.9241034
19	low	medium	-.3099309	-.3099309	-.5966266	-.9792863
20	medium	medium	-.3099309	-.3099309	-1.438578	.0723847
21	medium	medium	1.242431	1.242431	1.887814	1.226394
22	low	medium	1.242431	1.242431	2.109378	.2299061
23	medium	medium	1.485428	1.485428	.2915697	1.267381
24	medium	medium	.4425026	.4425026	1.394435	-.135942
25	medium	low	-.3099309	-.3099309	.6751905	.1077643
26	low	medium	1.074896	1.074896	.9831696	.0591996

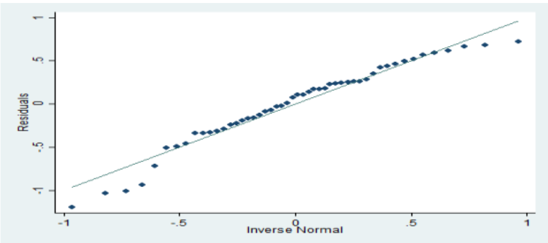
```
. gen eprodi=(f1_eproduct+f2_eproduct)/2
```



	f1_eprocess	eproci	f1_eproduct	f2_eproduct	eprodi
1	-.0428897	-.0428897	-.8242547	1.491949	.3338473
2	.4425026	.4425026	-.843515	.2404169	-.301549
3	-.0428897	-.0428897	.1871302	-1.155435	-.4841524
4	-.3099309	-.3099309	.5623995	-1.465588	-.4515942
5	-.4774654	-.4774654	.5570815	-1.564725	-.5038217
6	-.3099309	-.3099309	-.8082997	.5707589	-.1187704
7	-.8879973	-.8879973	.6578155	-.0212979	.3182588
8	-1.397433	-1.397433	-1.036042	.444851	-.2955953
9	-.7445065	-.7445065	.4353917	-.0480689	.1936614
10	-.4774654	-.4774654	-1.045933	-.108706	-.5773196
11	-.4774654	-.4774654	-1.216154	.0991558	-.558499
12	-.4774654	-.4774654	-1.438578	.0723847	-.6830964
13	-1.595854	-1.595854	-.0662237	-1.00108	-.5336518
14	-.4774654	-.4774654	-1.216154	.0991558	-.558499
15	-.8879973	-.8879973	-.0856317	-2.374881	-1.230256
16	-.8879973	-.8879973	-1.217013	-.9241034	-1.070558
17	-.3099309	-.3099309	.7182784	-2.751113	-1.016417
18	-.4774654	-.4774654	-1.217013	-.9241034	-1.070558
19	-.3099309	-.3099309	-.5966266	-.9792863	-.7879565
20	-.3099309	-.3099309	-1.438578	.0723847	-.6830964
21	1.242431	1.242431	1.887814	1.226394	1.557104
22	1.242431	1.242431	2.109378	.2299061	1.169642
23	1.485428	1.485428	.2915697	1.267381	.7794756
24	.4425026	.4425026	1.394435	-.135942	.6292467
25	-.3099309	-.3099309	.6751905	.1077643	.3914774
26	1.074896	1.074896	.9831696	.0591996	.5211846

<u>CLRM</u>

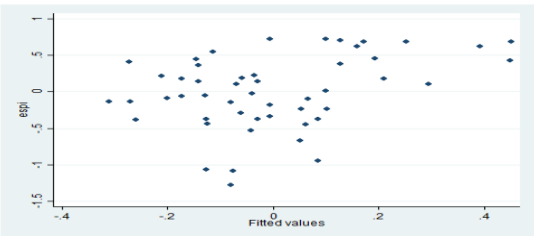
Residual_normal



VIF

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
      eprodi |      1.33    0.750984
 f1_eprocess |      1.33    0.750984
-------------+----------------------
    Mean VIF |      1.33
```

<u>Espi vs espihat</u>




```
. ovtest

Ramsey RESET test using powers of the fitted values of espi
       Ho:  model has no omitted variables
                F(3, 44) =      2.03
                Prob > F =      0.1237
```

```
. estat imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(5)      =      5.05
         Prob > chi2  =    0.4097

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |       5.05      5    0.4097
            Skewness |       5.46      2    0.0652
            Kurtosis |       0.00      1    0.9735
---------------------+-----------------------------
               Total |      10.51      8    0.2310
---------------------------------------------------
```

Anova Table

```
. regress espi eproci eprodi

      Source |       SS           df       MS      Number of obs   =        50
-------------+----------------------------------   F(2, 47)        =      3.46
       Model |  1.57220986         2  .786104929   Prob > F        =    0.0396
    Residual |  10.6777902        47  .227187025   R-squared       =    0.1283
-------------+----------------------------------   Adj R-squared   =    0.0913
       Total |       12.25        49  .250000001   Root MSE        =    .47664

