

## HOW ECO-INNOVATION & GREEN MANUFACTURING AFFECTS SUSTAINABILITY PERFORMANCE: A QUANTITATIVE STUDY IN PAKISTAN

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### ABSTRACT

The interest to become "greener" or all the more environmentally feasible for endeavors is developing. Because of pressing factor from the nearby specialists and the public authority, organizations needed to change their creation methods too. The target of this pilot research comprised of recognizing what green manufacturing and eco-innovation mean for the performance of organizations (ecological, monetary, and social). Information from 46 organizations in the auto, electrical, and gadget's ventures of Pakistan have been assembled through a questionnaire based study. Regression analysis was utilized to assess the exact model to approve the theoretical connection of the examination. Green manufacturing applications valuably affect natural and social execution, as per the finishes of the examination. Moreover, eco-innovation development decidedly affects the sustainability of organizations. Then again, advancement of eco-products fundamentally affects three performance regions.

**Keywords:** Corporate Sustainability Performance, Eco-Innovation, Green Manufacturing, Pakistan.

### I. INTRODUCTION

Basic themes for key business, the executives, assembling and item advancement issues emerge quick regarding climate and manageability issues. This more prominent comprehension of the indigenous habitat might be found in the imaginative and naturally delicate items which purchasers have gotten as of late. Thoughts for the administration of the climate are being analyzed to diminish natural contamination, as are green manufacturing, green marketing and green innovation.

The increment in the overall ecological enactment including the Montreal show, the Kyoto Protocol, that does not allow the usage of some unsafe materials from EEE (RoHS) and electrical gear and waste gadgets (WEEE), as (Chen et al., 2006). Ecological assurance targets might be joined to the various divisions in organizations by organizations utilizing dynamic natural administration systems to satisfy ecological guidelines and improve them through new merchandise or cycles and green performs (Greeno and Robinson, 1992).

To accomplish manageable turn of events, organizations need to reexamine items and apply new innovation to measures. Nidumolu et al., (2009) and Shrivastava (1995) states that item and cycle advancements may assist organizations with separating their items, improve item quality, and lessen creation costs. Eco-innovation might be a significant driver of monetary development. A few firms are beginning to foster clean advancements of the cutting edge to advance future financial development. With the assumption that these new wellsprings of energy will eventually supplant their center oil exercises, BP and Shell are expanding their interests in sun based, wind and other sustainable power advances (Hart and Milstein, 2003).

We investigated in this investigation that how eco-innovation and green manufacturing affects the exhibition of organization sustainability. Organizations chose from Pakistan fabricating industry should submit information for the testing of the expressed theories. For overview and examination three enterprises were chosen. The auto, electrical, and compound areas were remembered for the exploration as they are among the most dirtying enterprises during utilization and creation. The speculations introduced are expected to outline the connections between such components as sustainability, eco-innovation and green manufacturing.

### II. LITERATURE REVIEW AND HYPOTHESIS

#### Green Manufacturing:

Exceptionally new ideas that might be viewed because of the 1990's incorporate green manufacturing. Green manufacturing is portrayed as a savvy, framework wide and incorporated system to the decrease and end of all waste streams identified with item and material plan, creation, use or potentially removal (Handfield et al., 1997). As per the real factors of the assembling framework, Green Manufacturing Plan and Process program

with decreased energy utilization and assets, low contamination to the extent possible and the creation innovation and cycle courses. Green manufacturing necessities incorporate zero likely security concerns, zero wellbeing risks for makers and item customers, and zero contamination, squander reusing, and garbage removal to the extent attainable during the creation interaction (Gao et al. 2009).

