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Technological Factors and Adoption of Green Innovation - Moderating Role of Government Intervention: A Case of SMEs in Pakistan

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Abstract

The purpose of this study is twofold; one is to measure the size of the impact of technological factors on the adoption of green innovations in SMEs and second is to test the moderating role of government intervention between technological factors and adoption of green innovations. Technological factors consist of complexity, compatibility, relative advantage and tri-ability of green innovations while green innovations are new environment friendly methods of production. The self-administrative survey approach was used to collect the data through the questionnaire. The random probability sampling technique was used to collect the data from managers, senior executives, and technicians of SMEs. Multiple regression analysis was employed to measure the relationship and size of the impact of technological factors on the adoption of green technology. In addition, a hierarchical regression is used to investigate the moderating role of government intervention between technological factors and adoption of green technology.

The results suggest that the complexity of technology negatively and significantly affects the adoption of green technology while relative advantages and tri-ability positively and significantly affect adoption of green technology. The results of hierarchical regression analysis indicate that government intervention significantly moderates between complexity, relative advantages, tri-ability, and adoption of green technology. Considering the importance of green innovations in the reduction of global warming, policy makers can

get benefit from the evidence of this study and can take necessary measures to increase the possibilities of adoption of green innovations in SMEs.

Keywords: green innovation, green technology, complexity, compatibility, relative advantage, tri-ability, government intervention.

1. Introduction

After the 1970s, the excessive use of conventional natural resources in economic growth has damaged the environment and raised serious environmental concerns among stakeholders across the globe (Panwar et al., 2011; Qi, Shen et al., 2010). Although different actors of the economy may be held responsible for damaging the natural environment, but the considerable level of environmental issues is attributed to the activities of private sector enterprises (Gadenne et al., 2009). In response, many countries introduced different environmental regulations like restrictions on chlorofluorocarbons, the agenda of sustainable development in Johannesburg world summit and the European Union's Restriction of Hazardous Substances Directive, to put a pressure on the companies and confine them to adopt green innovation, environment friendly practices (Y.-S. Chen, 2008; Liu et al., 2012).

The large size firms responded actively and started to take action to reduce the emission of greenhouse gases (GHGs) (Ammenberg & Hjelm, 2003; Revell & Blackburn, 2007). However, SMEs tended low level of engagement in environment saving activities (Pinget et al., 2015) and continuously producing low value added goods with conventional methods that are harmful to the environment (Bø et al., 2013). Therefore, SMEs, being the engine of macroeconomic growth, not only contributing to socio economic progress but also damaging the environment significantly (Gadenne et al., 2009). It has been documented that almost 60% to 70% environment pollution is being produced by the SMEs in European regions, while the environmental impacts of SMEs in developing economies are even more alarming and uncountable (D. Chen et al., 2014).

In Pakistan, there are 98% manufacturing units are SMEs and among them 80% are situated in those urban areas that are located on river banks and most of them do not have adequate control over the emission of GHGs (Luken, 2000). The disposal of 70% untreated industrial wastes into the river water causes a great pollutional stress to the marine life and lung cancer to the residents of the area (Sahibzada & Qutub (1993). The SMEs in Pakistan are not adopting green innovations as per direction of environmental regulations to save the environment and to reduce the health hazards. Therefore, it is necessary for regulatory bodies to have a deep understanding about that why SMEs are not adopting environment-friendly strategies.

In the past, most of the empirical research focused the role of large size firms in environmental degradation and investigated the motivational factors for adoption of green innovation among large size companies (Bansal & Roth, 2000) and a few researchers established relationship between adoption of green innovation and SMEs financial development (Ebrahimi & Mirbargkar, 2017). However, the reasons behind the lack of adoption of green innovation in SMEs, particularly in developing economies are a relatively less researched area (Tilley, 1999). Recently, by realizing that SMEs, both in developing and developed economies, has significant environmental impacts, researchers are becoming keen to have a solid understanding of the factors that are influential to pro environmental strategies among SMEs (Blundel et al., 2013).

During the last few decades, empirical literature investigated various factors that influence the firm's environment friendly practices. Among them, individual, organizational and contextual factors have a greater impact on the adoption of green innovations while administrative factors are less influential in the adoption of green innovation (Gadenne et al., 2009; Henriques & Sadorsky, 1999; Lin & Ho, 2011). Similarly, some internal factors, knowledge, the growth of the company, manager's abilities, human capital and cost, and external factors, stake holder pressure, environment regulation, and networking, have frequently appeared in literature as influential factors in adoption of green innovation (Chapman et al., 2003; Etzion, 2007; González-Benito & González-Benito, 2006; Marin et al., 2015; Wahga et al., 2015). However, some studies suggested that in case of SMEs environment of the organization and cooperation with regulatory bodies are more relevant factors in the adoption of green innovation, especially in the information technology sector (Del Aguila-Obra & Padilla-Melendez, 2006).

Furthermore, in Canadian manufacturing companies, total quality management, and stakeholder pressure increase the adoption of green innovation (Henriques & Sadorsky, 2007) while in the China manufacturing sector, external knowledge sourcing significantly and negatively affects green innovation growth, if R&D levels among industries are weak. However, the strong R&D level causes to lower the negative impact of external knowledge sourcing on adoption of green innovation (Hou et al., 2017).

Yet, a few studies have analyzed the role of technological factors in the adoption of green innovation in the transportation sector; in the context of China (Lin & Ho, 2011) and found that technological factors have a greater influence on adoption of green innovation. However, the study of Lin and Ho (2011) did not consider all characteristics of technology while investigating the role of technological factors in the adoption of green innovation. Technological characteristics like complexity, compatibility, relative advantages and tri-ability (Jeyaraj et al., 2006; Rogers, 2003) have greater importance in the adoption of innovation. Up till now, the role of technological factors in the adoption of green innovation in the context of SMEs in Pakistan is missing and this study is an effort to fill the gap by investigating the role of technological factors in the adoption of green innovations among SMEs Pakistan. Moreover, this study also investigates the moderating role of government intervention as an external factor in the adoption of green innovations because the company pays special attention to government regulatory policies while designing company's environmental strategy.

Moreover, identification of technological factors in the adoption of green innovation is necessary because once the SMEs and policy makers get familiar with them, then they can easily find the solutions and switch to green phase smoothly.