------------------------------------------------------------------------------
        espi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      eproci |   .0135129   .0785138     0.17   0.864    -.1444365    .1714622
      eprodi |   .2432647   .1110352     2.19   0.033     .0198906    .4666388
       _cons |   7.71e-12   .0674073     0.00   1.000    -.1356059    .1356059
------------------------------------------------------------------------------
```

Section 6.2: Factor Analysis and Regression Analysis for RMG Sector

Factor Analysis (RMG Sector)

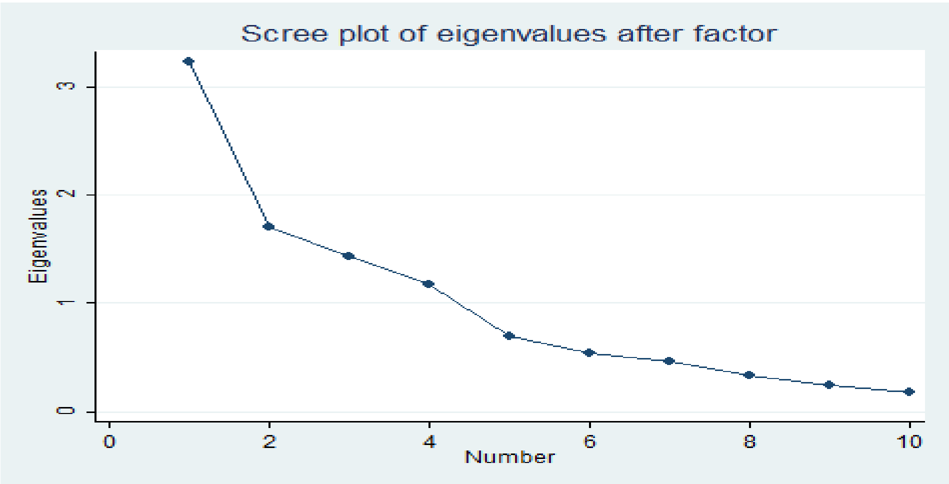
EFA

Environmental performance index

```
. factor env_per_indi1 env_per_indi2 env_per_indi3 env_per_indi4 env_per_indi5 env_per_indi6 env_per_indi7 env_per_indi8 env_per_indi9
> env_per_indi10, pcf
(obs=30)

Factor analysis/correlation                      Number of obs    =         30
    Method: principal-component factors          Retained factors =          4
    Rotation: (unrotated)                        Number of params =         34

    --------------------------------------------------------------------------
         Factor  |   Eigenvalue   Difference        Proportion   Cumulative
    -------------+------------------------------------------------------------
        Factor1  |      3.24218      1.54114            0.3242       0.3242
        Factor2  |      1.70103      0.26598            0.1701       0.4943
        Factor3  |      1.43505      0.26313            0.1435       0.6378
        Factor4  |      1.17192      0.47616            0.1172       0.7550
        Factor5  |      0.69576      0.16012            0.0696       0.8246
        Factor6  |      0.53563      0.07584            0.0536       0.8782
        Factor7  |      0.45980      0.12202            0.0460       0.9241
        Factor8  |      0.33778      0.09707            0.0338       0.9579
        Factor9  |      0.24072      0.06058            0.0241       0.9820
       Factor10  |      0.18013            .            0.0180       1.0000
    --------------------------------------------------------------------------
    LR test: independent vs. saturated:  chi2(45) =   97.14 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

    -------------------------------------------------------------
        Variable |  Factor1   Factor2   Factor3   Factor4 |   Uniqueness
    -------------+----------------------------------------+-------------
    env_per_in~1 |   0.7898    0.0279    0.0240   -0.3234 |      0.2702
    env_per_in~2 |   0.7095    0.2179   -0.2547    0.2024 |      0.3433
    env_per_in~3 |   0.4330   -0.5513    0.5298    0.2229 |      0.1781
    env_per_in~4 |   0.4103    0.1109    0.6993    0.4023 |      0.1686
    env_per_in~5 |   0.8450   -0.3568   -0.0291   -0.0929 |      0.1492
    env_per_in~6 |   0.3686    0.4786    0.4953   -0.3185 |      0.2884
    env_per_in~7 |   0.2606    0.3890   -0.3134    0.6697 |      0.2340
    env_per_in~8 |   0.6791   -0.1295   -0.3490   -0.3941 |      0.2449
    env_per_in~9 |  -0.2486    0.7185    0.2979   -0.2956 |      0.2458
    env_per_i~10 |   0.5642    0.5439   -0.2122    0.1164 |      0.3273
    -------------------------------------------------------------
```

