

# Turning Green to Gold in the Construction Industry: Fable or Fact?

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**Abstract:** Green principles have been increasingly incorporated into planning, design, construction, and maintenance processes in the engineering and construction industry. Along with the growth of the green initiative, going green not only demonstrates corporate social responsibility, but may yield significant economic benefits. This study compares financial performance between green and conventional firms in the engineering and construction industry. A total of 22 sample companies used in this empirical analysis are categorized into two groups—green versus conventional firms—in accordance with Engineering News Record and Newsweek green company lists. Two groups are compared in terms of short-term financial performance, long-term economic value, and market value. The analysis shows that green firms outperform conventional firms on return on equity (17.4 versus 8.2%) and economic value added margin (0.35 versus −1.43%). However, the green strategy has not yet been factored into corporate market value. The findings yield important managerial implications for engineering and construction organizations to integrate sustainability into their business operation. DOI: 10.1061/(ASCE)CO.1943-7862.0000676. © 2013 American Society of Civil Engineers.

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## Introduction

The incorporation of sustainability or green principles into project design and operation processes has been profoundly changing the construction industry. This change leads to a growing interest in pursuing green project certifications such as leadership in energy and environmental design (LEED) in the United States, and the building research establishment environmental assessment method (BREEAM) in Europe. Furthermore, going green could reshape corporate competition strategies and business operations. According to an executive survey conducted by McGraw-Hill (2009), approximately one-third of the 203 largest American corporations had dedicated a budget for sustainability and established a new position in corporate C-suites, titled the corporate sustainability officer (CSO), who has significant influence on business decisions. The green market has also become a bright spot across all construction sectors, with a remarkable growth rate even under the current economic recession. The value of green building construction starts was up 50% from 2008–2010 in the United States, increasing from \$42 billion to approximately \$63 billion. Green building projects are expected to consist of 40–48% of the nonresidential market

within the next 5 years. By 2015, the US green building market can reach \$135 billion a year (McGraw-Hill 2011).

This rapid expansion of the green construction market was driven by such factors as owners' desire for market differentiation, growing public awareness, increased local and federal government regulations, shareholders' demands, improvement in technology and sustainable materials, energy cost savings, and enhanced competitive advantage. Esty and Winston (2009) summarized four primary reasons for businesses to go green. These reasons can also be applicable to project organizations. First, the limitation of the natural world and rising resource costs constrain business operations and realign markets. Second, organizations are facing a growing spectrum of stakeholders who are concerned about environmental issues and corporate social responsibilities. Third, government regulations and policies are becoming broader and stricter on environmental problems. Lastly, rapidly rising media attention, transparency, and accountability on environmental stewardship have formed a mega-trend force to profoundly magnify its impact on organizations. The definition of a green organization in the construction, however, is often ambiguous. One may interpolate a green contractor because the company constructs an energy-efficient facility or uses recycled materials. As discussed in the next section, this paper follows the definition from the Engineering News Record (ENR) and Business Week in which green organizations must integrate sustainability into their organizational culture and business operations.

Going green can produce economic values for both clients and contractors. Early studies reported that green commercial buildings use 26% less energy, save 13% on maintenance costs, generate 33% less greenhouse gas emissions, increase occupancy ratio by 3.5%, raise return on investment by 6.6%, create 7.5% more building value, and improve 27% higher occupant satisfaction [Fowler and Rauch 2008; McGraw-Hill 2006; United States Green Building Council (USGBC) 2010; Lee et al. 2012; Oates and Sullivan 2012]. Associated with these green benefits, there is a cost for going green.

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On average, a LEED-certified project costs a 1.84% premium above the total construction cost. The construction costs of a LEED platinum building increases by at least 6.5% (Kats et al. 2003). Construction professionals became suspicious about the return on the investment of going green. How a green firm performs remains unknown, and this knowledge gap poses a major challenge, preventing construction firms from embracing sustainability principles and changing their business paradigm (Myers 2005).

Understanding the benefit and cost of going green helps construction organizations make better decisions on business operations and strategies. This paper presents an empirical analysis of financial performance between green and conventional organizations in the engineering and construction industry. To make a thorough comparison, the analysis is focused on three aspects of corporate financial performance, namely, short-term financial performance, long-term economic returns, and corporate market value. The entire paper is structured as follows. The following section reviews existing knowledge on this topic and proposes the research hypotheses. Section "The Experimental Design" describes the experimental design and data collection process. Section "The Result and Discussion" presents statistical analysis results and explanations. Section "Conclusion" concludes the knowledge contribution and practical implications for industrial professionals.

## Early Studies and Research Hypotheses

### Green Project versus Green Organization

Going green at the project level has been a long-time effort in the construction industry. The LEED certification, initiated in 1998, represents one of the earliest green initiatives in the US building construction industry. The LEED identifies and measures green project performance in nine criteria, including sustainable sites, water efficiency, energy and atmosphere, material and resources, indoor environmental quality, location and linkages, awareness and education, innovation in design, and regional priority (USGBC 2011). Since 2007, a few green rating systems have also been developed for infrastructure projects, including the American Society of Civil Engineers envision rating system, Federal Highway Administration (FHWA) Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) sustainable highways self-evaluation tool, GreenRoad, Green Leadership In Transportation Environmental Sustainability (GreenLITES), and Livable and Sustainable Transportation (I-LAST) (Cui and Zhu 2011).

More than just greening projects, construction organizations incorporate green principles and sustainability policies into their business operations, organizational culture, and management activities. Such green initiatives at the organizational level are believed to drive shareholders' value (Hart et al. 2003). Therefore, new rating systems have emerged to recognize green organizations, although the standards and criteria are still debated. The Newsweek considers the environmental impact, green policies, and green reputation to rank the 500 largest US green companies every year. Six construction and engineering firms were selected on the list in 2010. Similarly, ENR has published the top 100 green contractors and top 100 green design firms since 2007. The ranking was based on green project revenues and numbers of green certificated professionals. In addition, the Associated Builders and Contractors (ABC) has started to issue a green contractor certification to contractors based on four aspects (i.e., prerequisites, elective items, jobsite office complexes, education, and training) that can be further broken down into 53 detail criteria. By the end of 2010, less than 25 construction firms, primarily small to middle size,

had been certified under this system. Other green firm certification and ranking systems exist, for instance the Dow Jones sustainability index. However, few construction firms were evaluated or ranked there.

