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AN EMPIRICAL STUDY ON GREEN PRACTICE ADOPTION FOR SMES IN TAIWAN

Summary. This paper aims to analyze factors influencing the adoption of green practices for the small and medium-size enterprises (SMEs) in Taiwan from the perspective of technical innovation. The determinant factors consist of technological and organizational. Data to test research hypotheses came from a questionnaire survey on 219 SMEs in Taiwan. Research findings reveal that compatibility and relative advantage of green practices, organizational support and quality of human resources have significantly positive influences on the adoption of green practices for SMEs while the complexity of technology reveals significantly negative effects. Implications and opportunities for future research are also discussed in the paper.

Keywords: green practice adoption; technical innovation; determinants of innovation; SMEs

BADANIA EMPIRYCZNE NAD PRZYJMOWANIEM ZIELONYCH PRAKTYK PRZEZ MŚP NA TAJWANIE

Streszczenie. Celem niniejszego artykułu jest analiza czynników, wpływających na proces przyjmowania zielonych praktyk przez małe i średnie przedsiębiorstwa (MŚP) na Tajwanie, z perspektywy innowacji technicznej. Na determinanty składają się czynniki technologiczne i organizacyjne. Dane, które służą weryfikacji hipotez pochodzą z badań ankietowych, przeprowadzonych w 219 MŚP na Tajwanie. Wyniki badań wskazują, iż zgodność i względna przewaga zielonych praktyk, poparcie organizacyjne i jakość zasobów ludzkich wywierają znaczący, pozytywny wpływ na przyjmowanie zielonych praktyk przez MŚP, podczas gdy złożoność technologii wskazuje na znaczące efekty negatywne. W artykule również zostały omówione implikacje i przyczynki do dalszych badań.

Słowa kluczowe: przyjmowanie zielonych praktyk, innowacja techniczna, determinanty innowacji, MŚP

1. Introduction

While regarding commitment to the natural environment as an important variable within the business operation scenarios, an increasing number of companies all over the world are attentive to the concept of enhancing their competitiveness through improvements in the environmental performance, and mitigating the environmental impact of their production and service activities. This paper will focus on the green practice adoption of small and medium-size enterprises (SMEs) in Taiwan. Due to the global trend of environmental protection, SMEs in Taiwan have begun to take environmental issues into consideration. Company size has been repeatedly taken as a relevant organizational characteristic influencing companies' technical innovation¹ as well as environmental activities.² In general, large companies tend to adopt innovations and green practices more easily than small ones because they have sufficient resources and strong infrastructures. Small companies, in contrast, may suffer from the lack of financial resources and professionals, which results in difficulties in adopting green practices. Some researchers have analyzed the green behavior of SMEs.³ Much remains to be learned empirically about the factors influencing green practice adoption for SMEs.

Many researchers have proposed various explanations as to what factors influence firms' adoption of green practices.⁴ Stakeholder pressure, environmental regulation, company size, managers' characteristics, human resources and industry sector are relevant variables

¹ Frambach R.T., Schillewaert N.: Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. *Journal of Business Research* 2002, no 55, p. 163-176; Kimberly J.R., Evanisko M.J.: Organizational innovation: the influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal* 1981, no 24, p. 689-713.

² Del Brio J.A., Junquera B.: A review of the literature on environmental innovation management in SMEs: implications for public policies. *Technovation* 2003, no 23, p. 939-948; Etzion D.: Research on organizations and the natural environment, 1992-present: a review. *Journal of Management* 2007, no 33, p. 637-664; Gonzalez-Benito J., Gonzalez-Benito O.: A review of determinant factors of environmental proactivity. *Business Strategy and the Environment* 2006, no 15, p. 87-102.

³ Gadenne D.L., Kennedy J., McKeiver C.: An empirical study of environmental awareness and practices in SMEs. *Journal of Business Ethics* 2009, no 84, p. 45-63; Simpson M., Taylor N., Barker K.: Environmental responsibility in SMEs: Does it deliver competitive advantage? *Business Strategy and the Environment* 2004, no 13, p. 156-171.