1.1 Rationale of the Study

Global chemical industries are playing important role in defining the structure of the modern business world and converting the basic raw material into more than 70, 000 products ranging from pesticides and automobile to toys and clothing. A chemical product, during entire its life from production to disposal, has a significant and negative impact on the environment. So, to address the environmental concern, global chemical companies are continuously working on the adoption of green technologies. Apart from this, the chemical sector in Pakistan is still at emerging stage and producing with traditional technologies. Thus, Pakistan being developing economy with a significant contribution of chemical

industry in environment gives an opportunity to contribute in the literature by identifying the important factor that restricts the ability of SMEs to adopt a green innovation. There are several other reasons for proposing a research on this industry sector.

- The chemicals industry is playing important role in economic activities but unfortunately, there is no centralized authority to minimize its environmental impacts.
- Chemical industry is using natural gas, coal and coke, minerals, fuel oil and liquefied petroleum gas in production process which causes to discharge carbon dioxide (CO2) - a greenhouse gas - and volatile organic compounds (VOCs), as well as nitrogen oxides (NOx) that ultimately produce hazardous pollutants to the environment.
- Finally, local authorities like Islamabad Chamber of Commerce and Industry and United Nations Industrial Development Organization are given considerable attention to SMEs in Pakistan to fuel the green industrial revolution.

Therefore, all these factors establish a sound rationale for researching the factors affecting the adoption of green innovation behavior in SMEs operating in the chemical sector Pakistan.

1.2 Aim of the study

Study aims to

- Measure the size of the impact of technological factors on the firm's decision of green innovation adoption.
- Investigate the moderating role of government intervention between technological factors and green innovation adoption.

1.3 Significance of the Study

This research will contribute to the body of knowledge regarding adoption of green innovation and environmental sustainability by increasing the understanding of the factors that might enable the organization to adopt green innovations.

This study enables the policy makers to develop strategies regarding workshops and training that further help the SMEs to address their technological challenges positively. Moreover, this study will investigate a moderating role of government intervention between technological factors and adoption of green innovation and will provide the guidance to the public authorities that how they can facilitate the process of "go green SMEs". Further, this study will benefit the managers who want to enhance the financial performance and competitiveness of their firm through green innovation adoption.

2. Theoretical Background

2.1 Green Innovation Theory

According to Thompson (1992) innovation is a process that translates the idea into a product or service to meet new market demand. In addition, green innovation is the development of, product, process, and management strategies to affect the internal and external environment (Damanpour, 1992). Green innovation reduces the environmental impacts of the firm and enables them to achieve eco-targets and environmental benefits (Bernroider, 2002).

Therefore, green innovation can be divided into green product, green process and green management innovations (C.C. Chen et al., 2012; H.-L. Chen & Hsu, 2009). Product

innovations include modification in existing user characteristics and packaging of goods and services in response to environmental concerns (Bozkurt & Kalkan, 2014). Process innovation includes changes in methods, process, and equipment to produce environmentally friendly products that meet eco-targets (Antonioli et al., 2013). Green management innovation includes a new management method in commercial practices in the workplace and in the external relations of the company.

This study defines the firm's adoption of innovation as the initiation, development, and implementation of systems, programs, devices and processes that are new to the adopting firm (Damanpour, 1992).

2.2 SMEs and Adoption of Green Innovation

What are SMEs? The definition of small medium enterprises depends on the number of employees, capital or assets and turnover or a combination of these. The definition of SMEs varies from industry to industry and country to country. This study adopts European Union definition of SMEs and considered only those firms as SMEs which are having the number of workers up to 250.

It has been documented that each type of innovation, increase firm financial performance (Hassan et al., 2013) that motivate the SMEs to adopt innovations, but each type of innovation has different problems which cause to lower the chances to adopt the innovation. This degree of adoption of green innovation among SMEs depends on the benefits, that innovation yield for the organization, and on the organization's ability to adopt the innovation (Chau & Tam, 1997; Forbes et al., 2013). Hence, if the SMEs of an economy adopt innovation with a specific purpose to save the environment, then the economy will certainly produce higher economic growth with more social satisfaction and clean environment (Y.-S. Chen, 2008).

2.3 Related Research on Green Innovation

Several empirical studies investigated the factors that affect the firm's adoption of green innovation behavior. As Foster and Green (2000) investigated the role of legislation and customer pressure in research and development expenditure that further influence the adoption of the green innovation process. The environmental management system (EMS) or R & D department foster the process of green innovation (Rennings et al., 2006) while Wagner (2007) concluded that although EMS affect innovation process significantly but it has an insignificant association with product innovation. Moreover, environmental regulation, environment management tool and organizational factors encourage environmental innovation (Frondel et al., 2008). Another study focused that customer benefits, environment regulations and technological capabilities of R & D play an important role in the green innovation process (Kammerer, 2009). Conclusively, the whole literature regarding environment, innovation process focused three main explanatory variables: market pressure, government environmental regulation and internal condition of the firm (Foster & Green, 2000; Kammerer, 2009; Rehfeld et al., 2007). A few studies have investigated the influence firms' internal factors (Huang et al., 2016) and technological factors (Bollinger, 2015) on adoption of green innovation. Moreover, most of the studies declared the environment regulation as a determinant of adoption of green innovation while this study used government regulation as a moderating variable, which is not directly affecting adoption behavior but it is affecting the relationship of technological factors and adoption behavior of green innovation.

2.4 Technological Factors and Adoption of Green Innovation

Past literature identified different technological factors like easy to use, observe ability, rich information and uncertainty (Lin & Ho, 2011; Rogers, 2003; Savignac, 2008; Tornatzky & Klein, 1982) that affect the firm's cognitive belief toward the adoption of green innovation. This study focused complexity, compatibility, relative advantage and tri-ability because these four characteristics in literature are being found more important technological factors that significantly affect firm's behavior regarding adoption of innovation (Tornatzky & Klein, 1982).

The complexity of innovation reflects the extent to which an organization perceived that technology is difficult to understand and use. It is hypothesized that as the complexity of technology increases, it lowers the chances of adoption of innovation. Moreover, difficulty in innovation diffusion (Rogers, 2002) and knowledge sharing (Tornatzky & Klein, 1982) increases the degree of complexity in technology, so organization is more willing to adopt an innovation if the knowledge sharing about innovation is easy within the organization. Efficient knowledge sharing within organization facilitates the process of adoption of innovation that improves financial performance of the organization along with effective environmental management (Etzion, 2007). Contrarily, if a new innovation required laborious efforts to learn and diffuse, the degree of complexity increases and chances to adopt that complex technology decreases (Tornatzky et al., 1990). Similarly Bollinger (2015) highlighted the lack of private incentives, complex process of replacement of technology and lack of information about green innovation as possible factors that affect firm behavior of adoption of green innovation and study concluded that financial incentive, policy intervention, training, and information about the benefits of green innovation significantly reduces the use of polluting technology.

Compatibility reflects the organization's perception about the consistency of technology with the firm's existing values, experiences, and needs (Rogers, 2003) so if a firm perceived that the technology is compatible with the company's existing knowledge, the organization will be easily convinced to adopt that technical innovation (Chau & Tam, 1997). Similarly, if the green innovations are just an extension of company's existing knowledge, the diffusion of green innovation becomes convenient and smooth. As Dupuy (1997) conduct a study on technological changes and environmental policy in Ontario organic chemical industry and found that the innovations that are additions to existing technology are more quickly and easily diffused within the organization as compared to the technologies that are not consistent with firm's existing knowledge and production process. Moreover, it has been experienced that the innovations that are compatible with firm's capabilities have greater positive impacts on the environment (Etzion, 2007).

Relative advantage reflects organization's perception about advantages of innovation over its cost, so if firm perceives that relative advantages of innovation are greater than the cost and existing technology, the organization will be more willing to adopt the innovation (Robertson, 1971). The relative advantage can be in term of price, quality and ease of use, life span, and satisfaction that firm can enjoy after using the innovation. Accordingly, if relative advantages of innovation are greater, the companies are more willing to adopt the innovation and to search higher economic gains (Lin & Ho, 2011; Rogers, 2003).

Potential benefits that organizations can enjoy from the adoption of green innovations are the consumption of energy and natural resource will decrease, emission of GHGs will be

reduced, environmental and financial performance will improve and responsiveness to social environmental expectation will meet (Etzion, 2007; Hart, 1995). Similarly, del Río González (2005) investigate the factors affecting the adoption of clean technology in Spanish pulp and paper industry and found that financial benefits are important technological characteristics that affect the adoption of clean technologies. Therefore, the perceived net benefits motivate the organization to adopt the technology and earn the benefits.

Tri-ability, tri-ability reflects that organizations are more willing to adopt that type of innovation which can be tried before hand than innovations that cannot be tried, especially in the case when innovations have a high degree of uncertainty. Past research advocated different technological factors like the relative advantages, complexity, and compatibility of innovation affect adoption of green innovation adoption in the transportation sector in China (Lin & Ho, 2010; R.-H. Weng et al., 2011). The adoption of green practices is very much popular among Chinese logistic companies because they believe that it greatly contributes to the environment as well as in the economic performance of the company (Lin & Ho, 2008b).

Subsequently, Zailani et al., (2014) conducted a study in the transportation industry in Malaysia and found that human capital, customer pressure and environmental uncertainty significantly affect green technology innovation adoption while organizational and governmental support has an insignificant relationship with the adoption of green innovation. Hassan et al., (2013) investigate the relationship between adoption of innovation and firm financial performance in Pakistan manufacturing sector and found a positive relationship between adoption of innovation and firm's financial performance. As Radu (2016) explored the determinant of green ICT (Information and communication technologies) adoption in the organization and identified different economic, ethical and regulatory determinant of green ICT adoption in the organization.

Le, Hollenhorst et al. (2006) conducted a study in Vietnamese and found that relative advantages, tri-ability, increase in sales volume, reputation, and complexity is a significant determinant of adoption of innovation. As Matlay and Chibelushi (2008) documented that a firm easily adopts new technology, if it is not difficult to learn, otherwise not. Therefore, a few researchers like M.-H. Weng and Lin (2011) conduct a study on factors affecting green innovation in the context of SMEs in China and found that perceived complexity is more influential to the adoption of green innovation than compatibility and relative advantages and suggest that adequate knowledge is necessary to reduce perceived complexity.

2.5 Government Intervention and Adoption of Green Innovation

Government policies in developing nation play an important role to motivate the SMEs to adopt such methods of production that can save the environment (Gadenne et al., 2009). it has been observed in Malaysia and south Korea that SMEs transfer their production process from traditional to latest technology when government itself involved in policy making (Acs et al., 1997; Murad & Thomson, 2011) so government support and intervention policies are necessary to increase the willingness of SMEs for the adoption of green innovation (Lin & Ho, 2010). Similarly, Veugelers (2012) investigated the motives of firms for introducing clean innovations and found that policy intervention is more powerful tool to introduce and to implement clean technologies.

Moreover, most of the studies considered government intervention policies regarding subsidies and tax as an independent factor that affects adoption of green innovations. A few studies examined the moderating role of government intervention in context of Cambodia and concluded that government intervention play significant moderating role between internal factors like entrepreneurial value, management, and market strategies, and the growth performance of SMEs (Shariff et al., 2010) but no study investigates the moderating role of government intervention between technological factors and adoption of green innovation, especially in case of SMEs of Pakistan. The aim of this study is to check the moderating role of government intervention rather than considering it as one of the independent factors influencing adoption of green production. On the basis of literature review, the study proposes the following hypothesis and conceptual model.