There are very couple of studies on green manufacturing. The work on the whole thought of green manufacturing might be isolated into two classes, initially work on various scientific instruments and models used to deliver green made at various levels (Deif, 2011). Instances of the principal class are Mohnty and Deshmukh's (1998) work on the significance as an upper hand for green manufacturing. As a world path to future use of a natural model, based on nano/natural/material innovation Jovane et al. (2003) provided supporting and green manufacturing. Another economical worldview for green manufacturing was additionally given in Burk and Goughran (2007). This examination approach depends on little and medium-sized endeavors that have been ensured ISO 14001. For instance, Fiksel (1996), the subsequent gathering gathered a few logical apparatuses that created from research in item/measure plan for green manufacturing. For instance, Design for the Environment (DfE), Life Cycle Analysis (LCA), screening strategies and hazard investigation will be incorporated.

#### **Eco-Innovation:**

As a result of the rising ecological strain, Eco-innovation has gotten one of the major key instruments for accomplishing supportability in the modern ventures. Before, ecological speculations were considered unnecessary. However the opposition standards and examples for organizations have changed by solid natural enactment and famous tree huggers.

Specialists have been tending to eco-innovation from different points with the developing importance of eco-development since the last part of the 1990s. Initially, the investigations feature the factors driving eco-innovation and the consequences of eco-innovation execution with the more current examples of Dangelico and Pujari (2010) and Kammerer (2009). Furthermore, Hermosilla et al. (2010) is the last distribution to recognize the eco-innovation measures. The third meeting is based on eco-innovation (e.g. Cheng and Shiu 2012; Arundel and Kemp 2009).

The meaning of eco-innovation is characterized by Kemp and Pearson (2008) as the assembling, osmosis, or activity of an item, creation interaction, administration, or the executives strategy that is novel to or receives an association, bringing about a decrease of natural danger, contamination, and other adverse consequences of the utilization of assets (counting energy) over the existence cycle. In like manner, Jin et al. (2008) infer both the presentation of another or extensively upgraded great/administration and the bringing down of unfavorable ecological outcomes. The point of eco-innovation is to associate manageability exercises methodically with the system of a firm and apply this technique across the store network, from item creation and administration improvement through utilization (Jone et al. 2008).

Three main categories in which Green innovation divided: 1-eco-product, 2-green managerial and 3-eco-process innovation. In this investigation in which we put eco-product and eco-process innovation to the test. Cheng and Shiu, (2012) highlighted that the acceptance of eco-products will lead to the growth of new eco-products or improve existing eco-products with natural improvements. Carrying out the eco-process implies further developing existing assembling measures or adding new cycles to diminish the ecological impact (Cheng and Shiu, 2012).

#### **Corporate Sustainability:**

Because of the fast consumption of normal assets and stresses over the rich difference and corporate social duty, sustainability has gotten increasingly more fundamental for corporate exploration and practice in late many years. "As a way to fulfill the requests of the present without trading off the capability of people in the future to meet their necessities," the term sustainability is characterized (Hart and Milstein, 2003). The Report of Brundtland in 1987 and succeeding Johannesburg in 2002 and Earth Summits in Rio in 1992 have been distributed in which sustainability and natural concerns have been a first concern for the entire globe (Ambec and Lanoie, 2008). It has arisen that sustainability is characterized by three perspectives: economic performance, nature environment, and social (Elkington, 1994). This view is normally named the triple bottom

line (TBL). These three viewpoints are generally perceived at the corporate level as a portrayal of an association's sustainability execution.

Firm-level financial execution alludes to impacts on the monetary conditions and financial frameworks of an organization at nearby, public and overall levels (GRI, 2006). Monetary and benefit don't guarantee the drawn out sustainability of a firm any longer. A firm necessities to fuse into dynamic and technique arranging non-monetary exercises like social movement and ecological protection (Orlitzky, 2008).

Ecological and natural execution reports are portrayed as "the result of the administration of the climate by an organization" (ISO, 1990). IT manages the impact of an organization on 'non-living and living normal frameworks, including biological systems, air, land and water.' 4 fundamental ecological execution factors were featured by Ranganathan (1998) (1) utilization of material; (2) utilization of energy; (3) yield of non-item; (4) discharge of toxins.