⁴ Alvarez-Gil M.J., Berrone P., Husillos F.J., Lado N.: Reverse logistics, stakeholders' influence, organizational slack, and managers' posture. *Journal of Business Research* 2007, no 60, p. 463-473; Gadenne D.L., Kennedy J., McKeiver C.: An empirical study of environmental awareness and practices in SMEs. *Journal of Business Ethics* 2009, no 84, p. 45-63; Henriques I., Sadosky P.: The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academy of Management Journal* 1999, no 42, p. 87-99.

frequently appeared in related research.⁵ However, only a few studies analyze the green practice adoption behavior from the perspective of technical innovation. Applying environmental criteria into corporate operations requires exploring new resource combinations and deploying existing resources in new ways.⁶ Green practice adoption involves implementing new or modified processes, techniques and systems to reduce environmental harms. As innovation is the use of new technical and administrative knowledge, the adoption of green practices can be regarded as an innovation process.

Del Brio and Junquera⁷ have summarized some factors that influence green innovation management in SMEs, including financial resources, management style, human resources, manufacturing activity, technological approach, innovative capacity, and external cooperation. Rothenberg and Zyglidopoulos,⁸ in a study of the printing industry, found that the adoption of green innovations was positively associated with the dynamism of the company's task environment. Henriques and Sadorsky⁹ found that total quality management and external stakeholder pressure would increase the likelihood that Canadian manufacturing companies implement cleaner technical innovations. Most of them provide an insight into the influences of certain organizational and environmental factors on green innovation. However, scarce attention has been paid to how technological and organizational factors influence the adoption of green practices. Literature on technical innovation suggests that the nature of technology, and the capabilities of the organization are two general characteristics affecting the adoption of new technologies.¹⁰ Characteristics of a new technology such as compatibility, complexity, and relative advantage may affect its adoption.¹¹

To fill the research gap, the main purpose of this paper is to study the influences of technological and organizational factors on the adoption of green practices for SMEs. The next section formulates research hypotheses, and the third section describes the research methods. The fourth section discusses the research results, and the final section gives research conclusions and implications.

⁵ Etzion D.: op.cit.; Gonzalez-Benito J., Gonzalez-Benito O.: op.cit.

⁶ Hart S.L.: A natural resource-based view of the firm. *Academy of Management Review* 1995, no 20, p. 986-1014.

⁷ Del Brio J.A., Junquera B.: op.cit.

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⁹ Henriques I., Sadorsky P.: Environmental technical and administrative innovations in the Canadian Manufacturing Industry. *Business Strategy and the Environment* 2007, no 16, p. 119-132.

¹⁰ Chau P.Y.K., Tam K.Y.: Factors affecting the adoption of open systems: an exploratory study. *MIS Quarterly* 1997, no 21, p. 1-24; Frambach R.T., Schillewaert N.: op.cit.; Tornatzky L.G., Fleischer M.: *The Process of Technological Innovation*. Lexington Books, Lexington, MA 1990.

¹¹ Jeyaraj A., Rottman J.W., Lacity M.C.: A review of the predictors, linkages, and biases in IT innovation adoption research. *Journal of Information Technology* 2006, no 21, p. 1-23; Rogers E.M.: *Diffusion of Innovations*. Free Press, New York 2003; Tornatzky L.G., Klein K.J.: Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. *IEEE Transactions on Engineering Management* 1982, no 29, p. 28-45.

2. Research hypotheses

Technical innovation pertains to products, services, and production technologies that are new to organizations.¹² It is related to basic activities and concerned with either product or process. Adopting green practices can be seen as a technical innovation process. A number of explanations as to what factors influence technical innovation can be found in the literature. Frambach and Schillewaert¹³ suggest that the determinants influencing organizational adoption of innovations include perceived innovation characteristics and adopter's organizational characteristics. In general, the adoption of technical innovations will be affected by technological and organizational factors.¹⁴

2.1. Technological factors

The perceived technological characteristics of an innovation can be considered as cognitive beliefs reflected in an attitude towards the innovation. Several technological characteristics of an innovation can affect its adoption, including complexity, compatibility, relative advantage, triability, observability, ease of use, perceived usefulness, information intensity, uncertainty, and so on.¹⁵ This study focuses mainly on complexity, compatibility and relative advantage because these three characteristics have consistently been found to be more important in influencing adoption behavior than the other characteristics.¹⁶

