ASSESSING GREEN PRACTICES AND THEIR IMPACT ON THE ENVIRONMENTAL AND FINANCIAL PERFORMANCES OF CONSTRUCTION PROJECTS

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ABSTRACT

Industry players are urged to adopt green practices in their projects to address the environmental problems caused by construction activities. Despite an increasing adoption of green practices by construction players, it is still unclear whether such practices have improved projects' environmental and financial performances. The aim of this study was to investigate the relationship between green practices implemented in construction projects and their impact on the projects' environmental and financial performances. A structured questionnaire survey was distributed to members of a project team to gather information on the impact of green practices on construction projects' performances. The results revealed two areas of green practices: green project integrated practice and waste management practice, which had a significant and positive relationship with the project's environmental and financial performances. The results rebut the previous findings regarding the negative impact of green practices on a project's performances. The results imply that different types of green practices will have a varying degree of effect on the project's environmental and financial performances. It is important for project managers to focus on green project integrated practices and waste management to boost the project's environmental and financial performances.

Keywords: *: Construction project; environmental performance; financial performance; green practice*

1. INTRODUCTION

Construction activities have been blamed as one of the environmental polluters. Industry players are urged to adopt green practices in their projects to address this problem. Construction projects in Greece and China have begun to employ measures to minimise carbon emissions (Lai et al., 2017; Yu et al., 2018), and there is a rising awareness of ISO 140001 amongst the construction firms (Manoliadis et al., 2006). In 2016, MyCREST (Malaysian Carbon Reduction and Environmental Sustainability Tool) was adopted in all federal government projects and 20 private projects in Malaysia (Ministry of Work, 2015). Also in that year, the Low Carbon Cities Framework and Assessment System (LCCF) was adopted to evaluate carbon emissions from the cities and towns of Malaysia (Chin, 2016). Despite an increasing adoption of green practices by construction players, it is still unclear whether such practices have improved the projects' environmental and financial performances.

The green practice in construction refers to environmentally friendly or environmental practice that aims to reduce the negative impact of construction activities on the environment (Liu and Lin, 2016; Yusof et al., 2017). The green practice is reflected in the form of the 3Rs (reduce, reuse and recycle), the efficient use of resources or resource minimisation, and the reduction of waste (Zhang et al., 2015; Chang, 2016). Previous studies are not unified on whether green practices will yield a cleaner environment and better financial outcome. In the case of the link between green practice and environmental performance, the adoption of ISO14001 in a country where environmental regulations are indirect but costly will lead to a higher environmental performance (Arimura et al., 2016). Effective green practice in construction projects will result in less pollution and lower carbon emissions (Shen et al., 2011). In contrast, it was argued that green practices will not necessarily result in better environmental performance; thus, a cleaner environment (Ferrón-Vílchez, 2016). Similarly, it was found that ISO14001 adoption did not necessarily result in improved environmental performance (Yin and Schmeidler, 2009). In the case of the link between green practice and financial performance, green practices were revealed to be implemented in supply chain management in manufacturing, utilities, and transportation industries, which led to a firm's higher financial performance (Miroshnychenko et al., 2017). Higher financial performance is evident if there is an increase in profits through better prices of green products or services, the reduction in operational costs through measures of optimising the use of resources such as reduce, reuse and recycle practices, and cost savings being achieved from complying with environmental regulation (Olubunmi et al., 2016). However, the firm's profit was reduced by the adoption of ISO 14001 (Miroshnychenko et al., 2017). Studies in the construction sector have shown an insignificant relationship between green practices and financial performance (Kusuma and Koesrindartoto, 2014; Renard et al., 2013).

The need for another study to shed light on the relationships between green practices implemented in construction projects and their impact on the projects' environmental and financial performances was established from the above disagreement among scholars. Although the main intention of adopting green practices is to reduce the negative impact of construction activities on the environment or improve environmental performance (Shen et al., 2011; Lai et al., 2017), it was argued by scholars that most firms are profit-oriented and they will only be motivated to adopt green practices if such effort can increase their financial performance (Zhang et al., 2015; Olubunmi et al., 2016). To provide a better understanding on this issue, the aim of this paper is to investigate the impact of green practices on the environmental and financial performance of construction projects. Theoretically, the results will identify whether the green practice leads to a cleaner environment and a better profit; providing a better understanding to the on-going debate on the relationship between green practices and environmental and financial performances. Practically, the results will help project managers and clients to be selective and invest more in green practices that yield better environmental performance and higher profits.