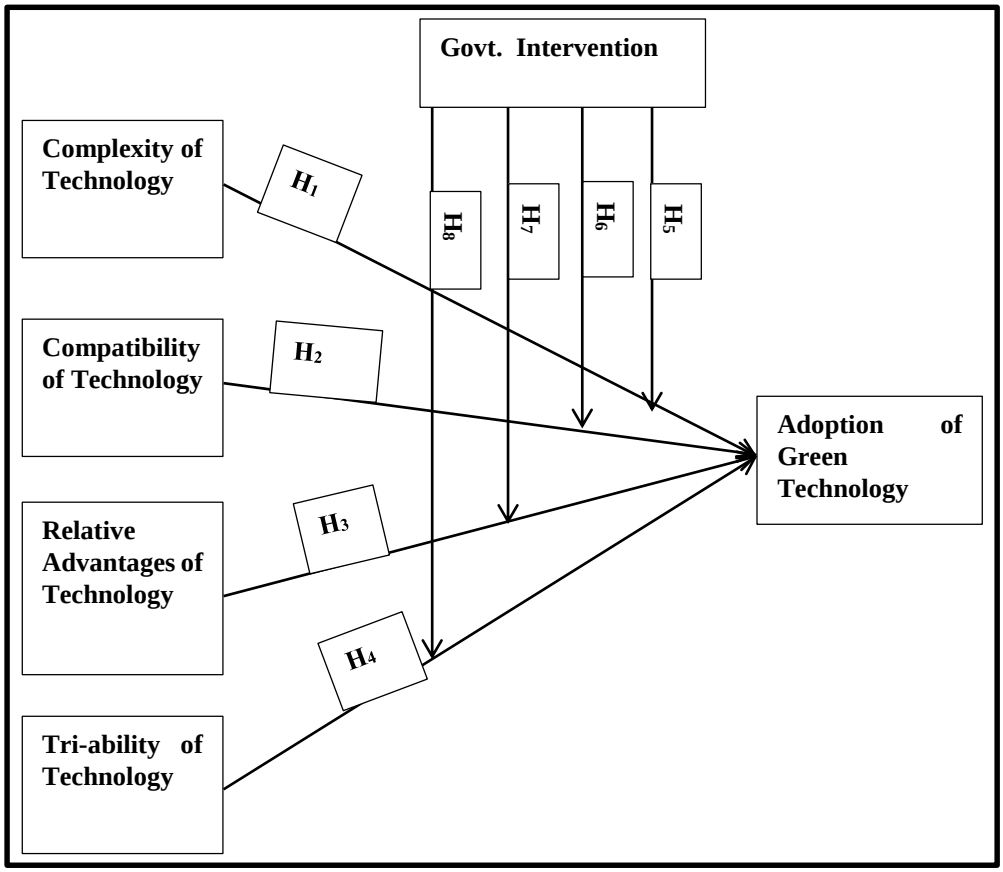

Figure 1: Conceptual Model

- **H_1:** There is a negative relationship between complexity and adoption of green technology in SMEs.
- **H_2:** There is a positive relationship between compatibility and adoption of green technology in SMEs.
- **H_3:** There is a positive relationship between relative advantages and adoption of green technology in SMEs.

- **H_4:** There is a positive relationship between tri-ability and adoption of green technology in SMEs.
- **H_5:** Government intervention moderate between complexity and adoption of green technology in SMEs.
- **H_6:** Government intervention moderate between compatibility and adoption of green technology in SMEs.
- **H_7:** Government intervention moderate between relative advantages and adoption of green technology in SMEs.
- **H_8:** Government intervention moderate between tri-ability and adoption of green technology in SMEs.

3. Methodology

Generally, there are three acceptable paradigms in research, constructivism, positivism, and pragmatism. The selection of paradigm provides the guidance to the researcher about philosophical assumption, selection of tools, instrument, participant, and methods to be used in the study (Mertens, 2014). The objective of my study is to propose a model and investigate the role of government intervention as a moderating variable between complexity, compatibility, tri-ability, and relative advantage of technology and adoption of green technology in SMEs Lahore. Thus the quantitative approach under positivism paradigm is appropriate to serve the objective of this study. The Self administrative survey approach was used to collect the data through a questionnaire. Furthermore, the study used the structured questionnaire as an instrument to collect the data with five point Likert scale, 1 indicates strongly disagree, 2 indicates disagree, 3 is neutral, 4 is agree and 5 strongly agrees. The study adopted and adapted questionnaire from Lin and Ho (2011) consisting of 4 items for complexity, 3 items for compatibility and 3 items for relative advantages of technology, 4 items of government intervention from Lin and Ho (2008a) and 3 items of tri-ability of technology is adopted from Moore and Benbasat (1991). In addition, this study measures the adoption of green innovation with the help of 4 item developed by Baines et al., (2012). When a study adapts the questionnaire, it should address the issues related to the validity of the instrument and reliability of data. Validity ensures that a scale is really measuring for what it has been developed to measure. There are several criteria to measure the validity of instrument like face, content, construct, convergent and discriminant validity. The instrument utilized in this study has established face and content validity. In addition, the study utilized PCA technique with varimax rotation to confirm convergent and discriminant construct validity. To ensure the reliability and internal consistency, the study employed Cronbach's alpha. It is one of the most commonly used methods to test internal reliability and its value varies between 0 (no consistency) to 1 (perfect consistency). However, the value less than 0.6 represent lack of internal consistency while above 0.6 values ensure internal consistency and reliability.

3.1 Description of Sampling

In the research process, the sampling is very important because it selects the sample from the population for investigation. Researchers generalize their findings about the population on the basis of sample results. Generally, there are two acceptable categories of sampling: probability sampling and non-probability sampling. In probability sampling, samples are drawn from the population and all sample units have an equal probability of being selected

is less prone to biases, it enables the researcher to generalize his claims regarding the population of their interest. This type of sampling is appropriate for quantitative research. This study, keeping in view the general procedure of quantitative research, used the probability method of sampling. The probability of sampling can be done by using its various types. When the list of the element composing population is possible, random sampling is best to utilize because it deals with the random selection of individual, so keeping in view this advantage, this study utilizes a random sampling technique (Secker et al., 1995).

The total population of SMEs, chemical industries, in Lahore is 932 and if we apply formula provided by Yamane (1967) to draw a minimum sample, which is as follows:

$$n = \frac{\mathrm{N}}{1 + \mathrm{Ne}^2}$$

Where:

n	=	the sample size
N	=	Total population of the study
e	=	level of significance (0.05 set in current research)

The study used above formula to arrive at minimum sample size:

$$n = \frac{932}{1 + 932\ (0.05)^2}$$

$$n = \frac{932}{1 + (932\ \times 0.0025)}$$

$$n = \frac{932}{1 + (2.33)}$$

$$n = \frac{932}{3.33}$$

$$n = 280$$

According to Yamane (1967) the sample size for this 280 but this study selected 300 chemical industries for data collection to decrease the sampling error (Ary et al., 2013). According to Dess and Beard (1984) the sample size should be above 200 for reliable results if study employs principle component analysis. Since this study selected chemical manufacturing companies because of their contributions towards the environmental problems (Levinson, 1996) so the target respondent should have the knowledge about the factors that restrict the ability of adoption of green innovation in SMEs. Thus, study selected Directors, senior managers and middle management like managers, senior engineers/executives for the purpose of investigation. Lahore is influential city and the hub of SMEs and has a greater trend to adopt green production practices and the results can be generalized for SMEs of all Pakistan.

Table 1: Descriptive Statistics

Items	Minimum	Maximum	Mean	Std. Deviation
Green innovation reduce negative impact of packaging	1.00	5.00	3.0250	1.28945
Green innovations reduce negative impacts of producing finish goods	1.00	5.00	3.2100	1.31321
Green innovations reduce negative impacts of use phase	1.00	5.00	3.1350	1.18057
Product can be recycle	1.00	5.00	3.0450	1.40815
Learning green practice is difficult	1.00	5.00	2.6750	1.06539
Understanding of green practices is difficult	1.00	5.00	2.6050	.89047
Sharing the knowledge of green practices is difficult	1.00	5.00	2.6800	.99627
Green practices required many experiences	1.00	5.00	2.8950	1.03408
Green practice is compatible with existing knowledge	1.00	5.00	3.0850	.98622
Green practice is integrated with company's existing system	1.00	5.00	3.1900	.92095
Green practice is consistent with our company value	1.00	5.00	3.2750	1.02206
Green practice is better environmental performance	1.00	5.00	3.4250	1.05353
Green practice can provide higher economic benefits	1.00	5.00	3.3550	1.09772
Green practice can enhance our reputation	1.00	5.00	3.4300	.97974
I have opportunity to try green technology	1.00	5.00	2.2650	1.00490
I am able to properly try the green technology	1.00	5.00	2.1250	.95073
I was permitted to use a green technology on a trial basis long enough to see its benefits	1.00	5.00	3.1850	1.01782
The government provides financial support for adoption of green practices	1.00	5.00	3.4000	1.10276
The government encourages the companies to produce green products	1.00	5.00	3.3200	1.11527
The government arranges training and workshops for manpower to promote green skill	1.00	5.00	3.1616	1.22749
The government defines the environmental regulation for the SMEs.	1.00	5.00	3.5623	1.33549

This study calculated the descriptive statistics for 21 items and reported them in table 1. The responses are recorded on a five Likert scale, so the responses of the respondent are varying between 1 to 5. The arithmetic mean across the observation is varying from 2.6050 to 3.5623. Arithmetic mean measures the central tendency of the data and is sensitive to extremely large and small values. The standard deviation is the square root of the variance and it measures the spread of a set of observation. The dispersion of the data is between the ranges of .89047 to 1.40815. This suggests an appreciable variation in the responses.

Table No 2: Validity of Scale and Reliability of Data

Items	Components Loading	Crobach,s alpha
Adoption of Green Innovation		
Reduce negative impact of packaging	.904	.778
Reduce negative impacts of producing finish goods	.919	
Reduce negative impacts of use phase	.891	
Product can be recycle	.668	
Complexity of Technology		
It is difficult to learning green practice	.774	.772
It is difficult to understanding of green practices	.862	
It is difficult to share the knowledge of green practices	.832	
Green technology needs many experiences for adoption	.627	
Compatibility of Technology		
Green practice is compatible	.832	.651
Integrating practice is company existing system	.818	
Green practice is consistent with our company value	.653	
Relative Advantage of Technology		
Green practice increases environmental performance	.821	.762
Green practice increases economic benefits	.822	
Green practice improves our reputation	.830	
Tri-ability of Green Technology		
I have the opportunity to try green technology	.656	.764
I am able to properly try the green technology	.751	
Permission to use a green technology on a trial basis long enough to see its benefits causes to increase adoptability	.659	
Government Intervention		
The government provides financial support for adoption of green practices	.755	.732
The government encourages the companies to produce green products	.851	
The government arranges training and workshops for manpower to promote green skill	.814	
The government defines the environmental regulation for the SMEs.	.881	

Table 2 shows the estimated value of Cronbach's alpha that are varying between .651 and .778. The estimated values indicate that each construct possesses high reliability because the value of Cronbach's alpha for each construct is greater than .6. The higher value of Cronbach's alpha for green technology and complexity of technology (.778 and .772) compatibility of technology (.651) and relative advantages of technology (.762) tri-ability of technology (.764) and government intervention (.732) shows that each construct is internally consistent. The higher the Cronbach's alpha value of a construct or near to 1 that indicates the higher reliability of measuring the construct of what it has been devised to measure.

Moreover, for all construct (adoption of green innovation, complexity, compatibility, relative advantages, tri-ability and government intervention) the all related items are loaded in one construct because the values of factor loading are greater than 0.40. As Straub et al., (2004) stated that cross loading of the items should not be above 0.40. The factor loading values for each construct ranging between .668-.908, .627-.862, .653-.832, .821-.830, .659-.751 and .755-.881.

3.2 Factor Analysis

For data reduction, PCA technique with varimax rotation method was used. The results are reported in table 3.

Table No 3: KMO and Bartlett's Test

Construct	**No. of Items**	**KMO**	**Bartlett's Test of Sphericity**	**Bartlett's Test of Sphericity Sig.**
Green Technology	4	.735	394.503	.000
Complexity of Technology	4	.702	252.560	.000
Compatibility of Technology	3	.613	94.931	.000
Relative advantage of Technology	3	.697	148.193	.000
Triability of Green Technology	3	.778	26.153	.000
Government Intervention	4	.662	130.051	.000

The KMO measures sampling adequacy and the values of KMO vary between 0 to 1. The zero value of KMO indicates that the application of factor analysis is inappropriate while one indicates that factor analysis is appropriate. The value of KMO closer to 1 is more desirable (Chang et al., 2014). The value of KMO for each construct (.735, .702, .613, .697,

.778 and .662) is above the recommended acceptable level of 0.6. So, this study continued with PCA.

Table No 4: Eigenvalues and Total Variance Explained

Construct	Comp.	Initial Eigenvalues		
		Total	% of Variance Explained	Cumulative % of Variance Explained
Green Technology	1	2.590	64.761	64.761
Complex Technology	1	2.426	60.649	60.649
Compatibility Technology	1	2.787	69.567	69.567
Relative Advantage of Technology	1	2.038	67.918	67.918
Tri-ability of Green Technology	1	2.428	67.616	67.616
Government Intervention	1	2.957	75.239	75.239

Only the principle component, having eigenvalue greater than 1, will be used for further analysis. Results indicate that green technology consists of 4 items and explain 64.761 % of the variance, the complexity of technology consists of 4 items, explained 60.649 % of the variance, the compatibility consists of 3 items, explained 69.567 % of the variance, relative advantages consist of 3 items, explained 67.981 % of the variance, the tri-ability of technology consists of 3 items, explain 67.616 % of variance and government intervention consists of 3 items, explained 75.239 % of the variance. The results indicate that the data has been obtained from a reliable instrument because all constructs have satisfied discriminant validity (loading of at least 0.40, no cross loading above 0.40) and convergent validity, eigenvalue of at least 1.