```
. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
env_per_in~1	0.7986
env_per_in~2	0.6415
env_per_in~3	0.5464
env_per_in~4	0.4613
env_per_in~5	0.6933
env_per_in~6	0.6101
env_per_in~7	0.4451
env_per_in~8	0.6323
env_per_in~9	0.6037
env_per_i~10	0.6511
Overall	0.6310



```
. rotate

Factor analysis/correlation                 Number of obs    =         30
    Method: principal-component factors     Retained factors =          4
    Rotation: orthogonal varimax (Kaiser off)  Number of params =      34
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.67293	1.00183	0.2673	0.2673
Factor2	1.67110	0.02205	0.1671	0.4344
Factor3	1.64905	0.09195	0.1649	0.5993
Factor4	1.55710	.	0.1557	0.7550

```
    LR test: independent vs. saturated:  chi2(45) =   97.14 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
env_per_in~1	0.8018	0.1766	0.0871	0.2193	0.2702
env_per_in~2	0.5253	0.1022	0.6084	0.0123	0.3433
env_per_in~3	0.2416	0.8172	-0.1809	-0.2509	0.1781
env_per_in~4	-0.0162	0.8422	0.2263	0.2660	0.1686
env_per_in~5	0.8247	0.3554	0.0712	-0.1981	0.1492
env_per_in~6	0.2564	0.2652	0.0067	0.7586	0.2884
env_per_in~7	-0.0822	0.0379	0.8639	-0.1067	0.2340
env_per_in~8	0.8539	-0.1444	0.0486	-0.0527	0.2449
env_per_in~9	-0.2720	-0.1779	-0.0072	0.8053	0.2458
env_per_i~10	0.3738	-0.0425	0.6584	0.3126	0.3273

```
Factor rotation matrix
```

	Factor1	Factor2	Factor3	Factor4
Factor1	0.8428	0.3829	0.3729	0.0639
Factor2	-0.1789	-0.2630	0.5410	0.7785
Factor3	-0.2282	0.7774	-0.3615	0.4614
Factor4	-0.4535	0.4241	0.6615	-0.4206

```
.

. predict f1 f2 f3 f4
(regression scoring assumed)

Scoring coefficients (method = regression; based on varimax rotated factors)
```

Variable	Factor1	Factor2	Factor3	Factor4
env_per_in~1	0.32369	-0.01508	-0.08883	0.15212
env_per_in~2	0.12368	-0.01462	0.32933	-0.04085
env_per_in~3	0.00003	0.50405	-0.13320	-0.15348
env_per_in~4	-0.17193	0.55570	0.13339	0.13926
env_per_in~5	0.29774	0.10559	-0.06137	-0.12266
env_per_in~6	0.08993	0.12259	-0.10991	0.49985
env_per_in~7	-0.18249	0.04323	0.61066	-0.15793
env_per_in~8	0.39817	-0.23147	-0.09761	-0.01665
env_per_in~9	-0.07319	-0.08603	-0.04199	0.52584
env_per_i~10	0.07816	-0.09026	0.35703	0.15004

```
. gen espi=(f1+f2+f3+f4)/4
```

```
. factor eco_peocess_1 eco_process_2 eco_process_3 eco_process_4 eco_process_5 eco_process_6, pcf
(obs=30)

Factor analysis/correlation                        Number of obs    =         30
    Method: principal-component factors            Retained factors =          1
    Rotation: (unrotated)                          Number of params =          6
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.74346	2.77295	0.6239	0.6239
Factor2	0.97051	0.37087	0.1618	0.7857
Factor3	0.59964	0.17308	0.0999	0.8856
Factor4	0.42656	0.25168	0.0711	0.9567
Factor5	0.17488	0.08993	0.0291	0.9858
Factor6	0.08495	.	0.0142	1.0000

LR test: independent vs. saturated: chi2(15) = 116.35 Prob>chi2 = 0.0000

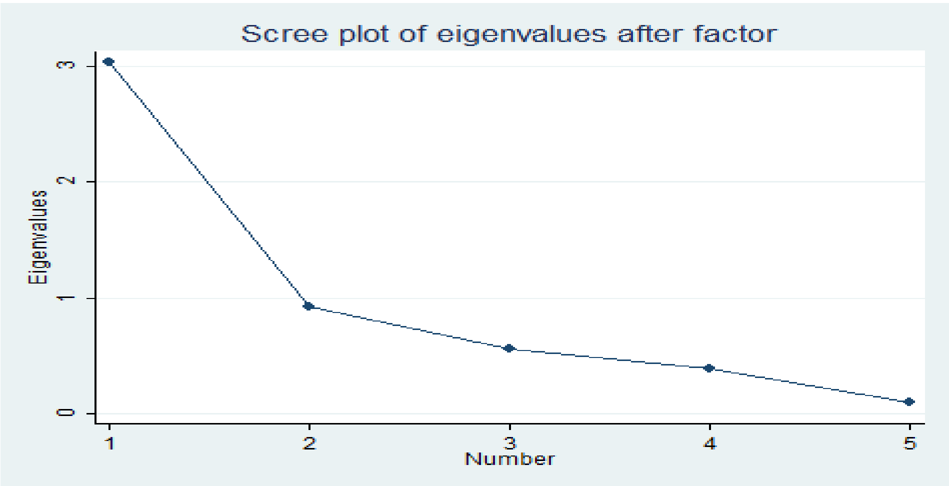
Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
eco_peoces~1	0.7002	0.5098
eco_proces~2	0.7879	0.3791
eco_proces~3	0.9470	0.1033
eco_proces~4	0.9182	0.1570
eco_proces~5	0.8733	0.2373
eco_proces~6	0.3605	0.8701

```
. estat kmo
```

Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
eco_peoces~1	0.8556
eco_proces~2	0.9315
eco_proces~3	0.7677
eco_proces~4	0.8425
eco_proces~5	0.8664
eco_proces~6	0.7644
Overall	0.8382



```
. rotate

Factor analysis/correlation                        Number of obs    =         30
    Method: principal-component factors            Retained factors =          1
    Rotation: orthogonal varimax (Kaiser off)      Number of params =          6
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	3.74346	.	0.6239	0.6239

```
    LR test: independent vs. saturated:  chi2(15) =  116.35 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Uniqueness
eco_peoces~1	0.7002	0.5098
eco_proces~2	0.7879	0.3791
eco_proces~3	0.9470	0.1033
eco_proces~4	0.9182	0.1570
eco_proces~5	0.8733	0.2373
eco_proces~6	0.3605	0.8701

```
Factor rotation matrix
```

	Factor1
Factor1	1.0000

```
. predict f1_eprocess
(regression scoring assumed)

Scoring coefficients (method = regression; based on varimax rotated factors)
```

Variable	Factor1
eco_peoces~1	0.18704
eco_proces~2	0.21049
eco_proces~3	0.25296
eco_proces~4	0.24527
eco_proces~5	0.23329
eco_proces~6	0.09630

```
. gen eproci=f1_eprocess
```

```
. factor eco_product_1 eco_product_2 eco_product_3 eco_product_4 eco_product_5 eco_product_6 eco_product_7 eco_product_8 eco_product_9
> eco_product_10, pcf
(obs=30)

Factor analysis/correlation                        Number of obs    =         30
    Method: principal-component factors            Retained factors =          3
    Rotation: (unrotated)                          Number of params =         27
```

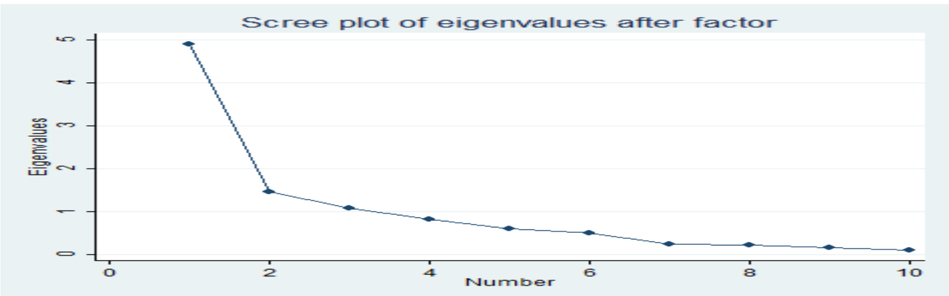
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.89066	3.44305	0.4891	0.4891
Factor2	1.44761	0.36594	0.1448	0.6338
Factor3	1.08167	0.27465	0.1082	0.7420
Factor4	0.80702	0.21339	0.0807	0.8227
Factor5	0.59363	0.10858	0.0594	0.8821
Factor6	0.48505	0.24929	0.0485	0.9306
Factor7	0.23577	0.01676	0.0236	0.9541
Factor8	0.21901	0.07518	0.0219	0.9760
Factor9	0.14383	0.04807	0.0144	0.9904
Factor10	0.09575	.	0.0096	1.0000

```
    LR test: independent vs. saturated:  chi2(45) =  172.37 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Uniqueness
eco_produc~1	0.7651	0.2278	-0.2401	0.3051
eco_produc~2	0.6289	0.6202	0.1465	0.1983
eco_produc~3	0.3972	0.7981	0.1286	0.1887
eco_produc~4	0.6778	-0.3649	-0.3122	0.3100
eco_produc~5	0.6750	0.0374	-0.6590	0.1086
eco_produc~6	0.8472	-0.0244	-0.1528	0.2584
eco_produc~7	0.7403	-0.2196	0.5074	0.1463
eco_produc~8	0.7170	-0.1143	0.3723	0.3342
eco_produc~9	0.5679	-0.3577	0.1431	0.5290
eco_produ~10	0.8571	-0.2229	0.1196	0.2014

```
.

. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
eco_produc~1	0.8640
eco_produc~2	0.6190
eco_produc~3	0.4821
eco_produc~4	0.7176
eco_produc~5	0.6732
eco_produc~6	0.7472
eco_produc~7	0.8390
eco_produc~8	0.7513
eco_produc~9	0.6316
eco_produ~10	0.7905
Overall	0.7248