2. MATERIALS AND METHODS

Two aspects of project performance; environmental and financial performances, were investigated as dependent variables in the present study. Generally, environmental performance can be defined as the consequence of doing construction in a responsible manner, such as with less pollution or with a cleaner environment (Bhattacharyya and Cummings, 2015). The improvement in compliance with environmental standards, minimising waste, and reduction of pollution are conceptualised as a project's environmental performance (Li et al., 2017; Shen et al., 2011). In the wake of the increasing stakeholder demand for a cleaner environment, construction organisations with higher environmental performance will be ahead of their competitors, able to gain public trust, and secure goodwill (Yadav et al., 2017). On the other hand, the reduction in project costs, high profits, and improved investment yield are indicators of the project's financial performance (Olubunmi et al., 2016; Rao and Holt, 2005). An argument arose on a seminal work that leaders of green practices enjoyed better prices for green products and services, which could lead towards higher profits (Porter and Van der Linde, 1995). It was found in a global study that pollution prevention practices, such as waste management and the use of non-toxic materials through internal organisational efforts or engaging environmental-friendly suppliers or contractors, could lead to better financial performance (Miroshnychenko et al., 2017). Although the financial performance of green practices takes a longer time before it can be observed (Li et al., 2017); at the very least, projects that adopt green practices can avoid fines due to non-compliance (Tan et al., 2011). Acknowledging the importance of economic measures, it was argued that the financial benefits of green practices could help to motivate environmental polluters to adopt green practices (Zhang et al., 2015). Supporting this point of view, emphasis was laid on the need to overcome cost barriers of green practices to motivate construction firms to adopt green practices (Chan et al., 2018).

Regarding the independent variables, three dimensions were used to conceptualise green practices in construction projects: green project integrated practice (Lam et al., 2011; Silvius et al., 2017), resource minimization (Oyedele et al., 2014; Pero et al., 2017), and waste management (Silvius et al., 2017). In the first dimension, the green project integrated practice can be defined as a desegregation of the disjointed phases of the project cycle, from the beginning to its completion, in line with the environmental mission (Lam et al., 2011; Yusof et al., 2017). In project integrated practices, the participation of the project key members is at the beginning of the project (Yusof et al., 2016). In such an arrangement, the green practice agenda is conveyed by the client and the project manager prior to project implementation (Banihashemi et al., 2017; Silvius et al., 2017). A major role will be played by client in providing the necessary support to ensure that the environmental needs of all stakeholders are identified and considered at the earliest stage, and that green practices are implemented throughout the project cycle (Banihashemi et al., 2017). Clients insisting on green design features such as balconies, sky gardens, solar chimneys and wind catchers reduce the need for artificial ventilation and reduce carbon emissions (Zhang et al., 2015). The effective green practice adoption is shown when such practices result in low carbon emissions, as well as less air, water, and soil pollution; or in other words, a better environmental performance (Shen et al., 2011). Therefore, the study's first hypothesis is:

H1: Green practices in project integrated practices significantly influence the project's environmental performance.

Likewise, the effective adoption of green practices in each project phase will also mean less wastage, avoidance of charges due to non-compliance, and result in higher profits (Rao and Holt, 2005). In Hong Kong, buildings with green design features, such as balconies and funnels, which are less than 8% of the gross floor area, enjoyed a tax reduction, attracted more users due to the building's pleasant indoor environment, thereby increasing the marketability of the building (Zhang et al., 2015). In addition, there have been improvements in government regulations and policies (Zhong and Wu, 2015), which include assessment methods (Ding, 2008; Kneifel, 2010) to promote and support green practice. In project integrated practice, the participation of all project team members at the earliest project phase can ensure that changes or amendments to environmental regulations are considered throughout the project cycle, resulting in cost saving due to compliance and better revenue (Tan et al., 2011). Therefore, the study's second hypothesis is:

H2: Green practices in project integrated practices significantly influence the project's financial performance.