Complexity is the degree to which a technical innovation is perceived to be difficult to understand and use. It will increase the difficulty in knowledge transfer and innovation diffusion¹⁷, and is usually hypothesized to be negatively related to innovation adoption.¹⁸ Green practices incorporate both tacit and explicit knowledge. The tacit knowledge may be inherent in identifying sources of pollution, reacting quickly to accidental spills, and proposing preventive solutions.¹⁹ A technology with high complexity contains a lot of tacit knowledge that requires laborious efforts to learn and diffuse.²⁰ Efficient knowledge sharing

¹² Kimberly J.R., Evanisko M.J.: op.cit.; Damanpour F.: Organizational innovation: a meta-analysis of effects of determinants and moderators. *Academy of Management Journal* 1991, no 34, p. 555-590.

¹³ Frambach R.T., Schillewaert N.: op.cit.

¹⁴ Scupola A.: The adoption of Internet commerce by SMEs in the South of Italy: an environmental, technological and organizational perspective. *Journal of Global Information Technology Management* 2003, no 6, p. 52-71; Tornatzky L.G., Fleischer M.: op.cit.

¹⁵ Frambach R.T., Schillewaert N.: op.cit.; Tornatzky L.G., Klein K.J.: op.cit.

¹⁶ Rogers E.M.: op.cit.; Sia C-L., Teo H-H., Tan B.C.Y., Wei K-K.: Effects of environmental uncertainty on organizational intention to adopt distributed work arrangements. *IEEE Transactions on Engineering Management* 2004, no 51, p. 253-267; Tornatzky L.G., Klein K.J.: op.cit.

¹⁷ Rogers E.M.: op.cit.

¹⁸ Tornatzky L.G., Klein K.J.: op.cit.

¹⁹ Boiral O.: Tacit knowledge and environmental management. *Long Range Planning* 2002, no 35, p. 291-317.

²⁰ Tornatzky L.G., Fleischer M.: op.cit.

can lead to better innovative capabilities in terms of higher order learning, and consequently can improve organizational performance including environmental management effectiveness.²¹ The difficulty in learning and sharing tacit knowledge makes it relatively difficult to adopt a complex technology. Therefore, the following hypothesis is proposed:

H1: *A negative association exists between the green practices' complexity and the adoption of green practices for SMEs.*

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, experiences, and needs of the firms.²² To lessen possible objection against the diffusion of a new technology, a company will be more likely to adopt the new technology that is more compatible with the company's current operational knowledge.²³ Compatibility is also relevant to green practice adoption. Because several green practices are additions to companies' current technologies, adoption of green practices is not a single event but can be described as a process of knowledge accumulation and integration. Green practices that are more compatible to a company's current technologies will be more easily to be diffused within the organization. Fit between previous experiences and environmental actions may generate a greater environmental effectiveness.²⁴ Therefore, the following hypothesis is proposed:

H2: *A positive association exists between the green practices' compatibility and the adoption of green practices for SMEs.*

Relative advantage is the perception that an innovation is more advantageous than its substitute idea. The perceived benefits may be measured in economic and social terms like convenience and satisfaction. Companies are more likely to adopt a technology which is able to provide better performance and higher economic gains than the other technologies. Relative advantage is positively related to the adoption of innovation.²⁵ Potential organizational benefits of green practices include reduced energy and natural resource consumption, reduced waste and pollutant emission, improved environmental and financial performance, and greater responsiveness to social environmental expectation.²⁶ The perceived net benefits that the green practice offers will serve as motivations for companies to adopt the technology. Therefore, the following hypothesis is proposed:

H3: *A positive association exists between the green practices' relative advantage and the adoption of green practices for SMEs.*

²¹ Etzion D.: op.cit.

²² Rogers E.M.: op.cit.

²³ Tornatzky L.G., Klein K.J.: op.cit.

²⁴ Etzion D.: op.cit.

²⁵ Rogers E.M.: op.cit.; Tornatzky L.G., Klein K.J.: op.cit.

²⁶ Etzion D.: op.cit.; Hart S.L.: op.cit.