Table 5: Correlation Matrix

Constructs	Green Innovation	Complexity	Compatibility	Relative Advantage	Tri-ability	Gov. Intervention
Green Innovation	1					
Complexity of Technology	-.163*	1				
Compatibility of Technology	.296*	.070*	1			
Relative advantages	.274**	-.227*	.317**	1		
Triability of Technology	.253*	.356*	.283*	.354*	1	
Government Intervention	.201*	.337*	.304**	.357**	.263**	1
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

Correlation coefficients of the independent variables of this study are being reported in Table 5. The correlation matrix indicates that the value of the coefficients of the independent variables is below than 0.5. It indicates that there is a weak association among independent variable and there is no problem of multi-collinearity (Cohen et al., 2003). Moreover, the correlation results also indicate the direction of the relationship among all constructs. The relationship between green innovation and complexity is negative while compatibility, relative advantages and tri-ability are positively correlated with green innovation. The direction of relationship among constructs confirms the results of this study in advance.

Table 6: Simple Regression Analysis

Independent Variable	**β**	**T**	**Sig**	**R^2**	**F. Statistics**
Complexity of Technology	-.163**	-2.317	.021	.211	79.6933
Compatibility of Technology	.096	1.351	.178	.096	31.6460
Relative Benefits of Technology	.274*	4.002	.000	.374	178.0383
Tri-ability of Technology	.153*	2.147	.0045	.258	103.6173

Results of simple regression analysis are reported in table 6. Results indicate that complexity of technology is significantly and negatively affect adoption of green technology (β = -.163, T = -2.31, p <.05). Similarly, relative benefits and tri-ability of technology significantly and positively affect adoption of green technology (β = .274, T = 4.002, p <.000, β =.153, T = 2.147, p < 0.05). The results of simple regression indicate the contribution of individual independent variables (Complexity of Technology, compatibility of Technology, relative contribution and Tri ability of Technology) in to dependent variable (Adoption of Green Technology).

Table 7: Multiple Regression Analysis

Dependent Variable = Adoption of Green Technology			
Independent Variable	**β**	**T**	**Sig.**
Constant	0.363	5.000	0.000
Complexity of Technology	-.145*	-2.110	.036
Compatibility of Technology	.025	0.353	.725
Relative Benefits of Technology	.273*	3.777	.000
Tri-ability of Technology	.074**	1.971	.086
R^2	.764	**F. Statistics**	190.35 (0.000)

Note: * indicate significance at less than 5% and** are indicating significance at less than 10%.

Results of multiple regressions are reported in table 7. Results indicate that complexity of technology is significantly and negatively affect adoption of green technology (β = -.14, T = -2.110, p <.05). Similarly, relative benefits and tri-ability of technology significantly and

positively affect adoption of green technology (β = .273, T = 3.777, p <.000, β =.074, T = 1.971, p < 0.1). However, compatibility of technology insignificantly associated with the adoption of green innovation. As the theory of planned behavior stated that behaviors of individuals are controlled by their beliefs, so the perception of the firm regarding green innovation significantly affects the adoption behavior of the firm (Sheppard et al., 1988). As perception regarding complexity increase, it will lower the chance to adopt the technology. Moreover, as the firm perceives that green innovation has greater advantages and tri-ability, the firm is more willing to adopt the green innovation.

The value of the adjusted R square indicates that 76 % variations in the adoption of green innovations are related with the modeled variables and value of F. statistics represent that model is a good fit.

3.3 Hierarchical Regression Analysis

The moderating effect of government intervention on the relationship between the complexity of technology and adoption of green technology was evaluated by using the three-step regression analysis. In model (1), the independent variable was the complexity of technology. In model (2) the independent variables were: (a) complexity of technology (b) government intervention. Moreover, in equation (3) the independent variables were (a) the complexity of technology (b) government intervention and (c) the interaction term, the cross product of the complexity of technology and government intervention. The dependent variable was the adoption of green technology. The results of the three step regression analysis are reported in table 8.

Table 8: Moderator Analysis in Case of Complexity and Government Intervention

Dependent Variable: Adoption of Green Technology						
Model	**Independent variable**	**B**	**T**	**Sig.**	**R^2**	**F. Statistics**
1	Constant	-.001	-.007	.994	.163	58.0335
	Complexity of Technology	-.164*	-2.309	.022		
2	Constant	.000	-.007	.994	.195	35.9720
	Complexity of Technology	-.168*	-2.372	.019		
	Government Intervention	.108*	2.929	.028		
3	Constant	.002	.026	.979	.203	18.7845
	Complexity of Technology	-.149*	-2.006	.046		
	Government Intervention	.107*	2.508	.023		
	Complexity of Technology * Government Intervention	-.065*	-2.812	.041		

Note: * indicate significance at less than 5%.

Results indicate that complexity of technology significantly and negatively associated with the adoption of green innovation in three models (β = -.164, T = -2.309, p < .05, β = -.168,

T = -2.372, p < .05, β = -.149, T = -2.006, p < .05). Similarly, in model 2 and 3, results indicates that government intervention positively and significantly affect green innovations (β = -.108, T = -2.929, p < .05, β = -.107, T = -2.508, p < .05). In model 3, an interaction term of complexity and government intervention indicate that government intervention significantly moderates between complexity and adoption of green technology and weaken the negative relationship among them (β = -.065, T = -2.812, p < .05). Adoption of green technology is limited due to its complex process to replace the existing technology and knowledge about the benefits of adoption of green innovation. Government can reduce the use of polluting technology by providing information and trainings regarding adoption of green innovation. Specifically, the information and training through demonstration increases the adoption of green technology (Bollinger, 2015).

The R square value substantially increases from 2nd equation to 3rd equation and support the hypothesis that government intervention significantly moderates between independent and dependent variable.

Table 9: Moderator Analysis in Case of Compatibility of Technology and Government Intervention

Dependent Variable: Adoption of Green Innovations						
Model	**Independent variable**	**B**	**T**	**Sig.**	**R^2**	**F. Statistics**
1	Constant	-.001	-.017	.986	.096	31.6460
	Compatibility of Technology	.097	1.355	.177		
2	Constant	-.001	-.017	.986	.122	20.6344
	Compatibility of Technology	.072	.967	.335		
	Government intervention	.080	1.064	.289		
3	Constant	-.012	-.164	.870	.127	14.3536
	Compatibility of Technology	.065	.846	.398		
	Government Intervention	.090	1.152	.251		
	Compatibility *Government intervention	.037	.472	.638		

In model (1), the independent variable is compatibility of technology. In model (2) the independent variables are (a) compatibility of technology (b) government intervention and in the model (3) the independent variables are (a) the compatibility of technology (b) government intervention and (c) the interaction term, the cross product of the compatibility and government intervention while the dependent variable is the adoption of green technology. The results of the three step regression analysis are given in table 9. The result indicates that the compatibility has an insignificant association with the adoption of green technology in all three models and government intervention does not play a moderating role between compatibility and green innovations.