```
. rotate

Factor analysis/correlation                        Number of obs    =         30
    Method: principal-component factors            Retained factors =          3
    Rotation: orthogonal varimax (Kaiser off)      Number of params =         27
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.94976	0.39381	0.2950	0.2950
Factor2	2.55595	0.64171	0.2556	0.5506
Factor3	1.91424	.	0.1914	0.7420

```
    LR test: independent vs. saturated:  chi2(45) =  172.37 Prob>chi2 = 0.0000
```

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
eco_produc~1	0.2911	0.6386	0.4498	0.3051
eco_produc~2	0.2737	0.2136	0.8253	0.1983
eco_produc~3	0.0319	0.0653	0.8978	0.1887
eco_produc~4	0.4247	0.7009	-0.1354	0.3100
eco_produc~5	0.0523	0.9276	0.1681	0.1086
eco_produc~6	0.5014	0.6475	0.2663	0.2584
eco_produc~7	0.9046	0.0882	0.1664	0.1463
eco_produc~8	0.7648	0.1680	0.2296	0.3342
eco_produc~9	0.6211	0.2783	-0.0886	0.5290
eco_produ~10	0.7522	0.4624	0.1378	0.2014

Factor rotation matrix

	Factor1	Factor2	Factor3
Factor1	0.6892	0.6213	0.3727
Factor2	-0.4003	-0.1022	0.9107
Factor3	0.6039	-0.7769	0.1783

```
.

. predict f1_eproduct f2_eproduct f3_eproduct
(regression scoring assumed)
```

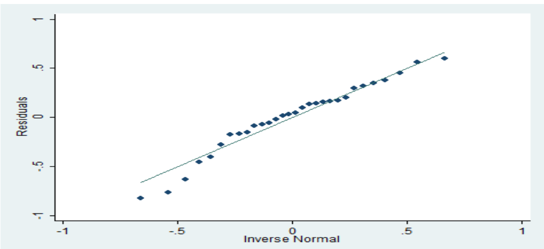
Scoring coefficients (method = regression; based on varimax rotated factors)

Variable	Factor1	Factor2	Factor3
eco_produc~1	-0.08927	0.25359	0.16204
eco_produc~2	-0.00107	-0.06910	0.46223
eco_produc~3	-0.09293	-0.09824	0.55355
eco_produc~4	0.02216	0.33606	-0.22937
eco_produc~5	-0.28315	0.55645	-0.03369
eco_produc~6	0.04084	0.21906	0.02405
eco_produc~7	0.44835	-0.25490	0.00194
eco_produc~8	0.34049	-0.16822	0.04414
eco_produc~9	0.25885	-0.00537	-0.15817
eco_produ~10	0.24920	0.03872	-0.05518

```
. gen eprodi=(f1_eproduct+f2_eproduct+f3_eproduct)/3
```

CLRM

Residual_normal

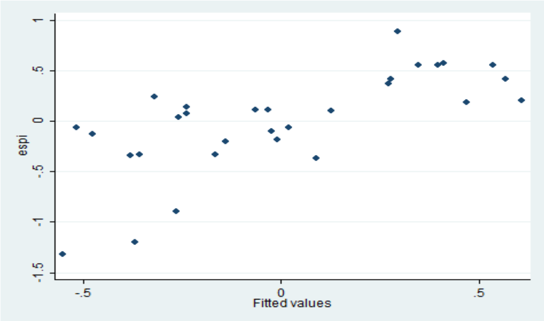


VIF

```
. vif
```

Variable	VIF	1/VIF
eproci	1.02	0.979547
eprodi	1.02	0.979547
Mean VIF	1.02	

<u>Espivsespihat</u>



. ovtest

Ramsey RESET test using powers of the fitted values of espi
Ho: model has no omitted variables
F(3, 24) = 1.29
Prob > F = 0.3019

. estat imtest, white

White's test for Ho: homoskedasticity
against Ha: unrestricted heteroskedasticity

chi2(5) = 11.32
Prob > chi2 = 0.0455

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	11.32	5	0.0455
Skewness	10.25	2	0.0059
Kurtosis	0.00	1	0.9784
Total	21.56	8	0.0058

. regress espi eproci eprodi

Source	SS	df	MS			
				Number of obs	=	30
				F(2, 27)	=	10.11
Model	3.10390261	2	1.55195131	Prob > F	=	0.0005
Residual	4.14609719	27	.153559155	R-squared	=	0.4281
				Adj R-squared	=	0.3858
Total	7.2499998	29	.249999993	Root MSE	=	.39187

espi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
eproci	.0520258	.0787912	0.66	0.515	-.1096403	.213692
eprodi	.525951	.1364703	3.85	0.001	.245937	.805965
_cons	1.24e-09	.0715447	0.00	1.000	-.1467975	.1467975