2.2. Organizational factors

Several studies have discussed the influences of a variety of organizational factors such as quality of human resources, top management's leadership skills, organizational support, organizational culture and organizational size on technical innovation and environmental strategy. This study focuses mainly on the quality of human resources and organizational support because they are organizational resource-related variables widely analyzed in research on technical innovation and environmental management.²⁷

The quality of human resources is an essential factor influencing technical innovation.²⁸ Qualified human resources are helpful to adopt innovations because of their competent learning and innovative capabilities. Adopting green practices is a complex process requiring cross-disciplinary coordination and significant changes in the existing operation process.²⁹ It is intensive in human resources and depends on the development and training of tacit skills through the employees' involvement.³⁰ Employees with competent learning capabilities will be apt to increase their absorptive capacity through training programs that can advance green practice adoption. Also, companies will have higher innovative capacity because of employees' improved innovative and learning capabilities. As the degree to which an organization is receptive to new ideas will influence its propensity to adopt new technologies,³¹ a company with higher innovative capacity will be more likely to successfully implement an advanced environmental strategy.³² Therefore, the following hypothesis is proposed:

H4: A positive association exists between the quality of human resources and the adoption of green practices for SMEs.

Organizational support is the extent to which a company helps employees using a particular technology or system. Providing incentive for innovation adoption and ensuring the availability of financial and technical resources for innovation have positive effects on the adoption of technical innovation.³³ For the development of environmental management,

²⁷ Alvarez-Gil M.J., Berrone P., Husillos F.J., Lado N.: op.cit.; Damanpour F.: op.cit.; Jeyaraj A., Rottman J.W., Lacity M.C.: op.cit.; Lee H.Y., Lee Y-K., Kwon D.: The intention to use computerized reservation systems: the moderating effects of organizational support and supplier incentive. *Journal of Business Research* 2005, no 58, p. 1552-1561.

²⁸ Tornatzky L.G., Fleischer M.: op.cit.

²⁹ Russo M.V., Fouts P.A.: A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal* 1997, no 40, p. 534-559.

³⁰ Hart S.L.: op.cit.; Del Brio J.A., Junquera B.: op.cit.

³¹ Frambach R.T., Schillewaert N.: op.cit.

³² Christmann P.: Effects of "best practices" of environmental management on cost advantage: the role of complementary assets. *Academy of Management Journal* 2000, no 43, p. 663-680; Judge W.Q., Elenkov D.: Organizational capacity for change and environmental performance: an empirical assessment of Bulgarian firms. *Journal of Business Research* 2005, no 58, p. 893-901.

³³ Jeyaraj A., Rottman J.W., Lacity M.C.: op.cit.; Lee H.Y., Lee Y-K., Kwon D.: The intention to use computerized reservation systems: the moderating effects of organizational support and supplier incentive. *Journal of Business Research* 2005, no 58, p. 1552-1561.

organizational support is essential because the employees will be motivated to implement green behavior and the resources required for adopting green practices will be more easily available. Also, the top management plays an essential role in organizational support. Many green practices require the collaboration and coordination of different departments and divisions during adoption. To ensure successful adoption, the central task of top management is to obtain resources and assemble them into organizational capabilities so that the company is able to adopt green practices to achieve environmental competitive advantage.³⁴ Therefore, the following hypothesis is proposed:

H5: A positive association exists between the organizational support and the adoption of green practices for SMEs.

3. Research methods

3.1. Sample and data collection

The data to test the proposed research hypotheses were collected by means of mailing questionnaires to SMEs in Taiwan. The questionnaire was developed in a two-stage process. First, an initial questionnaire was designed based on a review of studies analyzing similar theoretical constructs and a discussion with two experts in environmental management. Second, the initial questionnaire was modified by accommodating ten SME managers' suggestions to ensure that each item is interpreted as expected. Afterward the final version of the questionnaire was administered to sampled SMEs.

One thousand samples were randomly drawn from a list of SMEs in Taiwan. These companies were contacted via telephone to confirm the names of respondents and their mailing addresses. Questionnaires were mailed to these sampled companies' owners or senior managers who are familiar with the company's environmental activities. Two weeks after the questionnaires were mailed, a follow-up to the sampled companies was conducted to remind them of the importance of their responses. In total, 231 completed questionnaires were returned. Of these respondents, twelve unusable questionnaires were excluded, and 219 respondents were analyzed in the study. The overall response rate is 21.9 percent.