Table 10: Moderator Analysis in Case of Relative Advantage of Technology and Government Intervention

Dependent Variable: Adoption of Green Innovations						
Model	**Independent variable**	**B**	**T**	**sig**	**R^2**	**F. Statistics**
1	Constant Relative Advantage of Technology	-.004 .281*	-.051 4.050	.959 .000	.278	114.742
2	Constant Relative Advantage of Technology Government intervention	-.004 .280* .023*	-.051 3.762 2.035	.959 .000 .042	.279	57.4639
3	Constant Relative Advantage of Technology Government Intervention Relative Advantage*Government Intervention	-.034 .300* .018* .087*	-.471 3.90 2.15 2.05	.638 .000 .031 .040	.291	40.4965

In model (1), the independent variable is relative advantages of technology. In model (2) the independent variables are: (a) relative advantages of technology (b) government intervention and in the model (3) the independent variables are (a) the relative advantages of technology (b) government intervention and (c) the interaction term, the cross product of the relative advantages of technology and government intervention while the dependent variable is the adoption of green technology. The results of the three step regression analysis are given in table 10. The result indicates that the relative benefits of technology positively and significantly associated with the adoption of green technology in all three models ($\beta = .281$, $T = 4.050$, $p < .05$, $\beta = .280$, $T = 3.762$, $p < .05$, $\beta = .300$, $T = 3.90$, $p < .05$). As a firm perceives that the relative advantages of the green innovation are greater, then firm is more willing to adopt the green innovation. The Innovation Decision Process theory mentioned four stages, Knowledge, persuasion, implementation and confirmation, of adoption of innovation. According to the theory, as the potential firm learns about the merits of the innovation, the firm will decide to adopt the innovation (Rogers, 1995).

Similarly, in model 2 & 3, government intervention has positive and significant association with green innovation ($\beta = .023$, $T = 2.035$, $p < .05$, $\beta = .018$, $T = 2.15$, $p < .05$). In addition, the interaction term in model three indicates that government intervention significantly moderates between relative advantage and adoption of green innovation. Therefore, government intervention in the form of environmental regulation helps to reduce the use of conventional technology (Zailani et al., 2015).

Table 11: Moderating Analysis in Case of Tri-ability of Technology and Government Intervention

Dependent Variable = Adoption of Green Innovations						
Model	**Independent variable**	**B**	**T**	**Sig**	**R^2**	**F. Statistics**
1	Constant	0.001	.010	.992	0.052	16.3460
	Tri-ability of Technology	0.052*	2.731	.046		
2	Constant	0.001	.007	.994	0.130	22.1897
	Tri-ability of Technology	0.085*	3.151	.001		
	Government intervention	.124**	1.680	.095		
3	Constant	0.005	.068	.946	0.132	15.0046
	Tri-ability of Technology	0.083*	2.112	.0267		
	Government Intervention	0.122**	1.843	.082		
	Tri-ability of Technology *Government Intervention	.021*	3.337	.002		

The results of the moderation analysis in case of tri-ability of technology and government intervention are reported in table 11. In model (1), the independent variable is tri-ability of technology. In model (2) the independent variables are: (a) tri-ability of technology (b) government intervention and in model (3) the independent variables are (a) the tri-ability of technology (b) government intervention and (c) the interaction term, the cross product of the tri-ability of technology and government intervention while the dependent variable is the adoption of green technology. Result indicates that tri-ability positively and significantly associated with adoption of green technology in all three models ($\beta = .052$, $T = 2.731$, $p < .05$, $\beta = .085$, $T = 3.151$, $p < .05$, $\beta = .083$, $T = 2.112$, $p < .05$). Similarly in model 2 & 3, government intervention has positive and significant association with green innovation ($\beta = .124$, $T = 1.680$, $p < .05$, $\beta = .083$, $T = 1.843$, $p < .05$). In addition, interaction term in model three indicates that government intervention significantly moderate and strengthens the positive relationship between tri-ability of technology and adoption of green innovation.

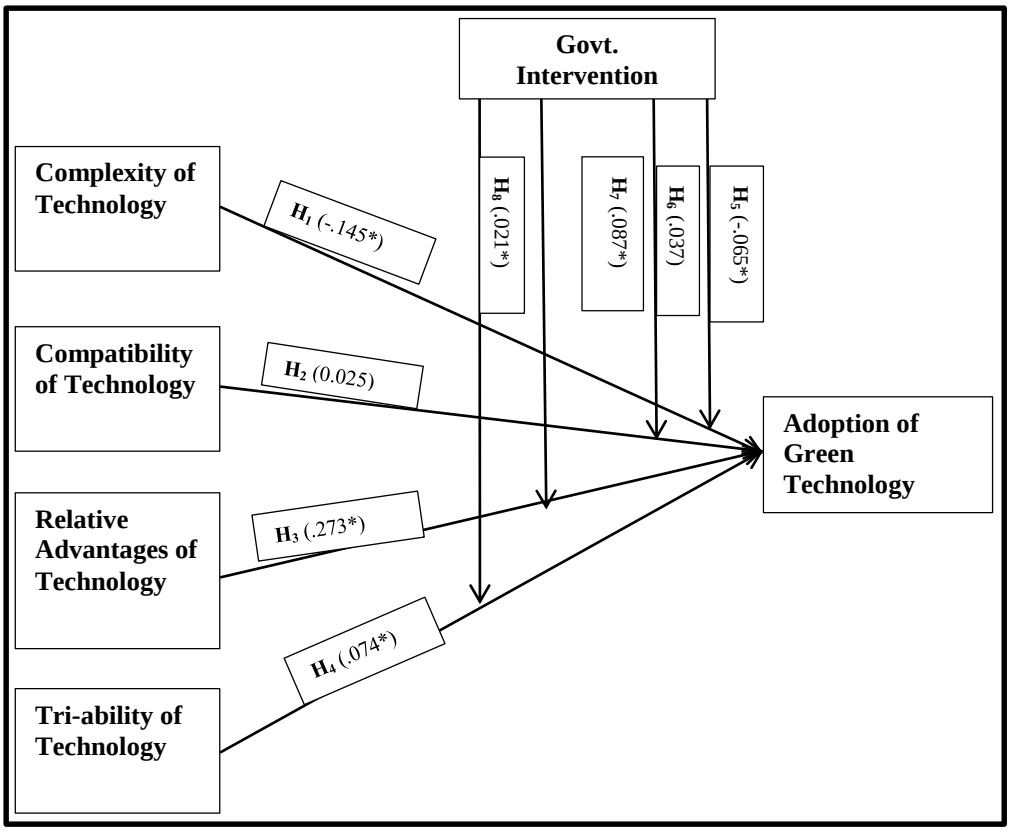

Figure 2: Relationship between Tri-Ability of Technology and Adoption of Green Innovation

