Exploring the influence of project manager leadership on the success of green building
——Based on multi-group structural equation model

Jinjian Liu1* Peidong Sang1 Lingqiao Zheng2

1 School of Management Engineering, Shandong Jianzhu University, Jinan 250101, China
2 Department of Urban Studies and Planning, University of Sheffield, Western Bank, Sheffield S10 2TN, UK;
*Corresponding author’s e-mail: sdjzljj0506@163.com

Abstract: The project manager's leadership is a key to the success of construction project. With the further worsening of environmental and energy problems, the development of green building has become an inevitable trend. There are little studies on project manager leadership evaluation based on green building project. Through literature review and group discussion, the key success indicators, project manager leadership style and 14 leadership indicators were determined. The hypothesis test was verified by questionnaire survey and multi-group structural equation model. The results provide a theoretical basis for selecting excellent project managers for green building projects.

1. Introduction
Project managers are the key figure of temporary organization and management of construction projects. Their leadership style, management ability and knowledge reserve will have a significant impact on the operation efficiency of the project. In China’s construction industry, project managers need to communicate and coordinate with the government, construction units, supervision units, subcontractors and other stakeholders outside, and lead project teams inside. The level of their leadership has a great impact on project performance [1]. Therefore, determining the leadership framework of project managers is the premise and basis for selecting a qualified project manager, which is an important path for project success.

However, in recent years, the accelerated development of new urbanization, the problems of resource shortage and environmental deterioration have restricted the development of the construction industry. Green building (GB) has gradually received widespread attention in China, and has achieved rapid development [2]. However, compared with other countries, the construction of China's GB started relatively late. In 2006, the first "Green Building Evaluation Criteria" was promulgated. Its definition of GB is: saving resources (energy, land, water and material) to the maximum extent, protecting the environment and reducing pollution in the whole life cycle of the building, and providing healthy, applicable and efficient use of space and harmonious coexistence with nature for people [3].

Starting from the project objectives, GBs have goals such as energy saving, land saving, water saving, material saving and environmental friendliness. At the construction stage, there are still some problems, such as novel design scheme, complex construction method, shortage of green materials and so on. These problems will put forward new requirements for the project managers’ leadership. Due to the late
start of GB development in China, there is a lack of research on this aspect. In view of this, this paper attempts to determine the key success indicators of GB through literature research. Then, focuses on the research and construction of project manager's leadership model.

2. Literature review

2.1 Key success indicators of green buildings

Through literature analysis, it is found that researchers hold the same idea on the definition of key success indicators of GB projects: to minimize the damage to the surrounding environmental system. LEED (Leadership in Energy and Environmental Design) evaluation system makes a comprehensive investigation of GBs from six aspects: location and transportation, sustainable building sites, water resources utilization, building energy conservation and atmosphere, resources and materials, and indoor air quality [4]. The GB certification index under BREEAM system mainly includes nine aspects: management, health and comfort, energy, transportation, water, materials, land use and ecology, garbage and pollution [5]. Singapore's Green Mark evaluation system measures the quality of GBs from five aspects: energy efficiency, water efficiency, environmental protection, indoor environmental quality and other green characteristics [6]. The 2014 edition of China's Green Building Evaluation Criteria gives seven evaluation indicators: land saving and outdoor environment utilization, energy saving and energy utilization, material saving and material resources, water saving and water resources utilization, indoor environment quality, operation management and construction management. This study chose the common indicators of each system as the key success indicators of GB projects. The final four GB key success indicators are displayed as follows: water saving(WS), energy saving(ES), material saving(MS) and indoor environment quality(IEQ).

2.2 Indicators of project manager's leadership

The effective lead of the project manager is the guarantee of the success of the GB project. To study the project managers' leadership, the first step is define their leadership style, and then determine the leadership indicators [7]. Liu's research proves that project managers with different leadership styles have different impacts on green innovation degree of construction projects [8]. The paper divides the project manager's leadership style by using the classical theory of Bass: transformational and transactional leadership style. Among them, transformational leadership means that project managers can provide clear objectives in their work, stimulate employees' willingness to work and give them humanistic care. Transactional leadership refers to the rewards and punishments that project managers mainly provide in material or spiritual aspects in their work [9].

Through literature review, this paper studies project managers' leadership indicators from four dimensions: organization and management, transformational leadership, basic quality and emotional quality (EQ). Project managers' organizational and managerial ability has a greater positive incentive effect on the success of GB projects. Zhang puts forward for the first time a competency evaluation system for Chinese construction project managers, which consists of four dimensions: management skill, cognition, emotional quotient and personality charm. Among them, organization and coordination and communication are attributed to the two most important factors in the management skills dimension [10]. Gushagr's research shows that communication skills, management skills and team building capabilities are the main factors affecting project success. So, there is a hypothesis H1:

H1: The ability of project managers to organize and manage has a positive impact on the key success indicators of green building projects.