³⁴ Judge W.Q., Elenkov D.: op.cit.; Zhu Q., Sarkis J., Cordeiro J.J., Lai K.: Firm-level correlates of emergent green supply chain management practices in the Chinese context. *Omega: The International Journal of Management Science* 2008, no 36, p. 577-591.

3.2. Measures

Green practice adoption refers to the decision of a company to use the green practices to respond to environmental issues. The green practices commonly used include consolidating shipments, disposing waste responsibly, purchasing ecological products, reducing energy consumption, reducing solid/water waste and emissions, using cleaner production methods, and using recyclable packaging/containers. Each sampled company was asked to score the degree of adoption of the green practices according to a seven-point scale anchored by “not at all” and “to a great extent”.

All the determinant factors were measured using 7-point Likert scales anchored by “strongly disagree” and “strongly agree”. Table 1 shows the measurement items of each factor. Complexity was measured by whether the green practices would be learned and used easily.³⁵ Compatibility was measured based on the degrees of perceived fitness between the green practice and the company’s existing technologies and processes.³⁶ Relative advantage was measured by whether the green practice could increase environmental and economic performance.³⁷ The quality of human resources was measured according to employees’ learning and innovative capabilities.³⁸ Organizational support was measured according to the degrees of the company’s resource supports and leaders’ attitudes toward environment issues.³⁹

The measurement items were submitted to factor analysis. Factors with eigenvalues greater than 1.0 are also summarized in Table 1. The result of factor analysis confirms the construct validity of this study. According to the reliability coefficients, the smallest value of Cronbach’s alpha for this study is 0.8536, which implies that the sampling results are reliable.⁴⁰

³⁵ Rogers E.M.: op.cit.; Sia C-L., Teo H-H., Tan B.C.Y., Wei K-K.: op.cit.

³⁶ Rogers E.M.: op.cit.; Sia C-L., Teo H-H., Tan B.C.Y., Wei K-K.: op.cit.; Chau P.Y.K., Tam K.Y.: op.cit.

³⁷ Rogers E.M.: op.cit.; Sia C-L., Teo H-H., Tan B.C.Y., Wei K-K.: op.cit.

³⁸ Scupola A.: op.cit.; Tornatzky L.G., Fleischer M.: op.cit.

³⁹ Lee H.Y., Lee Y-K., Kwon D.: op.cit.; Tornatzky L.G., Fleischer M.: op.cit.

⁴⁰ Nunnally J.C.: *Psychometric Theory*. McGraw-Hill, New York 1978.

Table 1

Measurement Items for Determinant Factors

Determinant Factors	Factor Loading	Cronbach's α
Technological Factors	0.8764	
Complexity of technology		
Learning the green practice is difficult.	0.847	
Understanding the green practice is difficult.	0.816	
Sharing the knowledge of the green practice is difficult.	0.735	
Using the green practice needs many experiences.	0.691	0.8901
Compatibility of technology		
The green practice is compatible with our existing operations.	0.807	
Integrating the green practice with company's existing system is easy.	0.744	
The green practice is consistent with our company's values.	0.692	0.8536
Relative advantage of technology		
The green practice can provide better environmental performance.	0.806	
The green practice can provide higher economic benefits.	0.759	
The green practice can enhance our company's reputation.	0.713	0.8804
Organizational Factors	0.9097	
Quality of human resources		
Employees can share knowledge with each others.	0.813	
Employees can learn new technologies easily.	0.767	
Employees can easily use new technologies to solve problems.	0.724	
Employees can provide new ideas for our company.	0.651	0.9104
Organizational support		
Top management encourages employees to learn green practices.	0.842	
Our company provides resources for employees to learn green practices.	0.816	
Our Company provides rewards for employees' green behavior.	0.714	
Top management can help employees when they face green problems.	0.683	0.9048
Total Cronbach's $\alpha = 0.8706$		

4. Results and discussions

The regression analysis was used to determine whether SMEs' green practice adoption is influenced by the proposed technological and organizational factors. Table 2 shows the standardized results of regression analysis. The significant results suggest that all the hypotheses are supported. The complexity, compatibility and relative advantage of green practices, quality of human resources, and organizational support exhibit significantly influences on the adoption of green practices for SMEs.