Section 6.3: Factor Analysis for Leather Sector

EFA

```
. factor env_per_indi1 env_per_indi2 env_per_indi3 env_per_indi4 env_per_indi5 env_
> per_indi6 env_per_indi7 env_per_indi8 env_per_indi9 env_per_indi10, pcf
(obs=20)

Factor analysis/correlation                        Number of obs    =       20
    Method: principal-component factors            Retained factors =        4
    Rotation: (unrotated)                          Number of params =       34
```

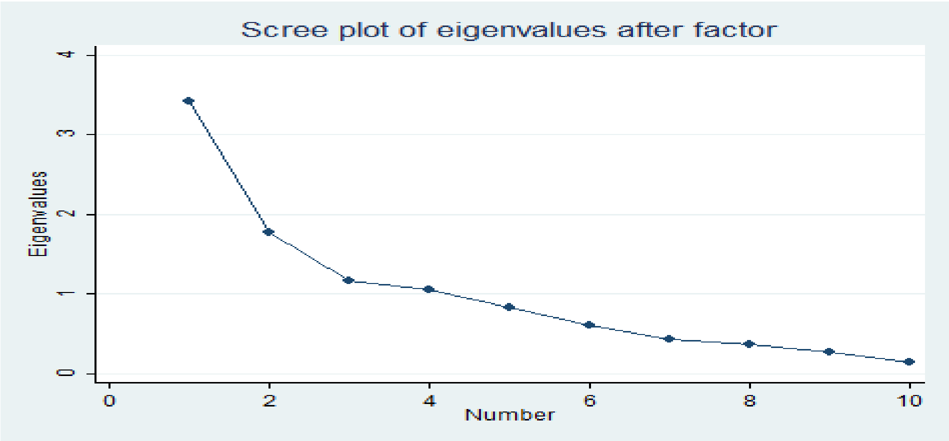
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.41884	1.64895	0.3419	0.3419
Factor2	1.76989	0.60577	0.1770	0.5189
Factor3	1.16413	0.11866	0.1164	0.6353
Factor4	1.04546	0.22228	0.1045	0.7398
Factor5	0.82318	0.22935	0.0823	0.8221
Factor6	0.59383	0.16933	0.0594	0.8815
Factor7	0.42450	0.06501	0.0425	0.9240
Factor8	0.35950	0.08993	0.0359	0.9599
Factor9	0.26957	0.13847	0.0270	0.9869
Factor10	0.13110	.	0.0131	1.0000

```
    LR test: independent vs. saturated:  chi2(45) =   62.41 Prob>chi2 = 0.0437

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
env_per_in~1	0.2636	-0.1420	-0.3410	0.7214	0.2737
env_per_in~2	0.8156	-0.0851	-0.1006	0.1046	0.3066
env_per_in~3	0.7343	0.0435	0.1364	-0.1883	0.4048
env_per_in~4	0.5206	-0.5919	-0.1115	-0.2800	0.2878
env_per_in~5	0.6883	-0.3876	0.1516	0.0676	0.3484
env_per_in~6	-0.2000	0.3694	0.7722	0.3087	0.1319
env_per_in~7	0.5610	0.5806	-0.0791	-0.4008	0.1813
env_per_in~8	0.6125	0.6968	-0.0141	-0.0047	0.1392
env_per_in~9	0.6823	0.2631	-0.0658	0.3738	0.3212
env_per_i~10	0.4527	-0.4602	0.6136	-0.0078	0.2067

```
.

. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
env_per_in~1	0.6325
env_per_in~2	0.8119
env_per_in~3	0.7743
env_per_in~4	0.6815
env_per_in~5	0.5881
env_per_in~6	0.3298
env_per_in~7	0.5170
env_per_in~8	0.5010
env_per_in~9	0.7758
env_per_i~10	0.4761
Overall	0.6151




```
. rotate

Factor analysis/correlation                        Number of obs    =        20
    Method: principal-component factors            Retained factors =         4
    Rotation: orthogonal varimax (Kaiser off)      Number of params =        34
```

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.45423	0.18885	0.2454	0.2454
Factor2	2.26538	0.90902	0.2265	0.4720
Factor3	1.35636	0.03401	0.1356	0.6076
Factor4	1.32235	.	0.1322	0.7398

```
    LR test: independent vs. saturated:  chi2(45) =   62.41 Prob>chi2 = 0.0437
```