Tabassi proposes that the leadership of project managers for sustainable construction should also have transformational leadership, in which transformational leadership refers to the ability of project managers to change individuals in their work [11], so as to surpass the status quo and improve the ability to innovate and adapt to the team environment. Daft earlier proposes that project managers should have the ability to train their subordinates and motivate them [12]. Dainty points out that in the context of urbanization, it is necessary to focus on improving project managers' health and safety management
Therefore, there is a hypothesis H2:

**H2: The transformational leadership ability of project managers has a positive impact on the key success indicators of green building projects.**

Basic quality refers to the professional skill knowledge and learning ability to keep pace with the times, which project managers need to possess. Hou pointed out that the most important dimension of project manager’s leadership is personal competence, which includes project manager's professional knowledge and learning ability. Cui proposed that project managers should possess personal qualities and basic knowledge and skills [14]. Chou proposes that the ability of information acquisition and policy interpretation should be emphasized by project managers in the process of GB projects. [15]So, there is a hypothesis H3:

**H3: The basic quality of project managers has a positive impact on the key success indicators of green building projects.**

The EQ of project managers also influences the success or failure of construction projects to a large extent. Liao proposed that project managers should have interpersonal competence to cope with the interpersonal complexity of the project [16]. Potter proposed that new interpersonal relationships need to be developed in more novel or complex projects, and project managers need to have higher EQ [17]. Therefore, there is a hypothesis H4:

**H4: The EQ ability of project managers has a positive impact on the key success indicators of green building projects.**

Finally, the project managers' leadership indicator system including basic quality, organization and management, EQ and transformational leadership is determined as shown in Table 1.

| Table 1 Proposed leadership of the project manager. |
|---------------------------------|------------------------------|
| Dimensions                      | Factors                      |
|---                              |------------------------------|
| Organize and manage             | F1 Co-operation              |
|                                 | F2 Engaging in communication |
|                                 | F3 Teamwork                  |
|                                 | F4 Conflict management       |
| Transformational leadership ability | F5 Develops followers into leaders |
|                                 | F6 Inspire followers to go beyond their own interest |
|                                 | F7 Health and safety management |
| Basic quality                   | F8 Professional knowledge    |
|                                 | F9 Information seeking and management |
|                                 | F10 Interpretation of policy |
|                                 | F11 Learning                 |
| Emotional quality               | F12 Interpersonal skills     |
|                                 | F13 Emotional control ability |
|                                 | F14 Guanxi management        |

3. Model construction and data analysis

3.1 Model construction

Based on the above literature review, this paper considers the following aspects when constructing the model of contractor project manager's professional competence to the key success indicators of GB construction: the model should reflect the basic characteristics of project manager's leadership, and should be representative and concise. This paper assumes that all exogenous latent variables directly affect the outcome variables, all variables are latent variables, and project manager’s leadership style is a moderating variable. According to the setting of the model, the interaction between variables is assumed as follows:
3.2 Data collection

In view of the research on the project managers’ leadership of GB, this paper collects data by means of questionnaire survey. In the first part of the questionnaire for background information collection, the project manager leadership style options are set. The questionnaire is designed according to 14 leadership indicators and 4 key success indicators, and each indicator is scored by the respondents. The questionnaire is scored by 5-point Likert scale. The scoring method is as follows: 5-point indicates that the leadership is very important for project managers in GB projects, and 1-point indicates that the leadership is not important.

In order to ensure data quality, the survey covers personnel of different units and enterprises, and also invites experts with different educational backgrounds, working experience and university researchers to participate. There are two ways to distribute questionnaires: one is to distribute them face to face, the other is to distribute them online by mail. The total number of questionnaires is 360, of which 339 are recovered and 310 are valid, and the effective recovery rate is 86.1%. The statistics of the specific subjects in the sample survey are shown in Table 2.