4. Discussion of Results

This study used combine perspective of innovation theory and theory of planned behavior to develop a comprehensive research model. This study used innovation theory to define green innovation and used the theory of planned behavior to explain that how perception about green innovation affect adoption of green innovation.

This study used regression analysis to investigate that whether adoption of green innovations are influenced by proposed technological factors and found some interesting finding. Table 7 shows standardized findings of regression analysis. The results support the H_1, H_3, and H_4. Similarly, the results of hierarchical regression support the hypothesis H_5, H_7, and H_8. The results of multiple regression analysis indicated that complexity of technology negatively and significantly affect the adoption of green innovations, it implies that SMEs with lack of technical experts or human capital are less willing to adopt green innovations, as innovations become simple, easy to learn and use then SMEs will explicitly adopt green innovations and play their role to reduce global warming. Our results are consistent with the studies which documented that organization are not interested to adopt that innovations which they perceived complex and demands a high level of expertise from employees (Brandyberry, 2003; Dwivedi et al., 2009).

Hence, the negative impact of complexity on green innovation implies that SMEs should spend their resources on the accumulation of environmental knowledge and on employees

training and expertise to reduce the perceived complexity of technology (Al-Qirim, 2005). The process of environment knowledge accumulation will enhance employee's experience that further reduce the perceived complexity and increases the probability of adoption of green innovation. Moreover, knowledge sharing process will readjust the values and operational system of the organization in the favour of green innovation.

Similarly, SMEs are more willing to adopt the green innovation, when they perceive that green innovation has greater economic and financial advantages than existing technology. The results also suggest that as relative advantages increases, the willingness of SMEs to adopt green innovation increases, so there is a positive and significant association between relative advantage and green innovations. The results suggest that organizations must recognize the benefits of green innovation over existing technology while making a decision regarding adoption of innovations because organizations are more willing to opt innovations which has the ability to fill their financial performance gap (Tornatzky & Klein, 1982).

Moreover, Results indicated that if SMEs have more opportunities to try the green innovation before adoption, they are more willing to adopt that innovation. So, tri-ability of technology positively and significantly affects adoption of new innovations. Our results are consistent with Darley and Beniger (1981), who argued that when the organization will experience the advantage of the innovation before adoption and it will be more willing to adopt the innovation. This study implies that if the owner and manager of SMEs are convinced that adoption of green innovation increases their competitive advantages and financial performance, they will be more willing to adopt the green innovation (Aziz & Samad, 2016; Hassan et al., 2013).

The results of hierarchical regression indicated that government intervention significantly moderates between complexity, relative advantages, tri-ability and adoption of green innovations. The results of hierarchical regression indicate that external factor, government intervention, significantly moderate and weaken the negative relationship between the complexity of technology and adoption of green innovation through employing different tools like taxes and subsidies. So government support and regulatory pressure will promote adoption of green innovation among SMEs. Similarly, government intervention through training workshops to disseminate the environment knowledge for SMEs employees can increase the willingness of SMEs to participate in green supply chain initiatives. Our results imply that government should arrange experts which can efficiently analyze the cost and benefit analysis of the green innovation for SMEs and share their finding with the SMEs to motivate them for green innovation adoption for the preservation of natural environment.

5. Conclusion

This study found that there are some certain factors like complexity, technology, relative advantages and tri-ability of technology that significantly affect practices of adoption of green technology. However, the influence of compatibility and adoption of green innovations is not significant. The study found that complexity of technology is negatively and significantly related to adoption of green technology. Similarly, relative advantage and tri-ability have positive and significant relationship with the adoption of green technology. Moreover, government intervention plays a significant moderating role

between complexity, relative advantages and tri-ability of technology and green technology adoption.

5.1 Implications of the Study

The hypothesized model provides a deeper understanding of the relationship between technological factors and adoption of green innovation. The findings of this study can be of immense help in promoting the adoption of green innovation in SMEs. This study identifies four important technological determinants that can play important role in adoption of green innovation in SMEs Pakistan.

This study provides guidance to the managers in the arrangement of workshops and training for the engineers and technical workers to develop the attitude and knowledge to facilitates the process of adoption of green innovation.

5.2 Limitation and Future Research Direction

The findings of this study have limited generalizability because data has been collected in Pakistan in a specific context. However, the data obtained from other countries may have different implications. Future studies can use the proposed model in other sectors of the economy and in other countries. In addition, this study used the subjective response of the sample because of unavailability of objective measurements of green innovation adoption behaviors for the SMEs in Pakistan. This study may suffer respondent biasness because participants may record socially acceptable or rational responses. Future research can be used objective data to investigate SMEs‟ green innovation adoption behaviors.

Moreover, this study used only four technological factors like complexity, compatibility, technology benefits and tri-ability to develop a conceptual framework of the determinant of adoption of green innovation. Future studies can incorporate technology awareness of SMEs owners and their family background to develop an understanding of technological factors affecting adoption of green innovation. Similarly, future studies can improve the theoretical model by linking adoption of green innovation with a sustainable environment.

5.3 Recommendations

Based on the findings of this study, the following recommendations are made:

- Government should arrange training and workshop programs for SMEs employees to enhance their capabilities, so the perceived complexity will decreases and organization can easily adopt new innovations.
- Manufacturer of green innovation should provide opportunities to the organization that they can use and analyze the benefits of green innovation before adoption.
- Government should provide experts to SMEs who can successfully evaluate the benefits of green innovation over the existing technology, so the willingness in SMEs to adopt green innovations will increase.

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