The second dimension is resource minimisation, which refers to the optimisation of the use of resources that also covers the 3Rs – reduce, reuse, and recycle activities throughout the project cycle (Oyedele et al., 2014; Yusof et al., 2016). A vital challenge in resource minimisation during project implementation is to minimise the use of water and energy (Martens and Carvalho, 2017). In terms of purchases, there have been green criteria in the selection of suppliers, where suppliers are selected based on environmental and social criteria (Pero et al., 2017). The purchase of recycled materials has been promoted by several companies as green materials, which is aimed at optimizing the use of resources (Ofori, 2000). Furthermore, the adoption of sensor technology to monitor energy and water consumptions are said to be able to improve environmental performance (Abuzeinab et al., 2016). Technical support and training to green suppliers are also provided by companies to increase their capabilities, as well as awareness towards sustainability (Ofori, 2000). The awareness and practices of resource minimisation can lead towards a cleaner environment (Pero et al., 2017). Thus, the third hypothesis is:

H3: Resource minimisation significantly influences the project's environmental performance.

In relation to resource minimization, the fact that some firms are reluctant to avoid overuse and wasting of resources was highlighted due to lack of evidence about its financial advantage (Li et al., 2017). On the contrary, the adoption of LEED or Leadership in Energy and Environmental Design rating system in the project management practice is suggested to ensure efficient use of resources and reduce wastage (Tabassi et al., 2016). As an example, investment in energy-efficient technology during housing development has resulted in better sale prices for low energy houses (Chegut et al., 2016). The use of local suppliers for building materials can avoid costly imported resources and reduce logistics cost (Pero et al., 2017). Aside from that, it was emphasized by Cheng et al. (2013) that effective resource management will optimise the use of resources, subsequently reducing project costs and thereby increasing profits. Therefore, the fourth hypothesis is:

H4: Resource minimisation significantly influences the project's financial performance.

The third and final dimension is waste management, which includes the monitoring of waste production during project implementation and ensuring that construction waste from landfills is minimised and properly destroyed (Silvius et al., 2017; Freitas and Magrini, 2017). Waste minimisation through effective waste management has become an important issue, as evidenced by many governments setting goals to reduce construction waste (Kern et al., 2015). In Malaysia, it was reported that 30% of the total waste came from construction and only 15% of this waste was collected by the waste management contractor (Chen, 2015). The industry players were urged to reduce this percentage through proper waste management, such as waste categorisation, reuse, and recycling to achieve zero waste at the construction site by 2030 (Ministry of Work, 2015). According to Ng et al. (2017), a framework that includes important elements, such as laws and regulations, scheme and incentives, consciousness and information on 3R, participation of contractors, and obtainable technology with a top-down approach and code of good governance, is required to be established in order to have an effective construction waste reduction through 3R among contractors. It was simulated by Wang et al. (2015) that, although offsite construction technology produces the better result in reducing construction waste, the synergy of multi-design strategies provides the highest waste reduction; thus, a better environmental performance. The practice of industrial symbiosis in the waste management system can help increase environmental performance by extending the construction waste destination to be used by another sector, such as manufacturing, and prevent it from ending up in the landfill (Freitas and Magrini, 2017). It is argued that waste management in a construction project can help reduce or eliminate waste; thus, resulting in a cleaner environment. Therefore, the fifth hypothesis of the study is:

H5: Waste management significantly influences the project's environmental performance.

Similarly, it was argued by Begum et al. (2006) that waste management could result in a 2.5% cost savings of the overall project costs if implemented properly. To promote the reuse and recycling of resources during project execution, a total index score was proposed by Cha et al. (2009) to manage and monitor construction waste. The proper on-site waste management by construction workers can ease up the need for waste disposal and transportation to landfills, leading to greater cost savings for contractors (Li et al., 2018). Since waste signifies cost, it is argued that stricter implementation of waste management during construction operations, such as waste prevention and avoiding the use of expired materials, entails cost savings and a better project's financial performance (Silvius and Schipper, 2016). In addition, it is argued that zero waste and circular economy practices in demolition projects provide financial benefits (Abuzeinab et al., 2016). Therefore, the sixth hypothesis of the study is:

H6: Waste management significantly influences the project's financial performance.