Social execution and announcing identify with the social designs inside which a firm works (Cooper, 2004). In Ranganathan (1998) four fundamental social execution parts are distinguished: (1) positions; (2) local area connections; (3) moral arrangement of assets; and (4) item friendly effects.

### **Hypotheses Development:**

Profitability, revenue growth, market share growth, and productivity growth are all aspects of economic performance (Zhu and Sarkis, 2004). A long-term plan may save domestic costs, open up new markets and make use of trash (Tsoulfas and Pappis, 2006). Green manufacturing adoption can have a beneficial influence on the expenses of a business. This can decrease energy consumption costs, reduce waste processing and disposal costs and prevent fines for environmental incidents (Zhu and Sarkis, 2004). A company's image, competitive advantage, and marketing exposure can be enhanced by Green manufacturing (Rao and Holt, 2005).

Environmental performance is described as influencing the natural environment of the business (Chien and Shih, 2007). Solid/liquid waste reduction, emissions reductions, a drop in resource consumption and for hazardous/destroying/toxic compounds, reduction in frequency of environmental accidents and better health of employees and the public comprise environmental performance (Zhu and Sarkis, 2004; Geyer and Jackson, 2004). Green manufacturing assimilation may lead to reduced waste, less resources and energy consumption, less contamination of environment. The research tends to support the concept of a favourable environment for green initiatives. The research data from industrial sector in China, for example, Zhu and Sarkis (2004) analysed and showed important positive correlations between green practices and environmental activities. The suggestion that green manufacturing is increasing environmental, economic, and social performance through costs and waste reductions, is made by Shrivastava (1995), Angell and Klassen (1999), and Sarkis (1998).

The performance of sustainable companies in developing nations, such as Pakistan, is regarded the major element in their environmental actions. That is why our country needs to properly examine the results of performance generated by green practices.

Porter and Van Der Linde (1995) have highlighted, Innovation in green goods and processes not only reduces the negative environmental effect, but also may improve the competitive benefit of companies. Chen (2008) and Chen et al. (2006) discussed the effects of green product and process innovation influence an organization's competitive advantage and green image. This was investigated in a qualitative case study by Noci and Verganti (1999). An IEI research was conducted by Chen et al. (2006) to explore how the competitiveness of process innovations and green product affects. Many researches of eco-innovation demonstrate that cost savings play a beneficial function to motivate, especially, cleaner manufacturing technology (Horbach, 2008; Frondel et al., 2007). Eco-innovations might thus originate from other economic motives, such an increase of market share or the decrease in cost. The contribution of eco-innovation to the company's success is also acknowledged from the aforementioned explanations (e.g., Klassen and Whybark, 1999; Christmann, 2000). The following are favourable links between company performance and eco-innovation: market share, return on investment, sales and profitability (Cheng and Shiu, 2012). It was proposed by Taylor (1992) that businesses engage in green innovation to improve environmental performance and green governance and meet customer needs to enhance company image among regulatory authorities and the general public.

Despite growing awareness for sustainable development innovation processes over the previous two decades, empirical research are extremely sparse on this issue. Earlier research focused on new environmentally-friendly goods' commercial potential and economic production. However, it was stated by Yang and Chen, (2011) that good's environmental and social effects are neglected.

Previous scientists concentrated primarily on green initiatives in western markets (Rivera-Camino, 2007; Hartman and Stafford, 1988). We explored eco-innovation and green manufacturing with the help of this research in the Pakistan production sector.

Consequently, Hypothesis are:

H1: Eco-Product Innovation is strongly linked to Corporate Sustainability Performance.

H2: Eco-Process Innovation is strongly linked to Corporate Sustainability Performance.