### Why Businesses Go Green

Organizations have a large variety of reasons to become green. A 2009 survey indicated that energy savings serve as the primary driver toward organizational green initiatives, followed by government regulation motivations, globalization influences, and increased competitive advantage. Being green also contributes to better customer loyalty and attraction, low tax and production costs, high productivity, and improved employee satisfaction and retention (McGraw-Hill 2009). In contrast, many companies may have to comply with environmental standards because of increasing pressure from large green companies on the supply chain (Esty and Winston 2009).

Going green may create corporate benefits and new competitive advantages (Esty and Porter 1998; Hart 1997). Esty and Winston (2009) revealed three basic benefits for adding green initiatives to an organization: the potential for upside benefits, the management of downside costs and risks, and a value-based concern for environmental stewardship. As Porter and Van der Linde (1995) pointed out, in a dynamic competition world, green and environmental principles stimulate innovations and new markets that not only reduce an organization's environmental footprint, but lower the production cost and improve a company's value. This statement seems especially true in the construction industry, where the green market explodes at a dramatic rate. Construction firms will be able to improve their productivity and cost efficiency through waste management, resource conservation for environmental compliance, and lean construction principles (Liker 2004). Additionally, the green competitive advantage can also be sustainable. By addressing environmental and societal concerns, green organizations create the shared value, which enhances corporate competitiveness and simultaneously yields extra productivity benefits in the long run (Porter and Kramer 2011). In theory, the green benefit can be summarized into five aspects as follows:

- **Economic return:** Embracing green strategy can make a positive impact on organizational economic returns, ranging from greening final products, to reducing operational cost, to creating new markets. Seventy-five percent of the largest American firms view sustainability as being consistent with their profit mission, improving financial performance, and therefore actively getting engaged into the sustainability initiatives (McGraw-Hill 2009). Common green practices, including recycling, employee green engagement and activities, green building initiative, and environmental compliance can provide significant economic return. Investment in green and energy-efficient buildings can achieve as much as 10% higher prices per square foot upon sale than conventional buildings (Miller et al. 2008). Initial capital investment in green initiatives will be paid back 10 times over when life-cycle savings are factored in (Kats et al. 2003).
- **Reduced risk:** Going green can avoid and mitigate potential risks from a wide range of aspects, such as regulatory risk from mandatory emissions reduction target, supply chain risk because of transferred environmental costs, product and technology risk caused by competitors' innovations, litigation risk associated with environmental lawsuits, and financial risk from reputation damage or deteriorating asset quality (Lash and Wellington 2007).
- **Brand publicity:** Companies recognize that going green can promote brand value and open unlimited business opportunities.

A green brand, although intangible, offers a differentiated product advantage, and furthermore enables a company to achieve and sustain above-average profitability. Recognizing the green value, an increasing number of companies have started to establish their green leadership by establishing organizational-wide green initiatives, labeling, and marketing green products. The Fluor Corporation (NYSE:FLR), for instance, extensively integrated being green and sustainability into their core business operations and activities. All these efforts have won the company acknowledgment as the best clean energy company, ENR top green design firms, and many awards, which in return helped the company to realize its growth and profitability objective (Fluor 2009).

- Broader sense of payback: Going green could also be a powerful mindset change in evaluating corporate investment and decision (Winston 2011). Traditional investment decision-making primarily depends on return on investment (ROI) in which environmental and societal values are hard to measure and generally out of the analysis scope. With increasing scrutiny on environmental liability and climate change impact, companies are required to measure, report, and manage their environmental risk and social responsibility. Therefore, while organizations are going green, they must incorporate environmental and societal concerns into business investment decisions. With this broader sense of decision-making criteria, organizations can also create a variety of innovative hedging strategies against business risks associated with market, regulation, environment, and society, and eventually create a substantial value to stakeholders.
- Advantage of early entry to new market: In addition to benefiting upstream and downstream industries, going green creates a green industrial sector that generates new green jobs and produces green products and services. It is expected that more than 2 million jobs will be created associated with the green economy (Pollin et al. 2008). Approximately half of new nonresidential construction nationwide will be green within the next 5 years (McGraw-Hill 2011). Organizations first moving into the green market gain the first mover advantage by acquiring governmental support, enriching learning experience, enlightening their workforce, and establishing their reputation. By capitalizing the first mover advantage, organizations will dominate followers in market share, profit margin, and other economic benefits (Lieberman and Montgomery 1988).

### Going Green and Financial Performance

Early research provides a growing body of evidence for linking going green and corporate financial performance. In classical economics, environmental compliance causes additional costs because of negative externality and therefore reduces profitability (Friedman 1970). Recent studies, however, pointed out that environmental investment could be profitable (Orlitzky et al. 2003). Good environmental performance and management can result in positive economic outcomes and significant financial benefits (Clarkson et al. 2011; Schaltegger and Synnestvedt 2002). Cohen et al. (1997) and Dowell et al. (2000) reported a possible higher market performance for environmentally friendly companies based on their empirical studies. Earlier studies were focused on publicly traded organizations to ensure data quality, reliability, and information transparency (Nakao et al. 2007). These data, including financial performance, insider activities, and company news, was audited by accredited third party auditors for compliance and generally accessible to the public (Dowell et al. 2000). The analysis, however, was primarily concentrated on a few measures, and could not provide a holistic evaluation of corporation performance. An

integrated evaluation that covers short-term financial performance, long-term corporate valuation, and capital market performance is still unavailable, and therefore became the focus of this paper.

The typical method in early studies was hypothesis testing through statistical or econometric models, including analysis of variance, regression analysis, and advanced statistical approaches (King and Lenox 2001; Konar and Cohen 2001). Cohen et al. (1997) constructed two industry-balanced portfolios and compared both accounting and market returns of the high polluter to the low polluter portfolio using a *t*-test based on a data set from the Standard and Poor's 500 companies. Dowell et al. (2000) analyzed the United States-based multinational enterprises' stock market performance in relation to the environmental standards, as measured by *t*-test, correlations analysis, and linear regression. Clarkson et al. (2011) used empirical econometric models to examine the firms' longitudinal financial performance in two stages: the determinant regression model for the stage of prior green, and the consequences model for the stage of post green. Scholars also contributed to the knowledge through qualitative and theoretical analysis (Schaltegger and Synnestvedt 2002). Orlitzky et al. (2003) used meta-analysis to review early evidence on the benefit from going green. A few studies applied a hybrid method by combining public databases with questionnaire surveys to provide industry-specific analysis (Delmas and Toffel 2008). These studies have been able to cover a broad range of industries, e.g., the polluting industry (Delmas and Toffel 2008; Clarkson et al. 2011), utilities (Filbeck and Gorman 2004), and the chemical industry (Blacconiere and Patten 1994). However, this is still a knowledge gap in empirical testing of the integrated impact of green strategies on the construction industry, which is characterized by its fragmentation, complexity, and nonintegrated environment.

### Research Hypotheses

Construction organizations were hesitant to embrace sustainability and to change their business paradigm because of the fragmented nature of the industry. This fragmentation associated with distributed construction supply chain and temporary client-contractor relations causes the best practices in other industries to provide limited insights and guidance for engineering construction organizations to move toward sustainability (Hendrickson and Au 1989). Instead, the industry must establish its own agenda for pursuing sustainability agenda (Myers 2005). Under this context, understanding the link between green operations and corporate financial performance is urgent for organizations to make green investment decisions. Additionally, exploring the value creation path through capital investment toward long-term profitability and market value is also critical to blueprint corporate green strategies and activities. Solving these corporate performance concerns in various aspects would essentially establish roadmap guidance for future green practices and present a typical green development plan for the entire construction industry. This paper tries to bridge this knowledge gap by specifically testing three hypotheses regarding the performance of green construction and engineering firms. The hypotheses are described as follows.

1. Green firms outperform conventional firms in short-term financial ratios [i.e., return on equity (ROE) and return on capital (ROC)].
2. Green firms make a significantly greater economic profit and long-term corporate value than conventional firms [i.e., economic value added (EVA) and revenue growth].
3. Going green will create a higher value and corporate recognition in the capital market (measured with price-to-earnings ratio and Tobin's *Q*).



## Experimental Design

Group analysis was conducted to evaluate the financial implication of going green. Two independent groups, namely green portfolio and conventional portfolio, were selected to examine their economic and financial performance. The study followed the four steps discussed as follows: (1) selecting performance measures at three levels: short-term, long-term, and market level; (2) sampling green and conventional companies; (3) analyzing data effectiveness; and (4) testing the hypotheses using statistical analysis.

### Financial Measures

In this paper, corporate performance is defined at three levels: (1) short-term financial performance measured with accounting ratios, i.e., operating profitability and investment return; (2) long-term economic value, i.e., EVA and revenue growth; and (3) capital market performance generally evaluated with price/earnings per share ( $P/E$ ) and Tobin's  $Q$ . Three levels of performance measurement depict a company's performance both on the book and in the capital market, and therefore provide a holistic evaluation of green companies compared to traditional ones. This study applies seven primary measures for performance evaluation summarized in Table 1.

#### Short-Term Financial Measures

In the field of financial accounting, corporate performance is examined annually with various profitability ratios, including ROE and ROC. This paper, following the standard practice, compares profitability ratios of green firms to conventional ones. The ROE was calculated by dividing net income by equity on book. It measures the profit generated from one dollar of equity investment and therefore reflects the operating efficiency against equity investment. The ROC is a proportion of a firm's net operating profit

after tax (NOPAT) to its book value of invested capital. The ROC measures how much return is generated on all invested capital and is considered another key indicator of a company's profitability. The greater the ratios, the better the company's performance.

### Long-Term Economic Values

Companies may gain in the short term, but lose out in the long run. Corporate long-term performance can be described with various approaches, e.g., revenue growth and enterprise value to asset (Clarkson et al. 2011). In this research, two dimensions were used to estimate the long-term performance—EVA as the static value created in a single year, and revenue growth as the incremental rate of corporate development. The EVA estimates the economic profit in excess of a required return for shareholders. It was first developed by Joel Stern in the 1960s then quickly became a widely-accepted indicator of corporate capability to create value for shareholders [Graduate School of Business at University of Chicago (GSB) 1998; Stern Stewart & Co 2011]. The EVA is calculated by subtracting from NOPAT a capital charge representing the cost of capital calculated on the basis of an average return investors expect. To normalize the impact of company size, EVA margin, or EVA-to-revenue, was used to make comparisons (evaDimensions 2010). Revenue growth is the percentage change in a company's revenue between two consecutive years. It measures the scale of business expansion and provides important insights on earnings growth.

### Market Value Measures

Stock price in the capital market directly links to stakeholders' profit and reflects market expectation on a company's long-term performance. Early studies used such indicators as  $P/E$ , Tobin's  $Q$ , and enterprise value (EV) to EBITDA ratio, where EBITDA represents earnings before interest, tax, depreciation, and amortization

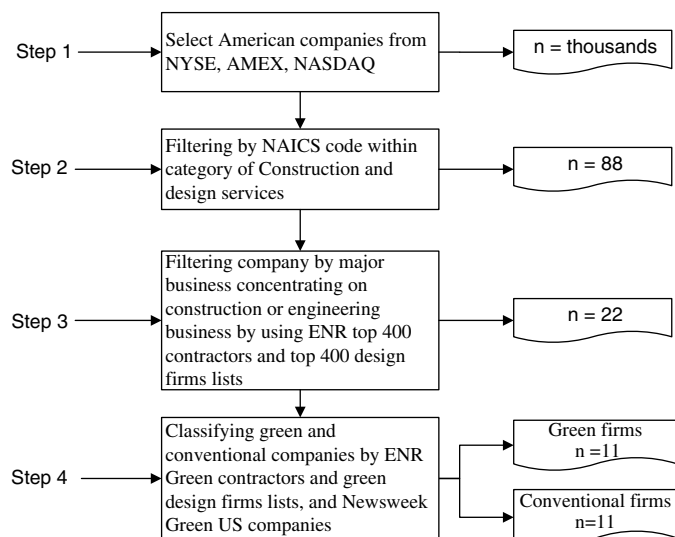
**Table 1.** Summarized Description of the Financial Measures for Construction Firms

Measure	Calculation	Note	Reference
ROE	$\text{ROE} = \text{Net profits} / \text{equity}$	ROE can be further broken down into five components by using DuPont analysis.	King and Lenox (2001), Hart and Ahuja (1996)
ROC	$\text{ROC} = \text{Net operating profit after tax} / \text{Invested capital} = \text{EBIT} - \text{tax} / \text{Invested capital}$	ROC is calculated by using NOPAT divided by invested capital, where the NOPAT is instead by using the reported EBIT minus the corporate tax liability.	Balatbat et al. (2010), Damodaran (2007)
EVA margin	$\text{EVA margin} = (\text{EVA} / \text{Revenue}) \times 100\%$	Notations, formulas, and data sources required in these calculations are shown in the appendix.	evaDimensions (2010)
Revenue growth	$\text{Revenue growth} = [(\text{Revenue}_t - \text{Revenue}_{t-1}) / \text{Revenue}_{t-1}] \times 100\%$	Annualized growth rate of a company's total revenue.	Clarkson et al. (2011)
$P/E$	$P/E = \text{Stock price} / \text{Earnings per share (EPS)}$	Stock price is accessed on the last trading day of each year. EPS is the amount of earnings per average outstanding shares of a company's stock, which is determined by company's net income over its weighted average outstanding shares. A high $P/E$ ratio represents that investors pay more for each unit of net income. It also suggests that the company is expected an optimistic earnings growth in the future. The average $P/E$ ratio in capital market is approximately 15–20.	Balatbat et al. (2010)
Tobin's $Q$	$\text{Tobin's } Q = \text{Total firm's market value} / \text{Replacement value of the firm's asset}$	Tobin's $Q$ ratio equals 1.0 when the market value exactly reflects firm's recorded assets. When $Q > 1$ , the market value is greater than the value of the firm's recorded assets or the stock is overvalued. If $Q < 1$ , the deployment of real assets will earn a sufficient rate of return. Investors are pessimistic about the future market returns. The average value of Tobin's $Q$ ratio in 1990–2009 is 0.76 (Milaljevic 2009).	King and Lenox (2001)
EV/EBITDA	$\text{EV/EBITDA} = \text{Enterprise value} / \text{EBITDA}$	A great ratio indicates that a company might be overvalued than its actual value, whereas a low ratio represents undervalue. The historical EV/EBITDA ratio in the stock market ranges from 6–8. The EV/EBITDA is neutral to a company's capital structure and allows more fair comparison than by using $P/E$ ratio.	Fernandez (2001)

(Jacobs et al. 2010; King and Lenox 2001). The  $P/E$  ratio is defined as the stock price per share divided by its earnings. This ratio is the most common measure of a company's market performance and value. Tobin's  $Q$  is the ratio between the market value and replacement cost of the same physical asset (Tobin 1969). Tobin's  $Q$  is usually used to provide a longer-term buy and hold approach for value-oriented analysis. The  $EV/EBITDA$  ratio is another common measure of corporate valuation in various industries (Fernandez 2001). The  $EV$  measures the price paid by investors, whereas  $EBITDA$  reflects a company's cash flow but excludes debt-related expenses and acquisition-related expenses. This ratio describes a company's market performance on a risk-adjusted basis.

### Sampling and Data Collection

The scope of this research was limited to publicly-traded engineering and construction firms in the United States because of data availability and integrity. The research used a cluster sampling technique that allows accurate and efficient representation of construction organizations (Fig. 1). Three major capital markets, including the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and NASDAQ Stock Market were used to identify sample companies based on the North American Industry Classification System (NAICS) code. Furthermore, widely accepted green company lists were applied to categorize sample companies into two groups: a green group versus a conventional one. Two major green lists were employed, including the ENR top 100 green contractors list in 2007, 2008, and 2009, top 100 green design firms in 2008 and 2009, and Newsweek green US companies rankings (Newsweek 2010). Finally, 11 green companies and another 11 conventional companies were selected to build a green group (or experimental group) and a conventional company group (or a control group). The list of companies and their business information are summarized in the appendix. The total revenues of the green portfolio in 2009 were \$84 billion with the total revenues of the conventional portfolio at \$11 billion. Furthermore, these companies are categorized into groups according to their primary service sector. The classification is intended to examine if green strategies have made similar financial impact on engineering and construction firms. Companies' financial data were collected through Yahoo finance, Hoover's online, Capital IQ, and other databases, which were licensed to the University of Maryland. All data have



**Fig. 1.** Sampling and classification process to select green and conventional firms

been carefully assessed for quality and applicability to this study using descriptive statistics, followed by a detailed investigation on organization financial reports. For instance, Layne Christensen recorded many extraordinary items in 2009, which caused a usual jump in its tax burden compared to other periods. Other similar types of outliers have been eliminated from the analysis.