3. RESULTS

A structured questionnaire survey was used to gather information on the impact of green practices on construction projects' performances. All the items were measured using a five-point Likert scale, ranging from "strongly disagree: 1" to "strongly agree: 5". The unit of analysis is the construction firms; consisting of contractors, property developers and consulting firms (architecture and engineering) that are involved in construction projects in Peninsular Malaysia. The targeted respondents are architects, engineers, and project managers working in these construction firms and participating in the decision-making of the projects, whether in the planning, design or construction phase, and have knowledge about the project's performance. A total of 210 usable responses were received, exceeding the minimum required sample size of 146, which was calculated using the gamma-exponential method. Majority of the firms were contractors, followed by property developers and consulting firms. Most firms were established between 11 and 20 years old, small in size and operating at the state level. Since the respondents were of different background and types of construction firms, the ANOVA (one-way analysis of variance) test was performed to check if these differences influenced their responses. The test indicates that p value = 0.458 (no significant difference), signifying that the respondents have similar knowledge about the project activities and performances. Table 1 presents the profile of the respondents.

Table 1: Profile of respondents

Respondents	Number	Percentage (%)
Type of firm		
Property developer	62	30
Contractor	93	44
Consulting firm	55	26
Establishment		
< 6 years	22	10
6 -10 years	64	30
11 - 20 years	86	41
> 20 years	38	18
Size of firm		
Small	92	44
Medium	59	28
Large	59	28
Geographical location		
State	103	49
Regional	61	29
National	38	18
International	8	4

Two stages of analysis were performed to analyse the data using the Warp partial least squares technique (WarpPLS) Version 6.0. In stage 1, where the measurement model was evaluated, indicator reliability was performed, alongside with convergent validity, internal consistency, and discriminate validity tests for the reflective latent variables, as well as the variance inflated factor (VIF), significant outer weights, and full collinearity VIF tests for the formative latent variables.

The loadings for all items were higher than 0.5 with the P values significant at <0.001, fulfilling Kock's (2014) rules for indicator reliability. The convergent validity of the latent variable was evaluated using the average variance extracted (AVE), and the AVE of all of the latent variables exceeded 0.5, in accordance with Fornell and Larcker's (1981) criteria; suggesting the measurement model's convergent validity. Composite reliability (CR) was used to evaluate the internal reliability of the reflective latent variables. All latent variables showed a CR of above 0.8 fulfilling the minimum criteria of Kock (2011) and Hair et al. (2011). Table 2 presents the results of the indicator reliability, convergent validity, and internal consistency tests for the reflective latent variables.

Table 2: Reliability and validity of the reflective latent variables

Latent variable/item	Loading	P values	AVE	CR
Project integrated practice			0.705	0.877
P1	0.878	<0.001		
P2	0.874	<0.001		
P3	0.761	<0.001		
Resource minimisation			0.673	0.911
R1	0.786	<0.001		
R2	0.854	<0.001		
R3	0.852	<0.001		
R4	0.820	<0.001		
R5	0.788	<0.001		
Waste management			0.649	0.881
W1	0.758	<0.001		
W2	0.829	<0.001		
W3	0.818	<0.001		
W4	0.816	<0.001		

Next, the discriminant validity of the reflective latent variables was evaluated using the cross-loadings and inter-correlation indicators. The measurement model revealed that the indicator loads were greater than each opposing latent variable, in accordance with the rules of Hair et al. (2012). Also, the square root of the AVE of a single latent variable was less than the value of the inter-correlations between the latent variable and other latent variables of the model (Table 3). These tests confirmed the discriminant validity of the reflective latent variables.

Table 3: Discriminant validity

Latent variables	PIP	RS	WM	EnvP	FP
Project integrated practice	0.839*				
Resource minimisation	0.570	0.820*			
Waste management	0.474	0.448	0.806*		
Environmental performance	0.499	0.345	0.521	0.832*	
Financial performance	0.580	0.392	0.420	0.487	0.861*

*Square root of the AVE values is on the diagonal

The present study has two formative latent variables: environmental performance and financial performance variables. The variance inflated factor (VIF) or collinearity between the indicators, significant outer weights, and full collinearity VIFs were used to evaluate these formative latent variables. Both formative latent variables showed VIFs of less than 5 and all items had significant outer weights, fulfilling Chin (2010) and Hair et al. (2011) rules. The full collinearity VIFs of the environmental performance and the financial performance variables were much lower than 3.3, which fulfilled the threshold of Kock and Lynn (2012). Thus, the formative latent variables presented a satisfactory level of the measurement model. Table 4 depicts the measurement model evaluation for the formative latent variables.