H3: Green Manufacturing is strongly linked to Corporate Sustainability Performance

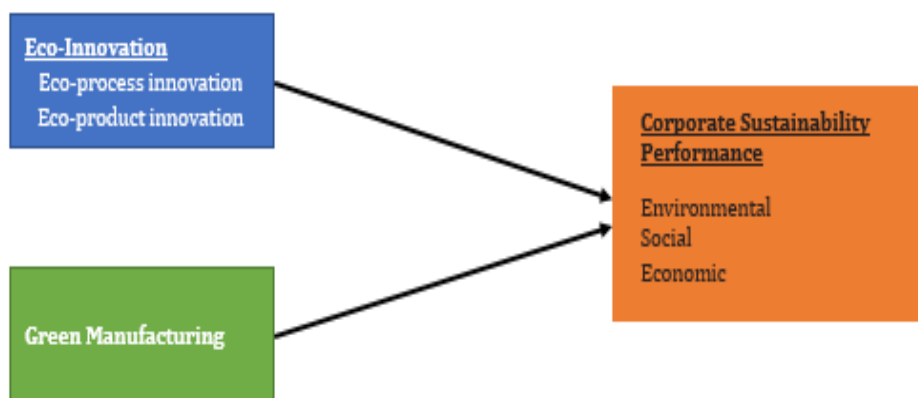


Fig. Research Model.

### III. METHODOLOGY

#### Research Goal:

The goal of this investigation is to show the connection between numerous variables, like eco-innovation , green manufacturing and the performance of organizational sustainability. A questionnaire field survey was performed to test the hypothesis.

#### Data Collection:

Quantitative data is collected with the help of survey to statistically assess the hypotheses was undertaken for the pilot research. 46 manufacturing managers from Pakistan tested the questionnaire pilotly. Through SPSS 25 statistical software data received from the 46 questionnaires have been analyzed and the hypothesized relationships tested by regression analysis. The analytical unit of the investigation is the single company. The population of this research includes businesses from Pakistan's automotive, chemical, and electronic industries.

### IV. ANALYSIS AND RESULTS

The questionnaires utilized for this research have been gathered and assembled from several validated literature instruments, however a number of changes have been made to the language in accordance with this research. Shang et al., (2010) stated that Green Manufacturing is embraced. Cheng and Shiu (2012) highlighted that eco-innovation scales are chosen which use 12 elements to scale two aspects ( eco-process and eco-product innovation ). Regardless, two elements are removed or because the load was feeble or two distinct factors were loaded. In terms of evaluating corporate sustainability, maximum mentors, academics and companies believe that the threefold results of one company vs one other are not commonly measured (Leonardo Academy, 2008). The Global Reporting Initiative (GRI) is the most recognized sustainability scale for corporations. GRI(2002), Veleva(2001), Azapagic(2003) and Ellenbecker were modified to the scale of sustainability utilized in this study (2001). A total of 39 products are utilized to assess green manufacturing, sustainability performance and eco-innovation in the five likert-type scale. The results are presented as follows in both reliability analysis and factor analysis. The main component analytics and a Varimax rotation were used to extract the factors. Kaiser Meyer Olkin stated that sample adequacy measurement is 0.701, data were considered suitable for analysis. The sphericity test of Bartlett was substantial (P<0.001), which indicated that

several of the answer categories had relationships. Identifying the number of components in each batch of data was done by using numbers larger than One (Churchill, 1991). To determine if these dimensions were consistent and dependable, on the basis of Cronbach alpha a reliability test was performed. Table No 1 shows the values for each dimension of Cronbach alpha. According to Nunnally (1978) each factor's dependability was significantly over 0.815 and suggests reliability and confidence.