Table 2

Standardized Regression Results for the Adoption of Green Practices

Dependent variables: Adoption of Green Practices		
Predictors	Standardized Coefficient β	<i>t</i>
Technological factors		
Complexity of technology	-0.127	-2.109*
Compatibility of technology	0.185	3.193**
Relative advantage of technology	0.193	4.035**
Organizational factors		
Quality of human resources	0.176	2.984**
Organizational support	0.212	4.219**
R^2	0.417	
<i>adj R</i> ²	0.394	
<i>F</i>	30.47**	

* $p < 0.05$ ** $p < 0.01$

SMEs will be more likely to adopt a green practice when they perceive that the practice is less complicated, easier to learn and use, more compatible to their existing business operations, and helpful for improving environmental and economic performance. To reduce the complexity of green practices, green practice providers can increase the explicitness of green practices that is helpful for the transfer and learning of related knowledge within an organization. Increasing the explicitness of knowledge can also help companies appreciating the compatibility of the green practices. As a result, SMEs are able to select a green practice that is more consistent with their existing system. Companies will be capable of reducing perceived complexity and increasing perceived compatibility through accumulating more environmental knowledge. During the process of accumulating environmental knowledge, companies will not only have more related experiences that are helpful for reducing the perceived complexity of green practices, but also adjust their values and operations towards environmental-friendly that advance the compatibility between companies' existing systems and new green practices. The relative advantage is a relevant technological factor influencing green practice adoption. The perceived net benefits, including improved environmental and economic performance, and better reputation, that the green practice offers will serve as motivations for companies to adopt the green practices. Del Rio Gonzalez,⁴¹ in a study of the Spanish pulp and paper industry, also suggests that economic and financial advantages are important technological characteristics that influence the adoption of clean technologies. Therefore, to advance green practice adoption, green practice providers should put more effort to make their customers appreciate the relative advantage of the practices.

⁴¹ Del Rio Gonzalez P.: op.cit.

For the organizational factors, qualified human resources and organizational support will affect SMEs' green practice adoption behavior. Employees' learning capabilities and the availability of resources are relevant for the adoption of green practices. Use of green practices may add complexity to production or delivery processes and require an amount of learning and training programs. To improve organizational learning capabilities, companies should recruit qualified employees, provide educating programs, and build knowledge management systems. On the other hand, the process of adopting green practices can build within a firm the resources of organizational commitment and learning, cross-functional integration, and increased employee skills and participation, which are emerging as prime resources in a competitive environment.⁴² The present result provides further evidence on the importance of organizational support, especially top management support, in green innovation. Organizational support gives employees motivation and resources to adopt environmental practices.

5. Conclusions

Based on a survey on SMEs in Taiwan, this study concludes that complexity, compatibility and relative advantage of green practices, quality of human resources, and organizational support exhibit significant influences on the adoption of green practices for SMEs. To advance green practice adoption, companies can attempt to increase the explicitness of green practices, improve their organizational learning capabilities, and make organizational resources easily available for their employees.

A major contribution of this study is to propose a new model analyzing the factors influencing green practice adoption for SMEs. Over the past decades, a growing literature stream focuses on understanding organizational adoption of green practices. So far, little research analyzes the determinants of adopting green practices from the perspective of technical innovation. Most studies have focused exclusively on organizational and factors and stakeholder pressure, and ignored the influences of technological characteristics of green practices. This study empirically evidences the significant influences of technological characteristics on green practice adoption. Thus, future research on environmental issues can take technological characteristics into account. Other possible technological and organizational factors can also be taken into considerations in future studies.

Regarding the limitations, this study may suffer from the respondent bias owing to the use of questionnaire survey. In addition, because this paper studies the green practice adoption of

⁴² Russo M.V., Fouts P.A.: op.cit.

SMEs in Taiwan, the research findings may be limited in their generalizability. Different countries may lead to conclusions different from the present study. Future studies can use the proposed model in other countries.

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