Table 4: Measurement model evaluation for formative latent variables

Formative latent variables	Weights	P-Value	VIF	Full collinearity VIFs
Environmental performance				1.630
Env1	0.249	<0.001	1.970	
Env2	0.265	<0.001	2.170	
Env3	0.248	<0.001	1.908	
Env4	0.237	<0.001	1.799	
Financial Performance				1.657
FP1	0.352	<0.001	2.403	
FP2	0.373	<0.001	2.658	
FP3	0.275	<0.001	1.496	

In stage 2, the structural model and the hypotheses were evaluated using the R2 measurements for the endogenous constructs and the path coefficients.

The model of the study showed 37% and 39% of the variances in the project's environmental and financial performances, respectively, suggesting a moderate relationship between green practices and the project's environmental and financial performances. Also, the Stone–Geisser's Q2 (cross-validated redundancy) for the project's environmental (Q2=0.406) and financial performances (Q2=0.389) was greater than zero, displaying the model's satisfactory predictive relevance and its explanatory power; thus, complying with Hair et al. (2011). Table 5 presents the result of the test hypotheses.

Table 5: Results of hypothesis testing

	Hypothesis	Path coefficient	p-value	Effect size (f^2)	Supported
H1	PIP → EnvP	0.371	<0.001	0.201	Yes
H2	PIP → FP	0.488	<0.001	0.290	Yes
H3	RM → EnvP	-0.034	0.312	0.013	No
H4	RM → FP	0.041	0.275	0.017	No
H5	WM → EnvP	0.341	<0.001	0.178	Yes
H6	WM → FP	0.186	0.003	0.079	Yes

The results reveal that the two areas of green practices: green project integrated practice and waste management practice, have a significant and positive relationship with the project's environmental and financial performances; this supports the **H1, H2, H5,** and **H6** hypotheses. Compared with the other green practices, the present study reveals that the green project integrated practice has the greatest effect on the project's financial performance (f2 = 0.290) and environmental performance (f2 = 0.201). However, the study showed insufficient evidence on the relationship between resource minimisation and the project's environmental and financial performances. One possible reason is that resource minimisation measures such as the 3Rs – reduce, reuse, and recycle activities or resource management are not widespread in Malaysian construction projects. Figure 1 shows the results of the structural model assessment.

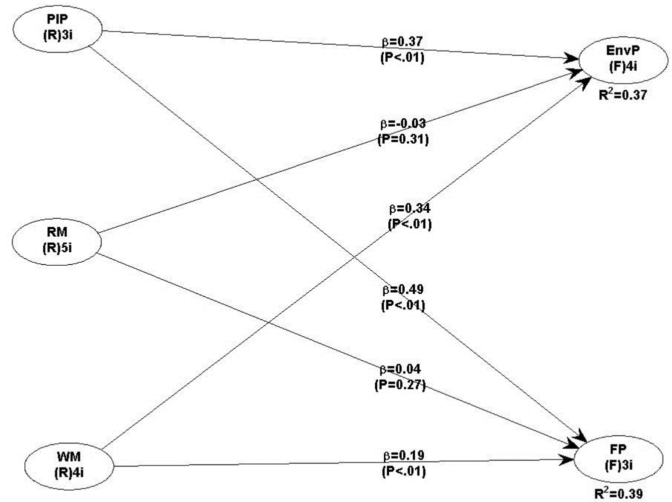

Figure 1: Structural model assessment

4. DISCUSSION

The present study revealed the positive and significant effect of green project integrated practice and waste management practice on project's environmental and financial performances. The results have provided empirical evidence on the benefit of green practices in a project's environmental and financial performances. The construction projects that integrate their planning-design-construction phases with green practices and the local ecosystem, and implement waste management practices such as waste monitoring, sorting, reuse, and recycling, will benefit in terms of a better environmental outcome, such as low carbon emission; less air, water, and soil pollution; and enhanced financial performance, such as reduction in project costs, greater profits, and improved investment yield. The results support the work of Banihashemi et al. (2017) and Zhang et al. (2015) on the positive impact of green project integrated practice on project's environmental performance. The results also support the work of Tan et al. (2011) on the positive influence of green project integrated practice on project's financial performance. Furthermore, the results support the work of Freitas and Magrini (2017) on the positive effect of waste management on project's environmental performance and finally it support the work of Begum et al. (2006) on the positive effect of waste management on a project's financial performance. At the same time, the results rebut the previous findings on the negative impact of the general green practices on performances advocated by Ferrón-Vílchez (2017), Kusuma and Koesrindartoto (2014), and Renard et al. (2013).

However, the present study provides insufficient evidence on the relationship between resource minimisation and project's environmental and financial performances, indicating that the link between the two remains vague and warrants further investigation. Optimising the use of water, materials and energy is a great challenge for construction managers. The unskilled labour and the traditional construction management that are widely used in the construction projects of developing countries may be the reasons for the insubstantial link between resource minimisation and project's environmental and financial performances.

The aforementioned results imply that not all types of green practices will have a similar impact on project's environmental and financial performances. In other words, the different types of green practices will have a varying degree of effect on the project's environmental and financial performances. Construction projects should be organized to allow key players in the project; architects, engineers, contractors and suppliers, along with the client, to be involved at the earliest stage to ensure that environmental goals are understood and considered throughout the project. The implementation of integrated project management rather than the traditional project organization mode or as suggested by Zhang et al. (2015); an appointment of the environmental specialist in a project team, together with a clear understanding of project's environmental values and measures (Tan et al., 2011) and supported by the necessary environmental regulations for construction projects (Banihashemi et al., 2017) are examples of green project integrated practices that can improve project's environmental and financial performances. In addition, waste management practices such as waste sorting, reuse and recycling, the use of offsite construction technology or prefabrication, and innovative waste recovering through industrial symbiosis, are suggested to increase project's environmental and financial performance. Clients and project managers should focus on these two aspects of green practices: green project integrated practices and waste management to boost the project's environmental and financial performances.

5. CONCLUSION

As a measure to address the negative impact of construction activities on the environment, construction firms are required to adopt green practices. The relationship between green practices implemented in construction projects and project's environmental and financial performances were investigated in this study. The results revealed two areas of green practices: green project integrated practice and waste management practice, which had a significant and positive relationship with the project's environmental and financial performances. Theoretically, the results provide support to Shen et al. (2011) and Miroshnychenko et al. (2017) earlier postulation on the impact of green practices on environmental and financial performances. Practically, the results are useful to clients, project managers and policy makers. To achieve better environmental performance and higher profit, they must ensure that environmental values and measures are considered in the planning, design and construction phases, and focus on waste management practices. The professional bodies of architecture, engineering and project management practice, together with the CIDB, can provide training to its members and construction players on the best practices for project integration and waste management. The results also guide policy makers to focus on green project integrated practice and waste management to boost the project's environmental and financial performances. Proper guidance and monitoring should be in place on how green project integrated practice and waste management can be implemented. Local authorities should provide the necessary facilities for waste sorting, reduce, reuse and recycling. An example of monetary incentives is tax reduction, while that of non-monetary incentives is faster approval.

A few constraints can be found in the study. First, insufficient evidence on the relationship between resource minimisation and the project's environmental and financial performances was shown in the study. How resource minimisation was implemented should be investigated in future studies and ways to encourage such practice in Malaysian construction projects should be found. Secondly, the study's model explains 37% and 39% of the variances in environmental and financial performances, respectively. Although such predictive levels are adequate, future studies should embark into other research methods, such as the mixed method or semi-structured interviews in qualitative research to identify other green practices that may affect project's environmental and financial performance. Thirdly, the effect of project size that may influence the relationship between green practices and project's environmental and financial performance is not considered in the present study. Project size is usually measured based on the economic value of a project, the duration or the number of people involved (Kärnä and Junnonen, 2017; Vachon and Klassen, 2006). In Malaysia, G8 contractor firms are expected to have ISO EMS 14001 certification and lead low-carbon projects for residential and commercial buildings and large infrastructure projects (CIDB, 2015). Future studies should investigate whether the project size can strengthen or weaken the relationship between green practices and the project's environmental and financial performance. Last but not least, although the results can be generalised to other developing countries similar in context to Malaysia, comparative studies between developing and developed countries will enrich the current understanding of the relationship between green practice and project performance.

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