Table 2 Background information of respondents.

| Category                | Frequency |
|-------------------------|-----------|
| Leadership style        |           |
| Transformational        | 133       |
| Transactional           | 177       |
| Working experience      |           |
| <5                      | 118       |
| 6-10                    | 43        |
| 11-15                   | 41        |
| 16-20                   | 37        |
| >20                     | 71        |
| Working category        |           |
| Real estate enterprise  | 42        |
| Construction engineering| 94        |
| Engineering consulting  | 54        |
| Engineering supervision | 46        |
| Professors              | 74        |
| Position                |           |
| Senior manager          | 41        |
| Middle manger           | 73        |
| Grass-roots managers    | 97        |
| Others                  | 99        |
3.3 Data analysis

3.3.1 Overall testing
In this paper, SPSS22.0 and AMOS22.0 are used for validation analysis of data. Firstly, the reliability and validity of the data are tested by SPSS22.0 software, and the overall Cornbach's α value is 0.941, which shows that the quality of the questionnaire recovered is good. Secondly, there is the confirmatory factor analysis of data, in which KMO statistic is 0.921; Bartlett spherical test results are significant (P = 0.000), the variance contribution rate of the extracted four common factors is 78.04% and the corresponding factor load of each variable is higher than the standard value of 0.5.

Fitness test of model: The test of model assumed is realized by AMOS 22.0 software. Before evaluating the model fitness, the paper makes a "violating estimation principle" test on the data in order to test whether the estimate number is within an acceptable range. There is no negative error term in the model, and the standard error is acceptable. The model does not show the result of "violating estimation principle", so it can be used to test the overall fitness of the model. The results of correlation fitting are shown in Table 3. In Table 3, the value of $\chi^2$/df is 3.016, which is almost equal to the critical value. However, is easily affected by the sample size. Therefore, the fitness of the model should not only be based on the ratio of Chi-square to the degree of freedom as a reference criterion, but also be combined with other fitness criteria. The indexes of GFI, PGFI, RMSEA and PNFI all meet the standards. Therefore, the overall fitness of the model is ideal.

Hypothesis testing of model: As can be seen from Table 4, the path coefficients of hypothesis testing are all positive, and the P value results are significant. Therefore, the four hypotheses proposed in this paper are supported on the whole level, that is, the project manager's organization and management ability, transformational leadership ability, basic quality ability and EQ have a great positive impact on the key success indicators of GB projects.

### Table 3 Goodness of fit of model.

| Goodness of Fit Measure | Level of Acceptance Fit | Fit Statistics |
|-------------------------|-------------------------|----------------|
| $\chi^2$/df             | <3                      | 3.016          |
| GFI                     | >0.9                    | 0.932          |
| RMESA                   | <0.1                    | 0.086          |
| PNFI                    | >0.5                    | 0.786          |
| PGFI                    | >0.5                    | 0.825          |

### Table 4 Hypothesis results for model

| Hypothesis | Estimate | P     | Result |
|------------|----------|-------|--------|
| H1         | 0.4      | ***   | Support|
| H2         | 0.423    | ***   | Support|
| H3         | 0.298    | ***   | Support|
| H4         | 0.316    | ***   | Support|

3.3.2 Multi-group analysis based on leadership style
Multi-group structural equation analysis (MSEA) can better distinguish and judge the fitness degree of a certain sample to the overall model. This paper chooses project manager leadership style as a moderating variable to conduct multi-group analysis. Multi-group analysis of project manager's leadership style shows that the fitness test of the model meets the minimum requirements in Table 3. These indicators show that the multi-group analysis model is well adapted to the sample data, and the specific results are shown in Table 5.

### Table 5 Results of multi-group analysis.

| Leadership Style | Hypothesis | Transformation | P   | Transaction | P   |
|------------------|------------|----------------|-----|-------------|-----|

4. Conclusion

The organization and management ability of project managers is positively correlated with the key success indicators of GB projects, and there is no significant difference in the analysis results of project managers' leadership style based on multi-group analysis. At present, the development of GBs in China is not yet mature. On the one hand, project managers have to deal with the doubts from investors; on the other hand, they have to solve the problem of shortage of technicians. It’s a necessary ability of project managers of the two leadership styles to establish a good communication mechanism with investors, supervision units and construction technicians to form a harmonious team cooperation relationship. The test results of hypothesis H1 are consistent with the reality.

The EQ of project managers is positively correlated with the key success indicators of GB projects. In the implementation process of GB construction, project managers are at the core of social network. Because most of the current GB projects are dominated by the government, the scope of communication between project managers and the government will be further expanded in this context. Compared with traditional construction projects, project managers will endure more complex social interaction activities. Good interpersonal skills, relationship development and other abilities will help them to quickly establish friendly relations with all parties.