**Table 1:** Factor and Reliability Analysis Results

Environmental Performance	Cronbach's Alpha Value	Factor Loading Value	Mean Value	Green Manufacturing	Cronbach's Alpha Value	Factor Loading Value	Mean Value
CPR4	0.846	0.914	3.7589	GM3	0.815	0.857	4.2912
CPR6		0.823		GM6		0.849	
CPR1		0.82		GM4		0.827	
CPR2		0.78		GM7		0.716	
CPR5		0.664		GM1		0.684	
CPR9		0.559		GM5		0.665	
CPR8		0.532		GM2		0.507	
<b>Eco-Product Innovation</b>				<b>Social Performance</b>			
EPR4	0.957	0.967	3.1214	SPR3	0.890	0.847	3.6174
EPR6		0.918		SPR9		0.834	
EPR7		0.904		SPR6		0.818	
EPR8		0.898		SPR2		0.807	
EPR2		0.893		SPR8		0.773	
EPR1		0.876		SPR5		0.750	
<b>Economic Performance</b>				SPR7		0.750	
EPN5	0.920	0.926	3.6746	<b>Eco-Process Innovation</b>			
EPN7		0.879		EPI3	0.890	0.893	3.784
EPN8		0.867		EPI1		0.874	
EPN4		0.808		EPI4		0.862	
EPN3		0.932		EPI2		0.846	
EPN2		0.926					
EPN1		0.834					
EPN6		0.664					

Regression analysis are also carried out in this study to check hypotheses and determine the course of relationships. Regression analysis results are shown in table no 2 to evaluate that how green manufacturing affects the performance of the company. Social performance ( sig=.001; F=11.980 ) and Environmentally performance ( sig=.001; F=12.847 ) is significantly favorable in green manufacturing. However, it has not been found that green manufacturing has any important economic impact.

**Table:2** Analysis of Corporate Sustainability Performance and Green Manufacturing

Independent Variables	Dependent Variable								
	Economic Performance			Environmental Performance			Social Performance		
	Beta	t	Sig	Beta	t	sig	Beta	t	Sig
Green manufacturing	.188	1.361	.181	.435	3.443	.001	.425	3.315	.001
R Square	.036			.189			.178		
Adjusted R Square	.017			.174			.162		
F	2.850			12.847			11.980		
sig	.281			.001			.001		

Table No 3 shows that the dimensions of eco-process innovation affect the three-dimensional aspects of corporate sustainability. However, no significant influence on any of the three performance categories was identified for innovation in eco-products. The findings of regression analyses therefore supports the both H2 hypothesis and H3 hypothesis.

**Table:3** Analysis of Corporate Sustainability Performance and Eco-Innovation

Independent variables	Dependent variable								
	Economic Performance			Environmental Performance			Social Performance		
	Beta	t	Sig	Beta	t	sig	Beta	t	Sig
Eco-process innovation	.374	2.352	.024	.515	3.599	.001	.720	5.779	.000
Eco-product innovation	-.092	-.577	.568	.024	.162	.874	-.093	-.743	.463
R Square	.076			.279			.454		
Adjusted R Square	.112			.250			.432		
F	4.208			10.724			21.82		
sig	.054			.000			.000		

## V. CONCLUSION

The results shows that the regression analysis among company sustainability (environmental, economic, social) performance and green eco-products innovation is not significant. It shows that innovation in environmentally friendly products does not work as well as innovation in environmental processes to improve the performance of an enterprise. This may be due to the sluggish innovation of the company. Furthermore, there have been beneficial consequences from the outcome on business sustainability performance of eco-process innovation. Pakistani companies have to include environmental efforts as a result of improving economic, environmental and social performance in their corporate management. Reducing raw material prices, efficiencies in production, decreased costs for the environment and safety at work, and enhanced business image might result in green manufacture. Numerous research have been conducted on the link between green practices and results, however the results are not convincing. Although the green initiatives found that they have a substantially positive relationship to organizational economic and environmental performance in Zhu et al. (2004), Rao and Holt (2005) and Carter et al. (2000), the Zhu et al. (2004) and Vachon and Klassen (2006b) had no substantial link between achievement outcomes and such green initiatives. The similar decision was found as the research of Vachon and Klassen (2006a). No link has been discovered between economic performance and green manufacturing. One explanation may be that environmental applications in Pakistan are very recent.

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