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
env_per_in~1	-0.0691	0.0138	-0.0917	0.8443	0.2737
env_per_in~2	0.4625	0.5048	-0.2528	0.4011	0.3066
env_per_in~3	0.5519	0.5258	-0.1148	0.0301	0.4048
env_per_in~4	-0.0050	0.6329	-0.5582	-0.0035	0.2878
env_per_in~5	0.1559	0.7301	-0.1639	0.2597	0.3484
env_per_in~6	0.0116	0.0357	0.9282	-0.0716	0.1319
env_per_in~7	0.8806	0.0153	-0.1139	-0.1735	0.1813
env_per_in~8	0.9031	-0.0170	0.1341	0.1645	0.1392
env_per_in~9	0.5582	0.2177	0.0553	0.5628	0.3212
env_per_i~10	-0.0635	0.8667	0.1920	-0.0343	0.2067

Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.6627	0.6333	-0.2225	0.3319
Factor2	0.7107	-0.5712	0.4067	-0.0565
Factor3	-0.0623	0.5158	0.7873	-0.3319
Factor4	-0.2276	-0.0809	0.4065	0.8812

.

```
. predict f1 f2 f3 f4
(regression scoring assumed)
```

Scoring coefficients (method = regression; based on varimax rotated factors)

Variable	Factor1	Factor2	Factor3	Factor4
env_per_in~1	-0.14467	-0.11229	0.00003	0.73536
env_per_in~2	0.10654	0.12587	-0.10001	0.19872
env_per_in~3	0.19350	0.19699	-0.01875	-0.12771
env_per_in~4	-0.06987	0.25971	-0.35418	-0.13477
env_per_in~5	-0.04506	0.31455	-0.00502	0.09299
env_per_in~6	0.00103	0.16204	0.74019	0.00879
env_per_in~7	0.43337	-0.08749	-0.11240	-0.27935
env_per_in~8	0.40029	-0.11728	0.10891	0.03730
env_per_in~9	0.16006	-0.01660	0.11684	0.39165
env_per_i~10	-0.12820	0.50487	0.27675	-0.12292

```
. gen espi=(f1+f2+f3+f4)/4
```

```
. factor eco_peocess_1 eco_process_2 eco_process_3 eco_process_4 eco_process_5 eco_process_6, pcf
(obs=20)

Factor analysis/correlation                    Number of obs    =        20
    Method: principal-component factors        Retained factors =         3
    Rotation: (unrotated)                      Number of params =        15
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.99556	0.30889	0.3326	0.3326
Factor2	1.68667	0.63361	0.2811	0.6137
Factor3	1.05306	0.18839	0.1755	0.7892
Factor4	0.86468	0.63207	0.1441	0.9333
Factor5	0.23260	0.06517	0.0388	0.9721
Factor6	0.16743	.	0.0279	1.0000

LR test: independent vs. saturated: chi2(15) = 36.49 Prob>chi2 = 0.0015

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
eco_peoces~1	0.6102	-0.6382	0.2652	0.1501
eco_proces~2	0.6639	-0.6615	0.1310	0.1045
eco_proces~3	0.4408	0.5980	0.6058	0.0811
eco_proces~4	0.6904	0.6460	0.0506	0.1035
eco_proces~5	0.4922	0.2582	-0.5700	0.3662
eco_proces~6	-0.5189	0.0157	0.5207	0.4593

```
. estat kmo
```

Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
eco_peoces~1	0.4338
eco_proces~2	0.4339
eco_proces~3	0.3375
eco_proces~4	0.4014
eco_proces~5	0.3398
eco_proces~6	0.2800
Overall	0.3851

Data are not appropriate to do further Factor Analysis

Eco Product Index

```
. factor eco_product_1 eco_product_2 eco_product_3 eco_product_4 eco_product_5 eco_product_6 eco_product_8 eco_product_9 eco_product_10
> , pcf
(obs=20)

Factor analysis/correlation                        Number of obs    =         20
    Method: principal-component factors            Retained factors =          3
    Rotation: (unrotated)                          Number of params =         24
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	2.28379	0.31729	0.2538	0.2538
Factor2	1.96650	0.44446	0.2185	0.4723
Factor3	1.52205	0.53039	0.1691	0.6414
Factor4	0.99166	0.17067	0.1102	0.7516
Factor5	0.82099	0.13455	0.0912	0.8428
Factor6	0.68645	0.32856	0.0763	0.9190
Factor7	0.35788	0.07742	0.0398	0.9588
Factor8	0.28046	0.19025	0.0312	0.9900
Factor9	0.09021	.	0.0100	1.0000

```
LR test: independent vs. saturated:  chi2(36) =   54.39 Prob>chi2 = 0.0253

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Factor2	Factor3	Uniqueness
eco_produc~1	0.5948	0.2276	-0.6545	0.1660
eco_produc~2	0.1608	0.7298	-0.1650	0.4142
eco_produc~3	0.2878	0.5696	-0.1829	0.5592
eco_produc~4	0.8749	0.0944	0.0117	0.2256
eco_produc~5	0.0432	-0.3802	-0.2606	0.7857
eco_produc~6	0.3716	-0.7215	-0.1673	0.3133
eco_produc~8	0.5115	-0.5691	0.1306	0.3973
eco_produc~9	0.7970	0.0548	0.4355	0.1720
eco_produ~10	0.1377	0.2378	0.8546	0.1942

```
.

. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

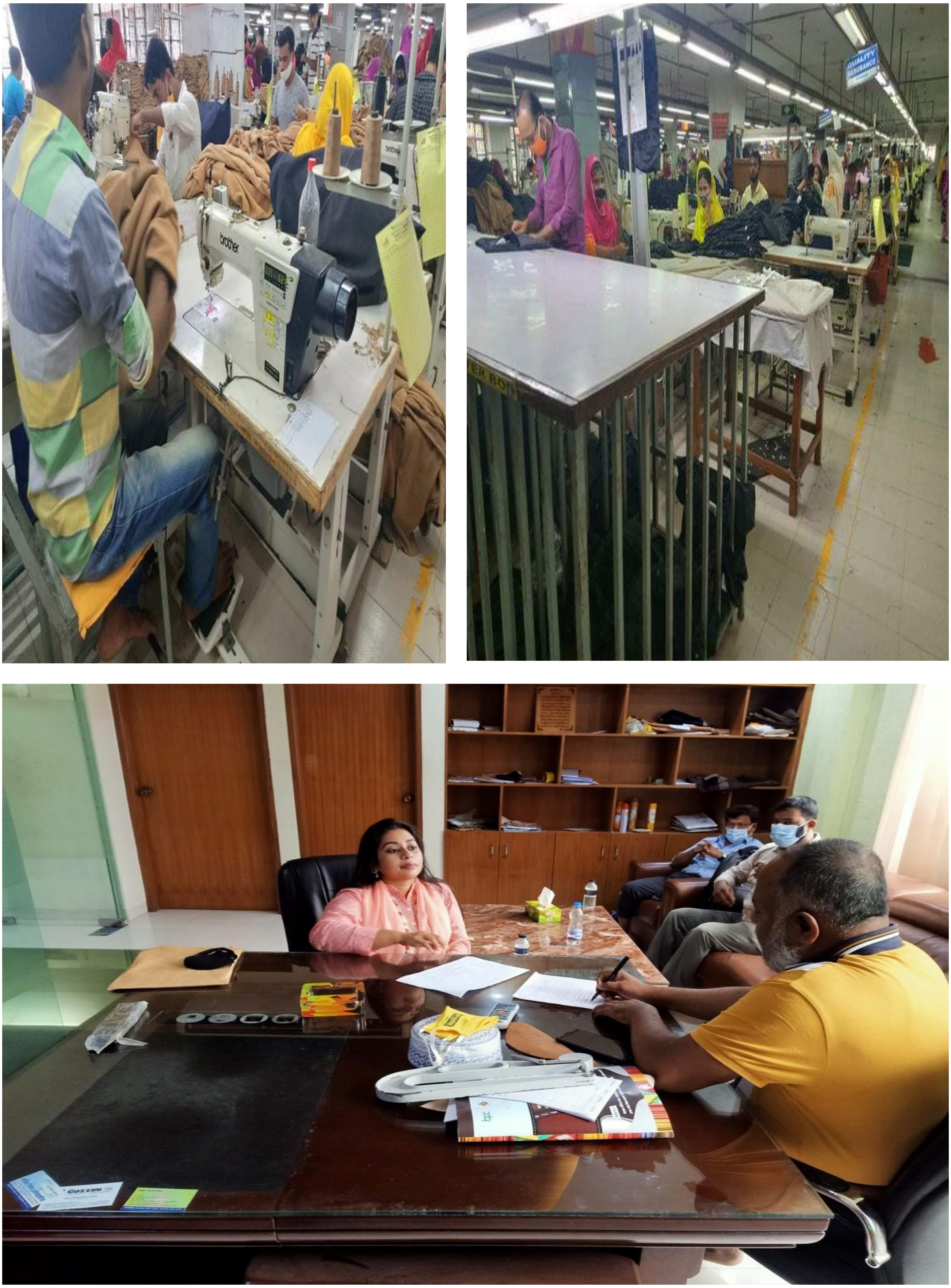
Variable	kmo
eco_produc~1	0.2462
eco_produc~2	0.2816
eco_produc~3	0.5288
eco_produc~4	0.5506
eco_produc~5	0.2522
eco_produc~6	0.3289
eco_produc~8	0.2795
eco_produc~9	0.4281
eco_produ~10	0.1782
Overall	0.3209

Data are not appropriate to do further Factor Analysis

Appendix 7

Pictures taken during the data collections from the industries:


Picture 7.1: During the data collection from the leather industries in 2020



Picture 7.2: During the data collection from the RMG industries in 2020