### Statistical Methodology

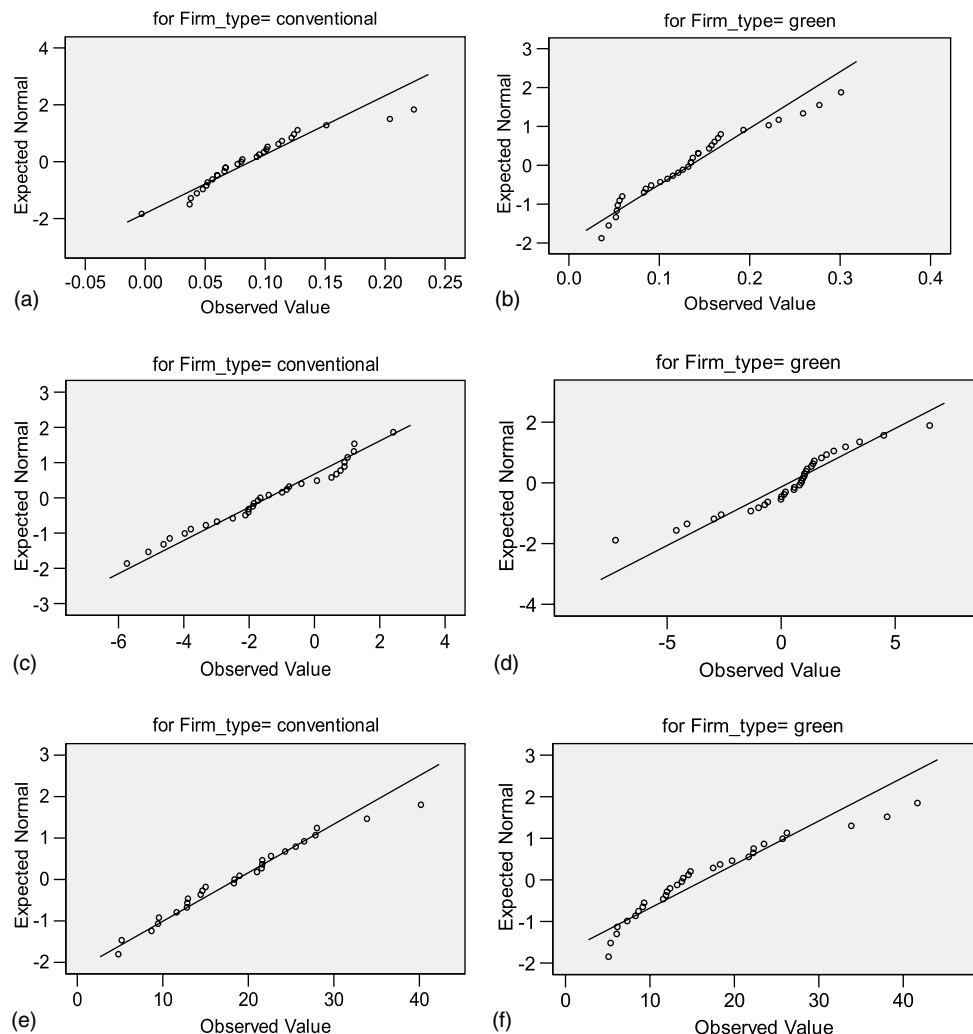
To test the hypotheses, a comparison was conducted to examine the financial measures between the experimental group and control group. All three years' data were combined to generate an acceptable sample size. Normality test was performed to select parametric or nonparametric statistical methods. Considering the relatively small sample size in this study, a normal quantile plot (also called Q-Q plot) was used to graphically examine the normality of the population. In the Q-Q plot, two probability distributions were compared by plotting their quantiles against one another. If the distributions were linearly related, the points in the Q-Q plot will approximately lie on a line. For the purpose of normality test, the sample data are plotted against an expected normal distribution in such a way that the observed points should form an approximate straight line. Departures from this straight line indicate the normality assumption does not hold. The normality test was performed for major financial measures of both experimental and control groups. The test results of the Q-Q plot in Fig. 2 display a clear linear pattern of sample data, which suggests that the data are normally distributed for both groups. Meanwhile, the assumption of homogeneity of variance for the  $t$ -test can also be reserved because of the equal number of observations for two portfolios ( $n_1 = n_2 = 11$ ). This assumption can ensure the statistical analysis is in compliance with acceptable Type I and Type II errors. In addition, the Pearson correlation has also been calculated to examine the independence among subject groups. The Pearson correlation result shows insignificant correlation except for Tobin's  $Q$  (0.6). A statistical analysis package, SPSS 17.0, was used to run  $t$ -test after data collection and tabulation. The SPSS built-in module and functions, especially box plot, was used to eliminate outliers in the data set.

### Result and Discussion

Based on the aforementioned financial performance metrics and available data sources for green and conventional contractors during 2007–2009, the result of  $t$ -test for two independent groups is summarized in Table 2. Selected financial performance measures in short-term, long-term, and capital market are depicted in Fig. 3.

#### Short-Term Financial Performance

Statistical analysis suggests that green firms outperform conventional firms by short-term financial measures. The average ROE among green firms was 17.4% in 2007–2009. This represents one time higher than the profitability of conventional firms during the same time frame, which is on average at 8.2% ( $p$ -value = 0.002). Because corporate operating performance depends largely on the macroeconomic conditions and market factors, it is interesting to compare the financial performance of green and conventional firms under the economic downturn. As shown in Fig. 4, green firms displayed better financial performance in times of both economic growth and downturn. In 2007, the profitability of green firms was 20.6% by ROE, or approximately 2.5 times the profitability of conventional ones. Because the economic recession started in December 2007, both groups experienced profit margin erosion as a result of weakened demand. The average ROE for



**Fig. 2.** Q-Q plots of financial measures for green and conventional firms for (a) ROC; (b) ROC; (c) EVA margin; (d) EVA margin; (e)  $P/E$  ratio; (f)  $P/E$  ratio

**Table 2.** Statistical Analysis of Financial Measures for Green and Conventional Firms

Measures	Mean		Standard deviation		T-test (1-tailed)
	Green firms	Conventional firms	Green firms	Conventional firms	
ROE	17.4%	8.2%	0.155	0.067	0.002 <sup>a</sup>
ROC	13.4%	8.8%	0.069	0.048	0.002 <sup>a</sup>
EVA margin (%)	0.351	-1.432	2.593	2.123	0.002 <sup>a</sup>
Revenue growth	12.4%	6.4%	0.160	0.180	0.093
$P/E$	16.478	18.607	9.544	8.536	0.190
Tobin's Q	0.995	1.013	0.709	0.605	0.457
EV/EBITDA	7.792	8.082	5.019	5.203	0.413

<sup>a</sup>Significant at the 0.01 level.

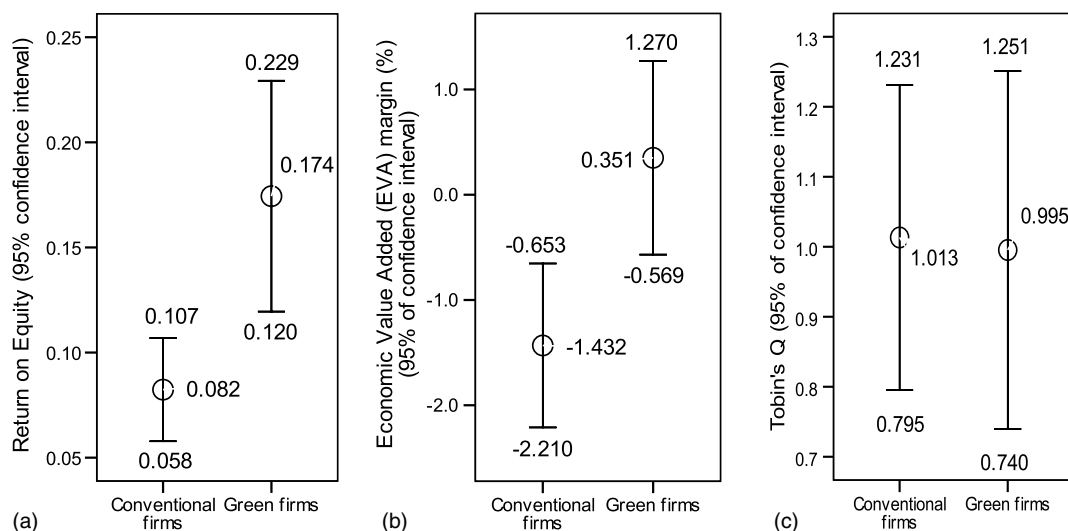
green firms decreased to 18.8% in 2008 and 13.0% in 2009, whereas conventional firms had a ROE of 11.2% in 2008 and 5.5% in 2009. The difference of profit margin had narrowed since the economic recession. It should be noted that green firms suffered from the economic recession much earlier than conventional ones. Whereas conventional firms still maintained a 35% growth rate of the net profit margin in 2008, green firms had already decreased their average ROE in the same year. The profitability growth during the early period of the recession may be attributed to the high backlog in the construction industry. According to the Associated

Builder and Contractors, the average backlog for the past four years ranged from 5–12 months (ABC 2012). Furthermore, green firms appeared more sensitive to the economic conditions and therefore more vulnerable to the economic downturn. Their profit margins shrunk at a faster rate than conventional ones in 2008 and 2009. It is also worth noting that construction organizations would benefit more than engineering firms when they move toward green operation. On average, construction firms made a 22.37% of return on equity as compared to engineering firms at 11.52%. Being relatively new to construction organizations, sustainability increasingly becomes ingrained in the mission and administration of construction organizations no matter whether they actually achieve or meet the requirements.

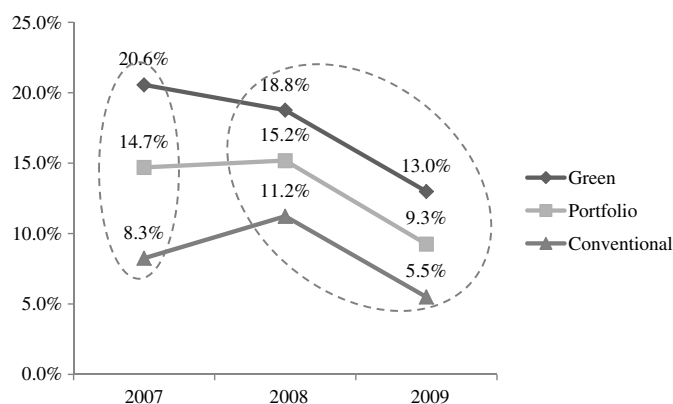
The ROC measures tax-adjusted operating return on invested capital. It indicates a company's operating efficiency for all capital under its control. The statistical analysis reports a difference between the green group and conventional one (13.4 versus 8.8%) at the significant level of 0.002 (see Table 2). This difference again indicates a higher operating profit for green firms in the engineering and construction industry.

### Long-Term Performance

In corporate finance, the corporate value is derived by discounting all future profits and future cash flow from the realized profits. Two



**Fig. 3.** Financial performance of green and conventional firms in (a) short-term; (b) long-term; (c) capital market



**Fig. 4.** Return on equity for green and conventional firms during 2007–2009

financial measures can be used to predict a company's performance in the long run, namely, annual economic profit and business growth. The EVA measures a company's economic profit in excess of all required return on all invested capital, both equity and debt. The fundamental concept of EVA calculation suggests that the corporate value is created only when the company realizes a return on investment that is above the required rate or the market average for all stakeholders. When more companies have to seek for innovative approaches to improve efficiency and create value to their shareholders under the current economic recessions, it is especially important to employ a company's EVA for performance evaluation. In this study, EVA margin, or EVA over revenue, was used to eliminate the impact of company size. The statistical analysis shows that the EVA margin of green contractors was significantly ( $p = 0.002$ ) higher than conventional contractors (0.35 versus 1.43%). This represents a positive economic profit for green firms, but an economic loss for conventional ones. All shareholders of green firms would receive required return from interests, dividends, or price appreciation. Conventional firms, however, did not deliver required return to stakeholders during the same period of time. Engineering firms yielded a higher EVA margin at 0.75% as compared to construction firms, which kept a 0.02% of EVA margin. This can be explained as the reason that the construction industry in general produces a low profit margin as a whole compared to other industrial sectors,

including engineering service providers. Within the engineering construction industry, green firms demonstrate better profitability and productivity through operating efficiency and asset management. Conventional firms, although with an average ROC of 8.8%, did not meet a required rate of return after considering the cost of equity in the market as a whole. Because the economic profit is viewed as an important driver and indicator for effective performance management, green firms show stronger capability to improve the firm's three Ps: price, product, and process (evaDimensions 2010).

During 2007–2009, green firms were observed to grow faster than conventional ones. On average, the revenue grew 12.4% annually for green firms versus 6.4% for conventional ones. However, this difference is statistically insignificant ( $p = 0.09$ ), probably because of the fact that the companies' revenue growth had been widely varied and substantially volatile under the economic recession. If only the period before the recession is considered, green firms led in revenue growth by 7.1% on average at a significant level of 5%. Therefore, it is safe to draw a conclusion that green firms have experienced more rapid growth, but could be highly vulnerable to unfavorable economic conditions. More evidences have been observed from the Engineering News Record (ENR 2012) green project records. During 2007–2008, the average green project revenues for the ENR top 100 green contractors raised dramatically from \$399 million to \$666 million, i.e., a 67% increase. The revenues suddenly dropped by 118.6% in 2009 when the economic recession was factored in.

### Capital Market Performance

Corporate market performance, or the performance of corporate stock, reflects the tendency for investors to weight a company's operational efficiency and to form expectations of future performance. Although going green produced significant financial results for construction and engineering firms, their stock prices have not responded to this strategic innovation. A comparison of  $P/E$ , Tobin's  $Q$ , and  $EV/EBITDA$  ratios shows insignificant difference between stock prices of green firms and conventional firms during 2007–2009 (Table 2). The  $P/E$  ratio of green firms and conventional firms was 16.5 and 18.6 with a  $p$ -value of 0.381. Tobin's  $Q$ , used to highlight over or undervaluation of financial assets stocks, shows indifference between green firms and conventional ones. The same result can be obtained when analyzing the



EV/EBITDA ratio between two groups, in which a high  $p$ -value proves that the null hypothesis is true.

It is unclear why being green has not yet been priced in the stock price for engineering and construction firms. Further analysis is needed before one draws a definitive conclusion regarding the relationship between going green and corporate stock price. Were green firms undervalued in the market, or did investors underestimate the potential gains from companies' sustainability strategies? Because green gains were approximately offset by the high volatility inherent in the return of going-green efforts, the present stock prices represent the risk-adjusted fair value of green firms.

### Dupont Analysis

Previous results provide a holistic picture of financial performance of green versus conventional firms. This section aims to identify the drivers behind the outperformance of green organizations through a detailed focus lens. The paper uses the DuPont analysis to compare the short-term performance difference. The DuPont method breaks down ROE into five components that represent a company's performance in tax burden, interest burden, operating profit margin, asset turnover, and financial leverage. The results are summarized in Table 3.

Better financial performance of green firms can be attributed to three aspects, i.e., strong asset turnover, high financial leverage, and low interest expense. At a significant level of 5%, these three indicators are significantly better for green firms. Calculated by dividing total revenues by total assets, asset turnover ratio measures a firm's efficiency at using its assets in generating revenue. Companies with strong asset turnover ratios are able to create higher value at the same amount of shareholders' investments. Given the asset turnover ratio of 1.87 for green firms and 1.25 for conventional firms, it is obvious that green firms generate approximately 50% more revenues than conventional firms with the same total assets. This result aligns with the rapid growth of the green construction market as reported by McGraw-Hill. As the fastest growing sector of the construction market, green buildings have grown from less than 2% of the US single-family residential construction market in 2005 to 17% in 2011. In addition to that, green residential is slated to increase to as much as 38% of the market by 2016 (McGraw-Hill 2012).

Financial leverage will increase the return on equity. Green firms tend to be highly leveraged. On average, green firms' 2.7x asset-to-equity ratio is significantly higher than conventional firms' 1.9x (Fig. 5). However, one should be cautious to draw firm conclusions from this analysis because of the sample characteristics in this study. Within the sample companies, the size of green firms is much larger than conventional firms. Early studies reported that larger firms have easier access to the capital market and borrow at more favorable interest rates (Ferri and Johns 1979). However, green firms do show a very competitive interest expense structure. While conventional firms have an average interest burden of 0.852, green firms demonstrate outstanding performance with an interest burden disproportionate to a company's size.

Interest burden measures the corporate financial efficiency and is determined by a percentage of earning before tax (EBT) over earning before interest and tax (EBIT). If the ratio is equal to and exceeds 1.0, a firm essentially generates extraordinary income. This implies that green companies are able to get access to extremely competitive loans, for example, federal credit programs, and benefit from their effective cash management.

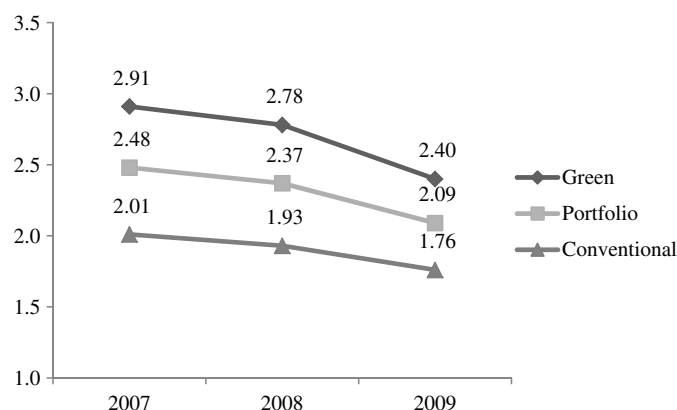
Going green does not offer operating cost advantage. On the contrary, green firms show significantly higher operating expenses than conventional ones because of initial investments in green

**Table 3.** T-Test of DuPont Analysis for Green and Conventional Firms

Measures	Mean		Standard deviation		T-test (1-tailed)
	Green firms	Conventional firms	Green firms	Conventional firms	
Asset turnover	1.870	1.251	0.650	0.469	0.000 <sup>a</sup>
Leverage	2.695	1.900	0.877	0.445	0.000 <sup>a</sup>
Interest burden	1.002	0.852	0.265	0.412	0.045 <sup>b</sup>
Operating profit margin	0.053	0.065	0.022	0.028	0.031 <sup>b</sup>
Tax burden	0.653	0.652	0.109	0.155	0.497

<sup>a</sup>Significant at the 0.01 level.

<sup>b</sup>Significant at the 0.05 level.



**Fig. 5.** Financial leverage for green and conventional firms during 2007–2009

technologies and processes. It should be noted that the cost disadvantage for green firms would narrow over time. In 2007, conventional firms led a cost advantage by 2.1% (7.0 versus 4.9% in operating profit margin). The difference slowly narrowed to 1.6% in 2008 and approximately towards zero in 2009. With an emphasis on a green market focus strategy rather than cost leadership, green firms will be able to overcome their cost disadvantages by leveraging differentiated products and prices. For example, by attaining an Energy Star or LEED certification, green contractors help commercial building owners increase the rent by 6% per square foot and raise the selling price by as much as 13% (Eichholtz et al. 2010a, b). Furthermore, the improvement in financial performance was not associated with the favorable taxation treatment of green firms. During the analysis period, green firms shared the same tax burden as the conventional ones.

