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Linking employee empowerment with productivity in off-site construction.

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1. Introduction

Much excitement surrounds off-site construction, as the introduction of techniques such as prefabrication and modularisation, over time, begin to resolve the productivity limitations of traditional on-site construction (Alazzaz and Whyte, 2012). The off-site construction industry is burgeoning; in the United Kingdom for example the total gross output of the off-site construction sector rose from £2.3 billion in 1998 to £5.8 billion in 2008, albeit for only 2.1% of the total value of construction activities (Taylor 2010). A main reason for industry's endorsement of off-site production methods appears to be a perceived improvement in productivity (Bernstein et al., 2011). Indeed Eastman and Sacks (2008) show off-site production can result in efficiency gains of 40% per employee.

Productivity, the amount of output per unit of (labour) input, is a dominant consideration in the world of off-site construction (Durdyev and Mbachu, 2011). Reliance on labour-intensive activities means that optimal labour productivity is a key performance indicator (Song and AbouRizk, 2008; Shen

et al., 2011). With productivity being closely related to commercial viability it is necessary to better understand the factors that may foster or hamper growth in this area such as: diminishing levels of specialist skills; non-optimal craftsmanship; and, poor management practices (Doloi, 2007; Eastman and Sacks, 2008; Abdel-Wahab and Vogl, 2011, Alvanchi et al., 2011). A significant cause of defects in off-site prefabricated products is poor workmanship, notwithstanding continual skills improvement and organisational employee motivation policies (Johnsson and Meiling, 2009). One key initiative recommended for the purposes of fostering labour productivity growth is empowerment, a management concept amalgamating notions of intrinsic motivation, job design, participative decision-making, social learning theory and self-management concepts (Egan, 1998; Dainty et al., 2002; Tuuli and Rowlinson, 2007a).

Empowerment approaches have somewhat limited appeal (Tuuli et al., 2010a; Tuuli et al., 2010b). Personnel issues confronting construction industries outlined in the Egan Report Rethinking Construction (Egan, 1998; Dainty et al., 2002) find the employee empowerment agenda sitting somewhat askew from traditional top-down hierarchies of influence, with client/designer dominating, and bottom placed labourer/employee having nominal input to construction methods.

The question then becomes to what extent interventions aimed at enhancing employee empowerment in the off-site construction sector are able to positively impact on labour productivity. To date, empirical studies with the

object of shedding light on this area are scarce. This paper seeks to resolve some of the ambiguity by investigating the relationship between employee empowerment and labour productivity via two off-site production case-studies.

2. **Background**

Strategies to increase (labour) productivity in construction are essential; as the comparative cost of human resources rises there is an increasing need to develop systems of work that lead to a growth in productivity (Tzafrir et al., 2004). However, measuring such strategies is challenging. Despite the apparent simplicity of the definition of labour productivity, this indicator is difficult to track consistently, largely because of the complexity of quantifying and comparing diversified outputs in construction (Song and AbouRizk 2008, Eastman and Sacks, 2008).

Broadly speaking, the link between productivity and empowerment is the presumption that empowered employees perform better than those less empowered, such that, greater productivity arises from the empowered employee's superior ability to resolve problems at the operations level, without the delay needed to contact line-managers (Tuuli and Rowlinson, 2009a), leading to greater productivity via localised workplace decisions that increase individual/organisational performance (Dainty et al., 2002; Liu et al. 2007).

Empowerment/employee-empowerment is often articulated using theoretical models (Tuuli and Rowlinson, 2007a; Sackey et al., 2011); approaches

include social–structural empowerment approaches, psychological empowerment and, critical and multi-dimensional approaches (Honold, 1997; Nesan, 2004; Spreitzer and Doneson, 2005; Spreitzer, 2007;), with Nesan and Holt (2002) and Price et al. (2003), suggest that employee empowerment be situated within production philosophies such as continuous improvement, total quality management (TQM), re-engineering; broadly, within non-technical project management (Jung et al. 2009).

Social-structural empowerment, concerned with power/powerlessness in accessing information and resources (Liden and Arad 1996; Spreitzer, 2007; Tuuli and Rowlinson, 2007a) has been associated with increases/improvements in individual and team performance (Tuuli and Rowlinson, 2009b). Psychological empowerment on the other hand, views empowerment as seeing one's (competent) input as important (Spreitzer, 1995; Tuuli and Rowlinson, 2009a, Tuuli and Rowlinson, 2010a; Tuuli and Rowlinson, 2010b; Tuuli et al., 2012). According to this view, empowerment is " a constellation of experienced cognitions" and these manifests as four positive sentiments of meaning (feeling one's work is important), competence (personal mastery), self-determination (autonomy), and impact (importance of work) (Tuuli and Rowlinson, 2009a). Similarly, mutual interaction in completing tasks was found to be positively related to psychological empowerment (Tuuli et al., 2012).

It is maintained however that an empowerment initiative conducted without careful management is likely to lead to its abandonment, as employees are

given more responsibility but without direction or a meaningful structure within which to exercise it. (Wendt, 2001; Price et al., 2003; Dainty et al.,2002; Spreitzer and Doneson, 2005). This argument might be suggested to extend earlier work on (the limited availability of) employee empowerment structures in the top-down construction sector by Hammuda and Dulaimi (1997), as well as the conceptual frameworks proposed for the manufacturing sector by Nesan (1997), Holt et al. (2000), and Nesan and Holt, (2002).

Gaps in understanding the relationship between employee empowerment and productivity still exist (Seibert et al., 2004; Logan and Ganster, 2007; Huq, 2010). The results of Tuuli and Rowlinson (2009a) highlight the influence of mediating factors that suggest that the empowerment/productivity relationship is more complex than first thought. The mediating effects of other important constructs in building-management literature such as trust, culture, and identity need to be further explored (Rowlinson and Cheung, 2008; Phua, 2013). Moreover, the specific nature of employee empowerment in off-site construction settings (site environment/culture/language, training and knowledge/change management requirements) is yet to be comprehensively assessed and taken into account in empirical studies (Hammuda and Dulaimi, 1997; Eylon and Au, 1999; Price et al., 2003; Spreitzer, 2007; Tuuli and Rowlinson 2010b).

This paper's investigation into employee empowerment and labour productivity through a case study of two off-site production companies is a step towards enhancing the field of construction management knowledge,

with Nesan's (1997; 2002) nine empowerment implementation activities evaluated against observational and survey data. Importantly, productivity in the off-site construction industry will be able to be explored by studying relationships between empowerment and productivity, towards a more precise definition of construction industry performance and the effects of employee empowerment on construction output variables such as safety, cost, schedule, value, and whole life value.

Whilst support for employer empowerment interventions exists (Argyris, 1998; Bowen and Lawler 1992; Tuuli and Rowlinson, 2007a, 2007b; Herbert, 2009;), the issues are yet to be fully explored (Holt et al. 2000; Dainty et al. 2002); There is a need for investigation into the hurdles to implementing employee empowerment programs in the construction sector, so that management can deal with barriers to empowerment strategies to help shed light on the limited implementation of employee empowerment interventions in the construction industry.

3. Method

Two case studies were performed in off-site construction (productivity) to examine empirically the effect of nine factors of employee empowerment, where the factors were generated on the basis of related research (Holt, 2000; