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DRIVING FACTORS FOR GREEN INNOVATION IN VIETNAMESE CONSTRUCTION ENTERPRISES

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ABSTRACT

Purpose: The aim of this study is to examine the influences of different factors on green innovation in Vietnamese construction enterprises.

Theoretical framework: The theoretical framework is built upon the resource-based view, the model of organizational innovation, and stakeholder theory.

Design/methodology/approach: The research carries out a literature survey related to construction enterprises, then empirical analysis is conducted among 450 employees and managers at all level working in this field with the results analyzed using Cronbach's Alpha analysis, exploratory factor analysis, pearson correlation analysis, linear regression analysis and One - way ANOVA analysis.

Findings: The results demonstrate that using renewable energy is well represented for green innovation in the Vietnamese construction industry and quantitative results also show positive impacts of all factors studied on green innovation: Green dynamic capabilities, Green creativity, Green knowledge sharing, Corporate environmental ethics, Pressure from industry competitors and regulators. In addition, the result affirmed there are statistically significant differences in the level of green innovation between construction enterprises of size and age, but not types of firm.

Research, Practical & Social implications: The study proposes solutions for both enterprises and regulators – one of the external stakeholders to develop green innovation in the construction sector.

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FATORES QUE IMPULSIONAM A INOVAÇÃO VERDE NAS EMPRESAS DE CONSTRUÇÃO VIETNAMITAS

RESUMO

Objetivo: O objetivo deste estudo é examinar as influências de diferentes fatores na inovação verde em empresas de construção vietnamitas.

Estrutura teórica: A estrutura teórica é construída sobre a visão baseada em recursos, o modelo de inovação organizacional e a teoria das partes interessadas.

Projeto/metodologia/abordagem: A pesquisa realiza um levantamento da literatura relacionada a empresas de construção e, em seguida, a análise empírica é conduzida entre 450 funcionários e gerentes de todos os níveis que

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trabalham nesse campo, com os resultados analisados por meio da análise Alfa de Cronbach, análise de fator exploratório, análise de correlação de Pearson, análise de regressão linear e análise ANOVA unidirecional.
Conclusões: Os resultados demonstram que o uso de energia renovável é bem representado pela inovação verde no setor de construção vietnamita, e os resultados quantitativos também mostram impactos positivos de todos os fatores estudados na inovação verde: Capacidades dinâmicas verdes, Criatividade verde, Compartilhamento de conhecimento verde, Ética ambiental corporativa, Pressão dos concorrentes e reguladores do setor. Além disso, o resultado afirmou que há diferenças estatisticamente significativas no nível de inovação verde entre as empresas de construção de tamanho e idade, mas não entre os tipos de empresa.
Implicações sociais, práticas e de pesquisa: O estudo propõe soluções tanto para as empresas quanto para os órgãos reguladores - uma das partes interessadas externas - para desenvolver a inovação verde no setor de construção.

Palavras-chave: Inovação Verde, Capacidades Dinâmicas Verdes, Criatividade Verde, Partes Interessadas, Empresas de Construção.

FACTORES QUE IMPULSAN LA INNOVACIÓN ECOLÓGICA EN LAS EMPRESAS CONSTRUCTORAS VIETNAMITAS

RESUMEN
Objetivo: El objetivo de este estudio es examinar la influencia de distintos factores en la innovación ecológica de las empresas vietnamitas de construcción.
Marco teórico: El marco teórico se basa en la visión basada en los recursos, el modelo de innovación organizativa y la teoría de las partes interesadas.
Diseño/metodología/enfoque: La investigación realiza un estudio de la bibliografía relacionada con las empresas de construcción y, a continuación, se lleva a cabo el análisis empírico entre 450 empleados y directivos de todos los niveles que trabajan en este campo, analizándose los resultados mediante el análisis alfa de Cronbach, el análisis factorial exploratorio, el análisis de correlación de Pearson, el análisis de regresión lineal y el análisis ANOVA unidireccional.
Conclusiones: Los resultados muestran que el uso de energías renovables está bien representado por la innovación verde en la industria vietnamita de la construcción, y los resultados cuantitativos también muestran impactos positivos de todos los factores estudiados sobre la innovación verde: capacidades dinámicas verdes, creatividad verde, intercambio de conocimientos verdes, ética medioambiental corporativa, presión de los competidores y reguladores de la industria. Además, el resultado afirma que existen diferencias estadísticamente significativas en el nivel de innovación verde entre las empresas de construcción de tamaño y edad, pero no entre los tipos de empresa.
Repercusiones sociales, prácticas y para la investigación: El estudio propone soluciones tanto para las empresas como para los reguladores -una de las partes interesadas externas- para desarrollar la innovación verde en el sector de la construcción.

Palabras clave: Innovación Verde, Capacidades Dinámicas Verdes, Creatividad Verde, Partes Interesadas, Empresas de Construcción.

INTRODUCTION

Environmental pollution and climate change have become one of the biggest concerns worldwide. Enterprises, the key driver for national economic development, are identified as the factors that consume the largest amout of water, energy, raw materials and have bad effects on the ecology. The global context as well as stakeholder pressure force firms to apply green strategies into their operations process. Enterprises of all sectors must innovate toward sustainable development when the limited natural resources are depleting gradually day by day. As environmental degradation is becoming more and more detrimental, green innovation has

appeared as a possible solution and brought multiple benefits to enterprises particularly and the whole society in general (Noronha et al, 2023). Recent studies have affirmed that firms which embed green elements in product and process imprment have more oppoturinities to achieve success in terms of market share, ecological reputation and financial performance (Abrudan et al, 2022; Chen, 2008). Besides, companies that pioneer in green innovation will receive "first - mover advantages" that allow them to assess higher prices for their green products as well as improve their brand images in the eyes of authorities and customers (Hart, 1995). Green innovation has a positive impact on competitive advantage for corporations compared to their competitors in the same industry (Chen et al., 2006).

In today's world, green innovation is mainly approached and explored in developed countries such as the United States, China and Europe, although unsustainable production activities mostly come from developing and industrializing countries like Vietnam. In these developing country, there are limited number of researches focuesd on green issues that has not been widespread to companies even though pollution is getting more and more serious (Hung et al., 2022). According to Hung et al., 2022, none of the past studies focused on the influence of different internal and external elements on green innovation performance, especially empirical studies. From the view of Vietnamese industrial structure, construction is one of the key industries creating the motivative growth of the national economy. This sector accounts for 37.86% of GDP in 2021, contributing 63.8% to the growth rate of the total added value of the whole economy compared to 2020 (Vietnam GSO, 2021) However, this industry also causes a huge impact on the environment (Hang, 2022), contributes about 23% to air pollution and 40% to drink water pollution (Vietnam GSO, 2021). How green innovation in this sector is happening and what are the key factors that motivate or hinder the implementation of green innovation in the industry requires more specific researches. Compared to the conventional innovation, the study of environmental innovation is new and still a grey area in the Vietnamese construction sector.

Therefore, this study concentrates on analyzing and evaluating factors affecting green innovation in construction enterprises in Vietnam. The main quantitative research methods used in this paper are regression analysis, combining descriptive statistics; comparing and synthesizing relevant documents. From the findings, we propose solutions toimprove green innovation for construction companies in the near future. The structure of this research paper consists of 6 parts: (i) Introduction, (ii) Literature Review, (iii) Theoretical Framework, (iv)Data and Methodology, (v) Results and Discussions, (iv) Contributions and Implications

LITERATURE REVIEW

Previous studies in the world have clarified the theory of green innovation as well as the factors effected on green innovation through empirical research in different fields and regions. Each studies has distinguish perspective of approaches and subjects.

Resources and capacity factors play key roles in company's green innovation. For example, Guo et al (2020), Aftab et al (2022) claimed that environmental ethics positively influenced green product and process innovation. In addition, knowledge sources, especially green knowlegde is considered as an important non-physical resources. Zhou et al (2020), Alzuod (2020) showed that knowledge sharing stood as intergal part of achieving green innovation. Promoting green knowledge sharing makes a big contribution to the success of green product development in a era of knowledge and information (Chang and Hung, 2021). Capability factor is also crucial for a company to attain environemtal innovation and sustainable competitive advantage. That's why some previous researches have shown both direct and indirect influences of capability factors on enterprises' green innovation.

Khan et al (2021) suggested that green supply chain management practices positively affected green innovation then enhanced the firm financial and environmental performance. Meanwhile, the increase of (green) dynamic capabilities helps to improve green innovation (Nassani et al, 2022; Yousaf, 2021; Yuan and Cao, 2022). Awan et al (2019), Zameer et al (2020), Song et al (2020), Malik et al (2021) added the indicator of green creativity as a key antecedents of green innovation. On the other hand, according to Li et al (2019) a firm's learning orientation, as well as market orientation is important driver for green innovation in a dynamic environment.

Having the same approach to stakeholder theory, previous studies have shown different influences of each member of the stakeholder on corporate green innovation. According to Shukla (2019), when service companies experienced excessive demands from internal and external stakeholders to minimize the ecological impact, the managers are predicted in upgrading their technological capabilities and practicing green innovation to attain effectiveness in making sustainable business decisions. Conducting research at Chinese express companies, Zhang et al (2020) affirmed that only the platform pressure was significant with the adopting intentions to green innovation while government pressure and customers pressure did not affect. Contrary to expectations, Thomas et al (2022) revealed that public administrations exert a negative influence; that is, they appear to hinder SMEs approach towards green innovations. Rui and Lu (2021) confirmed that stakeholders' regulatory pressure, normative

pressure, and imitation pressure from three aspects: government, customers,competitors can promote green innovation.

In Vietnam, green innovation has been studied very limitedly, although there has been initial steps to mention the importance of innovation and environmental protection in firm. Researching on innovation in the hotel, Ha (2020) focused on green product and process innovation, show that current general development trend of green innovation is to minimize negative impacts on the natural environment. Research results confirmed the importance of accessible knowledge as well as the ability to find and use knowledge to develop green innovation activities. Tinh (2020) researched about the drivers of the success of green new products at plastic enterprises in Ho Chi Minh. The result showed that green product innovation, green process innovation and risktaking had positive effects on the success of green new products.

There are quite a few studies on the factors affecting green innovation, but the research results in this field are not consistent and still controversial. In addition, studies on green innovation in Vietnam remain very limited as many typical factors (such as green dynamic capabilities, stakeholders pressure, green creativity, …) have not been considered yet. Green innovation in construction industries has been examined, but has not been studied intensively and comprehensively on the influencing factors in the context of Vietnam. The authors find that the above gaps are the premise and directions that can be exploited most effectively in this topic.

THEORETICAL FRAMEWORK

According to Hart (1995), resources consist of tangible assets (factory, finance, employees, ...) and intangible assets (technology, reputation, business know-how, ...) of the enterprise. Resources that create competitive advantage have four main characteristics include: valuable, rare, imperfectly imitable and non-substitutable (Barney, 1991). The *resource-based view* indicates that the company should be concerned not only with profitability in the present and growth in the medium term, but also with its future position and source of competitive advantage. Therefore, Hart (1995) asserted that it is necessary to add the ability to orient on the environment in the organization when business activities highly depend on the ecological environment.

In *The model of organizational innovation*, Amabile (1988) pointed out that innovation is a process consisting of 5 steps in order: setting the agenda, setting the stage, producing the

ideas, testing and implementing the ideas, outcome assessment. According to the author, the fact that individuals or small groups in departments work together to create new and useful ideas plays an important role at all steps of innovation implementation. So if creative ideas are not generated, there will be no innovation in the organization. Firms need creative ideas before they can develop and implement them.

Being judged as an alternative to shareholder theory, *stakeholder theory* was defined by Freeman (1984): "Stakeholders are any groups or individuals can influence or be affected when the organization reaches its targets, including shareholders, customers, employees, suppliers and regulators, competitors, environmentalists and critics". Accordingly, organizations must consider the contrasting interests of all other stakeholders who may influence or be affected by the achievement of organizational goals (Freeman, 1984). These stakeholders both contribute and exert strong pressure on the organization's operations and development. Therefore, in the process of operation, companies always need to consider the impact of pressure from stakeholders.

Green Innovation

Innovation – The predecessor of green innovation was first proposed at micro level by The Organization for Economic Co-operation and Development (OECD) as the improvement or implementation of a new product (good/service) or a new process, a new marketing method or a new way of organizing in business practice, within organization or in relation to the outside. The definitions of Chen et al. (2006) and Rennings (2000), defined that *Green innovations are innovations in the hardware or software of green products or green processes, including technological innovations to save energy, pollution prevention, waste recycling, green product design or corporate environmental governance* were accepted by many other scholars such as Chang (2011); Huang & Li (2015); Song & Yu (2017). We also decided to use Chen et al. (2006)'s definition about green innovation in this research.

Since its inception, green innovation has brought many benefits for human kind. *For the whole society*, especially with the high-level competitive industry in the global , green innovation is considered highly integral (Ar, 2012). Green innovation gradually changes cognition and productive model of nations toward clean and environmentally friendly technology, reduction on toxic gases and pollutants. Carrion-Flores and Innes (2010) stated that green innovation helps to decrease toxic chemicals releasing, put recyclable materials into real products and consolidate the relationship between businesses and government, consumers or

non-governmental organizations which have the same targets of environmental protection. *For businesses*, green innovation can help increasing effectiveness of resources consumption, potentially have a positive effect on financial performance (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013) in long-term due to the reduction of unnecessary costs, time, money and resources required. Not only does green innovation maintain the organizational profit margin, but also it can provide more profit from improvement (Chang, 2011). Besides, green innovation develops green image, helps corporates gain advantages of public judgement, increase firms' reputation (Weng et al., 2015) and reinforces green advantages (Amores et al., 2014; Chen et al., 2006). Ghisetti and Rennings (2014) emphasized the role of green innovation in establishing company protection for improvement and long-term development through fundamental of irreproducible or inflexible innovation such as continuously applying product differentiation.

Driving Factors for Green Innovation and Research Hypothesis

Along with corporate social responsibility, business ethics have been considered as an important driver of business management and administration in the modern context, when the responsibilities of executive board is not only gaining profit for the shareholders but also contribution to sustainable development for all stakeholders. Guo and Yang (2020) explicated that corporate environmental ethics (CEE) as "*an element of corporate culture that integrates environmental awareness into decision-making and formalizes green beliefs and ethics through environmental policies"*. Based on natural resources' perspective (Hart, 1995), CEE associates with innovation by establishing environmental policies and practical activities, therefore, improves firm's image and reputation, pave the way for financial position (Peng and Lin, 2008). Besides, the greater concerns of executive broad are, the larger domain and faster speed at which the company react to issue is (Eiadat et. al., 2008). Meanwhile, the explicit CEE policies will trigger active environmental activities of company's members, facilitate green innovation (Chen and et. al., 2006; Porter and van der Linde, 1995). Previous researches showed resemble relationship between CEE and green innovation in businesses. From resources-based view, Chang (2011) concluded that CEE has positive influence on both green product innovation and green process innovation. The same conclusion could be seen in studies of Chen and Chang (2013), El- Kassar et al. (2019), Guo and Yang (2020). Consequently, this research paper implies the following hypothesis:

Hypothesis 1 (H1): Corporate environmental ethics (CEE) has positive effect on green innovation.

Under the pressure of innovation and sustainable requirements nowadays, definition of green creativity (GC) was proposed by Chen and Chang (2012) as "*the development of new ideas about green products, green services, green processes, or green practices that are judged to be original, novel, and useful"*. Deriving from the model (Amabilie, 1988), there will be not any innovation without creative ideas, thus, this factor plays an essential role on innovation process (Anderson et. al., 2014). Ireland and Webb (2007) stated that ideas came from the fluctuation of dynamic environment should be considered carefully in order to put into practice. Therefore, the impact of creativity on innovation will be even more considerable and apparent in dynamic instead of static environment (Baron and Tang, 2011) because green initiatives which were developed on basis of green creativity are acknowledged to be vital fuels for environmental innovative activities. Many researches had the identity result that green creativity positively affects green innovation in organization and business such as Song and Yu (2017), Malik et al. (2021). Consequently, this research paper implies the following hypothesis:

Hypothesis 2 (H2): Green creativity (GC) has positive effect on green innovation.

According to the resource-based view and the change of business environment, dynamic capabilities are firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece et. al., 1997). With contemporary trend, dynamic capabilities can be used in order to develop and promote green initiatives by seize the potential opportunities, integrate resources depending on the changing environments. Chen and Chang (2013) clarified green dynamic capabilities (GDC) as "*the ability of a company to exploit its existing resources and knowledge to renew and develop its green organizational capabilities to react to the dynamic market"*. The more abilities a firm have to quickly adopt required changes related to environmental management, the higher level of development of green innovation that firm can have (Sun et al. 2020). The firm which has strong green dynamic capabilities can recognize the opportunities to create green business processes (Teece et. al., 1997; Teece, 2007; Teece, 2018), innovate effectively (Huang and Li, 2015; Lin and Chen, 2016); even can gain the successful product development (Chen and Chang, 2013) and firm performance (Chen et. al., 2015).

In today's fluctuating business environment, firms need green dynamic capabilities to innovate greenly through grabbing potential opportunities, quick adaption and the complete changes in not only products but also company's process. Many previous researches had the identity result when green dynamic capabilities positively affect green innovation in business

such as Huang and Li (2017), Lin and Chen (2016), Yousaf (2021), Singh et al. (2022), Rajkamal et al. (2022). Consequently, this research paper implies the following hypothesis:

Hypothesis 3 (H3): Green dynamic capabilities (GDC) has positive effect on green innovation.

Green knowledge sharing (GKS) was originally proposed by (Lin and Chen, 2016) as "*synthesis and sharing environmental knowledge throughout by members in the organization*". According to the resource-based view, knowledge is regarded as a vital intangible resource (Van der Hoof and Leeuw van Weenen, 2004), therefore, green knowledge sharing is an effective way to utilize resources, supporting innovation process and forming the core competence of corporate (Wong, 2013). Sharing information about environment help to not only renovate product but also build the foundation for effective and synchronic office working process innovation. Because encouragement knowledge sharing is not costly but can motivate greening company's products and process (Lin and Chen, 2016).

Although Hou et al. (2017) studying about Chinese manufacturing industry from 2008 to 2014 declared significantly negative effect of knowledge sharing on the growth of green innovation, the other scholars, for instance, Kamasak and Bulutlar (2010), Nonaka (1991), O'Neill and Adya (2007) claimed that if a firm has professional standards for knowledge sharing, it will have stronger capabilities to innovate products and processes. Having the same perspective, Lin and Chen (2016), Abbas and Sagsan's (2019), Alzuod (2020), Zhou et al. (2020) stated that green knowledge sharing influences firms' green innovation positively. Consequently, this research paper implies the following hypothesis:

Hypothesis 4 (H4): Green knowledge sharing (GKS) has positive effect on green innovation.

We need to base on domain and subjects of the research to analyze a firm's stakeholders. Therefore, we rely on Weng et. al. (2015) to clarify five primary stakeholders including external stakeholders (competitors and regulators) and internal stakeholders (customers, suppliers and employees) as these are common stakeholders in construction industry.

Regulators can affect the firms' environmental management by laws and policies (Huang et. al., 2009). These changes put pressures on firms to adjust decisions and green innovation process (Huang et. al., 2009; Hsu et. al., 2013; Rui and Lu, 2021; Weng et al, 2015; Zhang and Zhu, 2019). Moreover, pressure from regulators can have the biggest impact on green innovation (Rui and Lu, 2021).

When industry competitors offer new green products or processes, corporate may face the pressure to reevaluate its innovative capabilities and compare itself to the industry standards to make the proper adjustion (Weng et. al., 2015). This is assumed as normative pressure from competitors (Lin et al, 2014; Peng and Wei, 2015); so that corprorates have to make decision to increase or promote green practices in their companies if they do not want to lose their competitive advantages when there is a considerable trend of environmental innovation in most major industries of the economy. Hence, pressure from competitors influences green innovation positively (Hsu et. al., 2013; Huang et. al., 2009; Rui and Lu, 2021; Weng et. al., 2015). Consequently, this research paper implies the two following hypothesises:

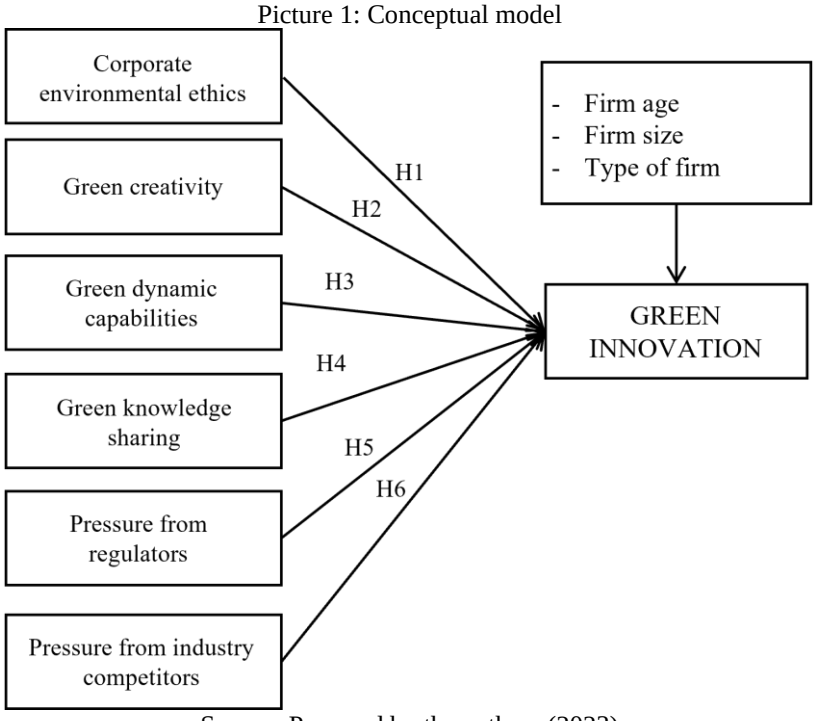
Hypothesis 5 (H5) Pressure from regulators (PFR) has positive effect on green innovation.

Hypothesis 6 (H6) Pressure from industry competitors (PFIC) has positive effect on green innovation.

Research Model

Based on the above theories and analysis, we proposes a research model with 06 independent variables and 01 dependent variable. Besides, in order to examine different level of green innovation in enterprises with different characteristics, we decide to use: size, age, type of firms as control variables.

Picture 1: Conceptual model



Source: Prepared by the authors (2023)

METHODOLOGY

Data collection

The authors use research data including both primary and secondary data. Secondary data is collected through corporate reports or articles, scientific research topics.

Primary data was collected by means of online (Google forms) and offline (paper survey) methods for those who belong to the business leadership such as directors, deputy directors and employees fully grasp relevant information of construction enterprises in Vietnam. Enterprises surveyd include: contractors; construction consultants; enterprises producing technological equipment and construction materials and enterprises investing in construction. The time to take place is from November 20, 2021 to March 20, 2022.

Measurement Variables

The measurement of the questionnaire items in this study is by use of five-point Likert scale from 1 to 5 rating from strongly disagreement to strongly agreement.

Green innovation is measured by 7 items, which 6 of them developed from Chen et al.'s research (2006) while the last items was proposed by the authors' of this paper. Corporate environmental ethics is measured by 4 items developed from Chang (2011). Green creativity is measured by 6 items developed from Chen and Chang (2013). Green dynamic capabilities is measured by 5 items developed from Chen and Chang (2013). Green knowledge sharing consists of 7 items adapted from Abbas and Sağsan (2019), Lin and Chen (2016), Rubel et al (2021). Pressure from regulators includes 5 items developed from Qi et al (2010), Rui and Lu (2021). Pressure from industry competitors: includes 5 items and refers to Christmann (2004), Hsu and et al (2013).

The deatailed questionnaire is fully expressed in Appendix 1.

Data Analysis

The authors use SPSS 26.0 software to analyze the data. The steps of data analysis include: (1) Checking the reliability of the scale by Cronbach's Alpha coefficient, (2) EFA factor analysis to check convergence, and eliminate unsatisfactory know-how, (3) Pearson correlation analysis, (4) Linear regression analysis to verify the influence of factors on the dependent variable, (5) One - way ANOVA is used to examine the difference in green innovation of construction enterprises with different characteristics in terms of: size, operating time and business type.

RESULTS AND DISCUSSION

Sample Description

The total questionaires collected was 472 . After removing 22 unqualified ones, the number of valid questionaires included in the analysis was 450, equivalent to 95.3%.

About the types of construction enterprise where respondents are working, the number of people coming from joint stock companies makes up the largest share (60.2%), the rest are representatives from private enterprises and partnerships (21.8%), limited liability company (18.0%). Regarding the age of companies, most managers and employees participating in the survey come from enterprises with an average age (10-30 years). The number of respondents from companies with less than 100 employees accounts for the majority with 49.8%, the rest are managers and employees from businesses with 100 - 200 people (27.6%) and more than 200 people (22.7%).

Reliability and Validity

Cronbach's Alpha test removes one item – GKS(3) because the total correlation coefficient is less than 0.3. After removing this item, all constructs have Cronbach's Alpha coefficients > 0.7 and the remaining items all have the total correlation coefficients greater than 0.3, suitable for next analyzing step.

Table 1: The Cronbach's a coefficients of the constructs

Constructs	Numbers of items		Cronbach Anpha coefficient
	Before	After	
Corporate environmental ethics	4	4	0.789
Green dynamic capabilities	5	5	0.810
Green creativity	5	5	0.788
Green knowledge sharing	7	6	0.822
Pressure from regulators	5	5	0.817
Pressure from industry competitors	5	5	0.814
Green innovation	7	7	0.847

Source: Prepared by the authors (2023)

Exploratory Factor Analysis (EFA)

First factor analysis results: GKS(6) is excluded because this item is uploaded in both factor groups 1 and 3. At the same time, the test also removed item PFIC(5) because this item has loading coefficient less than 0.5. The remaining items meet the requirements of separation and convergence between groups; also, all items have factor loading coefficients greater than

0.5, showing that these observed variables are statistically significant for inclusion in the next analysis steps.

Second factor analysis results:

Table 2: Results of exploratory factor analysis (EFA).

	KMO and Bartlett	Sig	Number of factors	Number of items	Accumulation percentage of explained variance (%)
Independent variables	0.916	0.000	6	28	58.214%
Dependent variable	0.894	0.000	1	7	52.275%

Source: Prepared by the authors (2023)

Independent variables

The second EFA analysis results remains 28 items of 6 independent variables. The KMO coefficient of Barlett's Test is 0.916 > 0.5 with significance level sig = 0.000 < 0.5, so the data used for factor analysis is appropriate. Eigenvalues of the first 6 constructs > 1, so only 6 groups of construct are created, completely consistent with the original model of 6 factor groups. The total variance extracted was 58.214%,, which means that 6 independent variables extracting 58.214% from 28 observed variables. The model after EFA analysis with the independent variable is evaluated as suitable.

Dependent variable

The KMO coefficient of Barlett's test is 0.894 > 0.5 with the significance level sig = 0.000 < 0.5, the items are correlated with each other, so the data used for factor analysis is appropriate. The analysis results only have one Eigenvalues > 1, so only one dependent variable is created, which coincides with the Green innovation variable in the proposed model. The cumulative explained variation is 52.275%, indicating that the above factor explains 52.275% of the variation of 7 items

Correlation Analysis

Table 3: Descriptives and correlation coefficients between the constructs

	Mean	SD	GI	CEE	DC	GDC	GKS	GFS
GI	3.812	0.638						
CEE	3.833	0.862	0.449**					
GC	4.051	0.780	0.584**	0.357**				
GDC	4.058	0.738	0.577**	0.407**	0.387**			
GKS	4.033	0.764	0.518**	0.349**	0.433**	0.394**		

PFR	4.062	0.773	0.527**	0.386**	0.533**	0.445**	0.456**	
PFIC	4.096	0.764	0.443**	0.325**	0.395**	0.297**	0.480**	0.457**

Note: * p < 0.05, ** p < 0.01
Source: Prepared by the authors (2023)

The results show that the sig of Pearson correlation between the independent variables (CEE, GC, GDC, GKS, PFR, PFIC) and the dependent variable (GI) are all < 0.05, which shows that 6 independent variables are correlated with the dependent variable. The correlation between Green creativity and Green innovation is the strongest (r = 0.584) and with Pressure from industry competitors is the weakest (r = 0.443). It can be seen that between the variables, correlation coefficients are not exceeding 0.8. We conclude that there is no multicollinearity between the independent variables and the dependent variable as well as between the independent variables.

Regression Analysis

The linear regression analysis by the one-pass method (Enter) with 6 independent variables, namely CEE, GC, GDC, GKS, PFR, PFIC and the dependent variable Green Innovation shows the result in Table 4.

Table 4 : Empirical results of regression analysis

Model	Coefficients[a]						
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
Constant	0.398	0.151		2.645	0.008		
CEE	0.081	0.027	0.109	2.965	0.003	0.745	1.341
GC	0.226	0.033	0.277	6.952	0.000	0.639	1.565
GDC	0.254	0.033	0.294	7.742	0.000	0.701	1.427
GKS	0.132	0.033	0.158	3.975	0.000	0.643	1.556
PFR	0.076	0.035	0.092	2.199	0.028	0.577	1.734
PRIC	0.078	0.032	0.093	2.413	0.016	0.680	1.471

Source: Prepared by the authors (2023)

The sample regression equation is rewritten with the normalized regression coefficient as follow:

GI = 0.109*CEE +0.277*GC + 0.294*GDC + 0.158*GKS + 0.092*GFR + 0.093*GFIC

Regression result shows that the adjusted R2 value is 0.546, meaning 54.6% the change of green innovation is explained by 6 independent variables, the remaining 45.4% is due to out-of-model variables and random error. The model does not have autocorrelation (DW = 1,710)

and multicollinearity (VIF < 2). At the same time, the sig of t-test of 6 constructs are all < 0.05, which means that the factors included in the model are appropriate and statistically significant at the 5% level of significance. Thus, hypotheses H1, H2, H3, H4, H5, H6 are accepted with 95% confidence level, meaning that 6 factors: Corporate environmental ethics, Green creativity, Green dynamic capabilities, Green knowledge sharing, Pressure from regulators, Pressure from industry competitors have positive impacts on Green Innovation in Vietnamese construction enterprises.

In particular, the influence of 6 factors according to the degree of the normalized coefficient β are following: Green dynamic capabilities (β = 0.294); Green creativity (β = 0.277); Green knowledge sharing (β = 0.158); Corporate environmental ethics (β = 0.109); (β = 0.196); Pressure from industry competitors (0.093) and finally Pressure from egulators (β = 0.092).

Difference Analysis

To examine the influence of characteristics including: size, age, type of business on green innovation of construction enterprises in Vietnam, firstky we use Levene test to check if the variances of the groups are equal, then use the results of Welch test or the F test to draw conclusions about the differences.

Table 5 : Results of One – way ANOVA test

Complementary hypothesis	Sig. (Levene test)	Sig. (Welch test)	Conclusion
There are differences in green innovation between types of construction enterprises	0.161 > 0.05	0.087 > 0.05	Rejected
There are differences in green innovation between sizes of construction enterprises	0.035 < 0.05	0.000 < 0.05	Accepted
There are differences in green innovation between ages of construction enterprises	0.0 2< 0.05	0.000 < 0.05	Accepted

Source: Prepared by the authors (2023)

About types of enterprises

The results in Table 5 show that the Sig value of the Levene test is 0.161 > 0.05, indicating the variance between types of enterprises is not different. Besides, the Sig value of Welch test is 0.087, also > 0.05. Therefore, at the 95% confidence level, there is no statistically significant difference in the level of green innovation between construction enterprises of different types.

About sizes of enterprises

Based on the results of Table 5, the Sig value of the Levene test is 0.035<0.05, showing that there are differences in variance between groups in terms of size of enterprises. Next, the result of Welch's Sig test is 0.000 < 0.05, showing that there are statistically significant differences in green innovation of enterprises based on different enterprise sizes. The larger size, the higher green innovation level of the enterprise: Under 100 employees (3.49), from 100 to less than 200 employees (3.86), over 200 employees (4.46).

About the ages of enterprises

According to Table 5, the Sig value of Levene test is 0.02 < 0.05, showing that there are differences in variance between groups in terms of ages of enterprises. Next, the Welch test gives Sig = 0.000 < 0.05, which proves that there is a statistically significant difference in green innovation of enterprises based on the ages of different enterprises. The more years of operation, the higher green innovation level of the enterprise: under 10 years is the lowest (3.39) and the highest is over 50 years old (4.44).

DISCUSSION

Green Dynamic Capabilities: When the green dynamic capabilities of enterprises increases, they respond and adapt faster, so green innovation will rise in both size and quality. In details, Green dynamic capabilities enhances green innovation of enterprises by promoting companies' responds to environmental changes and regulations through green strategic goals, green management, R&D and applying green technologies, knowledge and techniques. Besides, green innovation is gradually becoming an urgent requirement but often associated with high risks. This requires businesses to flexibly seize green business opportunities and quickly adapt to reduce risks. At this time, green dynamic capabilities become an important factor to promote green innovation and determining the success of the innovation. Many reseachers also share the same results, such as: Chen et al (2015), Eriksson (2014), Huang and Li (2015), Lin and Chen (2016), Singh et al (2022), Yousaf (2021).

Green creativity: Creativity brings unique ideas which are different from previous products and processes. Also, these suggestions are useful with many outstanding advantages which overcome limitations of old products. When green creativity is enhanced, new ideas which increase in both quantity and quality are considered and selected by businesses before turned into specific inventions and actions. This effect is even easier to be observed in

construction industry which has the most direct and significant impact on environment at any stages of its process. Therefore, almost every useful creative ideas can directly improve the development of green innovation. This result is similar to the research of Malik et al (2021), Song and Yu (2017).

Green knowledge sharing: Green innovation includes the process of improving and developing product. These activities require lots of specialized as well as general knowledge related to the environment. Sharing green knowledge will help spread, communicate, improve understanding, and build common knowledge of whole enterprises. In addition, this factor promotes sharing and cooperation between stages and departments, transforming knowledge into representative knowledge for organization to apply, helping managers with decision making and employees for implementing green innovation. Therefore, sharing green knowledge will create necessary resources to help businesses innovate greenly. This is consistent with previous research results of Abbas and Sagsan's (2019), Alzoud (2020), Lin and Chen (2016), Zhou et al (2020).

Corporate environmental ethics: Corporate environmental ethics expresses through the environmental policies of enterprise. Especially, in the fields which have significant impacts on the environment as construction, requirements of choosing green materials or green suppliers, ensuring pollution reduction during construction, ... are the fundamentals of specific and particular actions to protect the environment and businesses can make green innovation become more and more popular. In addition, businesses that have a long-term plan and vision, placing the environment in a prioritized position in their operations also tend to innovate greener. The studies of Chang (2011), Chen and Chang (2013), El-Kassar et al. (2018), Guo and Yang (2020) all show similar results.

Pressure from industry competitors and regulators: Firstly, the construction market in Vietnam is still not fully-developed and diversified, leading to a relatively large value dependence among small and medium-sized construction enterprises which do not have enough resources to innovate, creates little process innovation for businesses that hold less important positions in value chains and supply chains. In addition, the market trend of sustainable development has opened more niche markets for construction enterprises such as specializing in research and development of green materials, green buildings,... Projects which have international certification of green buildings are interested by many businesses because of their prestige and scale. That means the levels of competition in these new markets are also very high, however, most Vietnamese construction enterprises still do not have enough resources to

compete with foreign competitors with strong resources - abundant capital, advanced technology, large scale and long operating years. Besides, it is shown that Vietnamese construction enterprises are not aware of the long-term benefits in green innovation, but only focus on short-term profits. This phenomenon shows that it is difficult to encourage green innovation in organizations because they only passively change to meet the requirements of the States management agency. From the perspective of the relationship between enterprises and the States, great pressure can also appear due to the overlapping and inadequate policy systems, which only put administrative pressure on enterprises, not closely promote innovation by taking action in positive and proactive manners. This result is consistent with the studies of previous studies such as Huang et al. (2009), Hsu et al. (2013), Rui and Lu (2021), Weng et al (2015), Zhang and Zhu (2019).

CONCLUSION

This study makes significant contributions to the issue of green innovation in enterprises. A theoretical contribution of this study that can not be found in previous researches is scale development for Green innovation and Pressure from industry competitors, doing qualitative research, study find new observed variables to suit the actual situation of the construction industry in Vietnam. On the other hand, we find the following factors: Corporate environmental ethics; Green dynamic capabilities; Green creativity; Green knowledge sharing; Pressure from regulators; Pressure from industry competitors have a positive impact on green innovation of enterprises. Thereby, the results of quantitative analysis help business managers, government and employees understand the role of these factors.

From the results of this study we propose recommendations for construction enterprises as well as State management agencies to promote green innovation activities in the construction field in the coming time.

For Construction Businesses

Firstly, construction businesses should be aware of the importance of green dynamic capabilities, prioritizing in selecting managers with long - term vision to help businesses take advantage of green business opportunities. Empowering, establishing quick response teams who specialize in collecting information about the green construction market to flexibly assess the certainty of each opportunity, support managers' decisions in green innovation.

Secondly, businesses need to invest resources to develop RandD activities, orient employees and all company in particular on developing and using green products and green technology to position the differences of company. Constructing policies and reward mechanisms to encourage employees on carrying out green innovation.

Thirdly, Green knowledge sharing is considered as the most easily impacted factor to stimulate green innovation in construction enterprises. Companies should have regular meetings between departments to discuss major topics in green construction: green architecture, green building, green materials,… to balance financial capacity with ability to implement green innovation. Managers need to specify the level of information about the environment that each department needs to know, in order to improve the general knowledge base of whole organization.

Fourthly, to increase corporate environmental ethics, businesses need to actively realize this factor by specific items in the policy at work Reasonably allocating annual budget and other related resources for these policies and environmental issues. Regularly organizing training programs to improve environmental awareness and behavioral capacity of employees.

Fifthly,to turn pressure from regulators into a driving force for green innovation, it is essential to get rid of the short-term thinking that spending on the environment is an unnecessary investment; stop just wanting to deal with directives and environmental law. Proactively propos recommendations related to environmental management, policies and regulations for the Government, local authorities.

Finally,in the context of fierce competitive environment, in order to transform this pressure into a driving force for green innovation, enterprises need to continuously observe the improvement of competitors and analyze their strategic orientations in the field of green innovation, then integrate what can be learned from competitors Setting the goal of achieving green building certification or ISO 14001 as a signal to increase competitive advantage. Increasing research and cooperation with successful FDI construction enterprises in green innovation in Singapore, Korea, European countries, …. to transfer technology and improve quality of human resources. Enhancing exchanges between members in their supply chain, setting the goal of comprehensively greening the supply chain from production to design and construction.

For Authority

The government should subsidize green initiatives and provide financial support to businesses who volunteer to join in environmental programs. State management agencies need to coordinate with banks to promote the implementation of green credit packages, giving incentives to green construction projects. Organizingseminars on green innovation in the construction industry, to share experiences and green innovation methods. Building forums, promoting learning exchange between domestic and international businesses, between businesses and experts. In order to have clear references and instructions for businesses, the State needs to continue improving the system of policies that is not strict enough, reduce regulations and overlap. At the local level, the authorities need to pay attention to the actual environmental performance of companies, also should regularly check the environmental commitments that businesses accept to comply.

This study has made certain contributions, but there are still some limitations. Firstly, due to the issue of funding and time to conduct the survey at the time of the outbreak of the Covid-19 pandemic, the research sample may not meet the requirements of representativeness and generality well. Secondly, the researched enterprises have different products and operational processes, so it affects the analysis of results and proposes recommendations. Finally, green innovation in construction enterprises is also influenced by many factors stemming from the internal and external environment. From these limitations, there are gaps as well as opportunities to research more deeply in the future. About the survey subjects: for the construction sector, further studies should delve into each field of activity to make the research results more condensed and the proposed solutions more specific. In addition, research on factors affecting green innovation can be extended to many other industries. Besides, green innovation in construction enterprises can be directly influenced by many factors. Therefore, further studies can exploit other factors affecting green innovation in enterprises. In this study, the authors used a number of theories as a foundation: Natural - resource - based view, organizational innovation model of Teresa M. Amabile (1988), stakeholder theory. Therefore, in future studies, it is possible to supplement or select other theories to better clarify the green innovation of enterprises.

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APPENDIX

Measurement Scales Used in the Study

Configuration for all measurement scales: 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree.

Variables	Encryption	Indicators/observed variables
Green innovation	GI1	The company chooses the materials of the product that produce the least amount of pollution for conducting the product development or design.
	GI2	The company uses the fewest amounts of materials to comprise the product for conducting the product development or design.
	GI3	When develop or design product, the company would circumspectly deliberate whether the product is easy to recycle, reuse, and decompose for conducting the product development or design.
	GI4	The manufacturing process of the company effectively reduces the emission of hazardous substances or waste.
	GI5	The manufacturing process of the company reduces the consumption of water, electricity, coal, or oil.
	GI6	The manufacturing process of the company reduces the use of raw materials (sand, stone, cement, wood, etc.).
	GI7	The manufacturing process of the company uses renewable energy.
Corporate environmental ethics	CEE1	The company has concrete environmental policies.
	CEE2	The company has a budget to spend on purchases and investments that consider environmental factors.
	CEE3	The company has integrated its environmental plan, vision, or mission to its marketing events.
	CEE4	The company has integrated its environmental plan, vision, or mission to company's culture.
Green creativity	GC1	Company employees suggest new ways to achieve environmental goals.
	GC2	Company employees propose new green ideas to improve environmental performance.
	GC3	Company employees promote and champion new green ideas to colleagues.
	GC4	Company employees implement green ideas into a comprehensive plan.
	GC5	Company employees would find out creative solutions to environmental problems.
Green dynamic capabilities	GDC1	The company has the ability that can fast monitor the environment to identify new green opportunities.
	GDC2	The company has the ability to develop green technology.
	GDC3	The company has the ability to assimilate, learn, generate, combine, share, transform, and apply new green knowledge.
	GDC4	The company has the ability to successfully integrate and manage specialized green knowledge within the company.
	GDC5	The company has the ability to successfully allocate resources to develop green innovation.
Green knowledge sharing	GKS1	Employees in the company know exactly who to ask when they need information about issues in the market.
	GKS2	The company usually have meetings between departments to discuss market trends and developments.
	GKS3	The company's workspace is designed to help people easily communicate with each other.
	GKS4	The company actively encourages mentoring and consultation among employees.
	GKS5	Employees in the company often use electronic means (video, phone, internal software, ...) to communicate with each other in the company.

	GKS6	Company employees are expected to discuss with each other after going to seminars, symposia or exhibitions.
	GKS7	Company employees share environmental knowledge read from newspapers, magazines, television, ... with colleagues.
Pressure from regulators	PFR1	Environmental protection regulations in Vietnam are very strict.
	PFR2	Environmental protection regulations have a considerable impact on company.
	PFR3	Environmental protection regulations can effectively deal with issues regarding the greening of construction process.
	PFR4	Local governments are very concerned about enterprises' environmental practices.
	PFR5	Local governments regard environmental performance as an important indicator to evaluate the reputation of enterprises.
Pressure from industry competitors	PFIC1	The company's direct competitors set environmental standards for their products and operations.
	PFIC2	The company's direct competitors set environmental standards for their business strategies.
	PFIC3	The company's direct competitors believe that green innovation benefits operational activities.
	PFIC4	The company's direct competitors consider green innovation as a criterion to improve customers'belief.
	PFIC5	The company's direct competitors consider green innovation beneficial significant benefit compared to the cost.