### Conclusion

This study suggests that going green is paid off at the corporate level, but not at the market level. In the short term, green companies can earn a higher return on equity and investment than conventional ones. In the long term, the going green strategy could create tangible values in two aspects: high economic profit and strong revenue growth. These two aspects ensure green firms gain incremental positive values and eventually outperform the others. However, going green has not yet been paid off in the financial market, as demonstrated by the  $P/E$  ratio, Tobin's  $Q$  ratio, or the EV/EBITDA ratio. Although it is still unclear why going green has not been incorporated into the stock price, two factors probably contribute to the better financial performance of green firms. First, green firms have strong asset turnover because of rapid growth of the green market during the recent period. Therefore, green firms can



generate higher revenues at relatively low assets. Second, green firms obtain favorable debt terms and therefore reduce their interest expenses and support their high financial leverage. Although green firms generally face high operating costs, the reduction in financial cost helps offset the cost disadvantage of going green.

The study provides valuable insights on organizational and investment strategies in the engineering and construction industry. By investing in green technologies and implementing green strategies, construction organizations can create added value to stakeholders. The green strategy represents a higher return on capital and larger economic profit. The extra profit results from riding with the green wave and requires construction organization to follow a focus strategy. The cost disadvantage of going green would narrow when the initial green technology investment is depreciated over time. More importantly, going green enables a firm to achieve increased differentiation, and sequentially safeguards the potential for profit margin. Additionally, construction firms must be aware of increased risks associated with the green strategy. With substantial financial

benefits from going green, green companies are more vulnerable to uncertain market conditions, and therefore may not attract sustained interest from private equity. Conversely, these undervalued green organizations represent a potential exciting investment opportunity for long-term investors.

Because of the availability of confidential financial data, the research was focused on publicly traded engineering and construction firms. One should be cautious of applying the results from this study directly to privately owned organizations. Although this study provides valuable managerial insights on why an organization embraces sustainability in its business operation, it remains unknown what internal and external factors play the role and how they transform the organization into a successful and profitable system when it moves toward green operations and sustainability. It is also worth further investigation on the impact of economic market conditions on different construction sectors. After all, economic stimulus plans may promote more growth in some sectors than in others.

## Appendix. List of Green Companies and Conventional Companies

The appendix shows at-a-glance information about sample companies used in this study, including company name, stock ticker, green evaluation criteria, industrial sector, business scope and annual revenue in 2009.

Number	Green company	Public market and ticker	Green criteria	Sector	Business scope	Revenues in 2009 (\$ in millions)
1	KBR, Inc.	NYSE: KBR	ENR-GC	D/E	Engineering and construction	12,060
2	Tutor Perini Corporation	NYSE: TPC	ENR-GC	C	Civil and building construction	5,152
3	Primoris Services Corporation	NASDAQ (GM): PRIM	ENR-GC	C	Construction and infrastructure	467
4	URS Corporation	NYSE: URS	ENR-GD	D/E	Engineering, construction, and technical services	9,249
5	AECOM Technology Corporation	NYSE: ACM	ENR-GD	D/E	Professional technical and management services	6,119
6	Tetra Tech, Inc.	NASDAQ (GS): TTEK	ENR-GD	D/E	Environmental engineering and consulting	1,386
7	Fluor Corporation	NYSE: FLR	Newsweek	C	Engineering, procurement, construction, maintenance, and project management	21,990
8	Jacobs Engineering Group Inc.	NYSE: JEC	Newsweek	D/E	Technical, professional, and construction services	11,467
9	Mcdermott International, Inc.	NYSE: MDR	Newsweek	C	Engineering and construction	3,282
10	EMCOR Group, Inc.	NYSE: EME	Newsweek	C	Construction, infrastructure, and facilities services	5,548
11	The Shaw Group Inc.	NYSE: SHAW	Newsweek	C	Engineering, procurement, and construction	7,280
					Subtotal:	84,000
Number	Conditional company	Public market And ticker	Industry		Business scope	2009 Revenues (\$ in millions)
1	Granite Construction Incorporated	NYSE: GVA	ENR-C	C	Heavy civil construction and materials	1,963
2	Pike Electric Corporation	NYSE: PIKE	ENR-C	C	Engineering, construction, and maintenance	613
3	Hill International, Inc.	NYSE: HIL	ENR-C	D/E	Project management and construction	422
4	TRC Companies, Inc.	NYSE: TRR	ENR-C	D/E	Engineering, consulting, and construction management	255
5	Layne Christensen Company	NASDAQ (GS): LAYN	ENR-C	C	Infrastructure and mineral services	866
6	Matrix Service Company	NASDAQ (GS): MTRX	ENR-C	C	Engineering, fabrication, construction, repair, and maintenance	690
7	Sterling Construction Company, Inc.	NASDAQ (GS): STRL	ENR-C	C	Heavy civil construction	391
8	Orion Marine Group, Inc.	NYSE: ORN	ENR-C	C	Heavy civil marine construction	293
9	Great Lakes Dredge and Dock Corporation	NASDAQ (GS): GLDD	ENR-C	C	Specialized construction	622
10	Willbros Group Inc.	NYSE: WG	ENR-C	D/E	Project management, engineering, material procurement, maintenance	1,260
11	Quanta Services, Inc.	NYSE: PWR	ENR-C	C	Specialized infrastructure construction	3,318
					Subtotal:	10,693

Note: ENR-GC indicates ENR top 100 green contractors list (2007–2010); ENR-GD indicates ENR top 100 green design firms list (2008–2010); Newsweek indicates green 500 US companies in 2010; ENR-C indicates ENR top 400 general contractors; revenue data are accessed from the Google finance database; D/E represents design/engineering firms; C represents construction firms based on the corporate publicly traded category.

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