The transformational leadership of project managers is positively correlated with the key success indicators of GB projects. The results of leadership style analysis of project managers based on multi-group analysis show that there are significant differences: The P value of transactional leadership data is greater than 0.05 (P=0.096), indicating that there is no relationship between this ability and project success. Transactional leaders believe that the establishment of reward and punishment system can effectively stimulate the initiative of employees. They hold the view that project managers should pay more attention to the control of professional technology in the implementation of GB projects. This result also confirms the conclusion of hypothesis H3. There is a positive correlation between the basic quality of project managers and the key success indicators of GB projects. The multi-group analysis of this hypothesis shows that the influence coefficient of transformational leadership (E= 0.296) is significantly lower than that of transactional leadership (E = 0.439).

The results of the test of H2 and H3 are demonstrated by experts. The results are as follows: Firstly, most of the current project managers do not have the experience of participating in GB and do not have the corresponding basic knowledge of GB because the GB is in the initial stage of the Chinese market. Second, project managers tend to neglect the self-improvement concept of keeping pace with the times and lifelong learning in their complicated work. In the early development stage of GB, it is more appropriate to select project managers with transformational leadership style to mobilize the enthusiasm of the whole staff. In the mature stage of development, project managers with transactional leadership style can be selected to reduce communication costs.

Reference

[1] Zuo Jian. Ten Reasons for Sustainable Development of Project Management from a Global Perspective [J]. Project Management Review,2017(02):14-19+7. (In Chinese)
[2] Zuo J , Zhao Z Y . Green building research–current status and future agenda: A review[J]. Renewable and Sustainable Energy Reviews, 2014, 30(Complete):271-281.
[3] Jin Libin, Huo Chengding. Research on Green Building Development from the Perspective of Beautiful China [J]. Eco-economy,2018,34(12):76-81.(In Chinese)
[4] Thilakaratne R , Lew V . Is LEED Leading Asia?: an Analysis of Global Adaptation and Trends[J]. Procedia Engineering, 2011, 21(none):1136-1144.
[5] Lee W L , Burnett J . Benchmarking energy use assessment of HK-BEAM, BREEAM and LEED[J].

\[
\begin{align*}
H1 & : 0.452 \quad *** \quad 0.471 \quad *** \\
H2 & : 0.327 \quad *** \quad 0.206 \quad 0.096 \\
H3 & : 0.296 \quad *** \quad 0.439 \quad *** \\
H4 & : 0.371 \quad *** \quad 0.327 \quad *** \\
\end{align*}
\]
Building and Environment, 2008, 43(11):1882-1891.

[6] Hwang B G, Shan M, Supa'at, Nur Nadiah Binte. Green commercial building projects in Singapore: Critical risk factors and mitigation measures[J]. Sustainable Cities and Society, 2017, 30:237-247.

[7] Xie Yanping, He Qinghua. The Impact of Service Leadership Behavior of Project Managers on Project Performance [J]. Journal of Tongji University (Natural Science Edition), 2016, 44(11):1790-1795. (In Chinese)

[8] Liu Le. Research on the Influencing Mechanism of Leadership Style on Green Innovation of Construction Projects [D]. Dongbei University of Finance and Economics, 2018. (In Chinese)

[9] Bass B M. Leadership: Good, better, best[J]. Organizational Dynamics, 1985, 13(3):26-40.

[10] Zhang Shuiibo, Kang Fei. Measurement of Competency Characteristics of Project Managers: Model Construction and Validity Testing [J]. Soft Science, 2014, 28(03):73-77. (In Chinese)

[11] Tabassi A A, Roufechaei K M, Ramli M, et al. Leadership Competences of Sustainable Construction Project Managers [J]. Journal of Cleaner Production, 2016: S0959652616002535.

[12] Daft R L. Information richness: a new approach to managerial behavior and organizational design [J]. Research in organizational behavior, 1984, 6.

[13] Dainty A R J, Cheng M I, Moore D R. Redefining performance measures for construction project managers: an empirical evaluation [J]. Construction Management and Economics, 2003, 21(2):209-218.

[14] Cui Caiyun, Liu Yong, Wang Jianping. Research on Project Manager Competency Test Based on Competency Model [J]. Project Management Technology, 2012, 10(12): 64-67. (In Chinese)

[15] Chou J S, Ngo N T. Identifying critical project management techniques and skills for construction professionals to achieving project success[C]// IEEE International Conference on Industrial Engineering & Engineering Management. IEEE, 2015.

[16] Shi Yin, Liao Qiyun. Credit problem of construction project manager can not be ignored [J]. Urban Development, 2015(06): 80-81. (In Chinese)

[17] Potter E M, Egbelakin T, Phipps R, et al. Emotional intelligence and transformational leadership behaviours of construction project managers [J]. Journal of Financial Management of Property and Construction, 2018: 00-00.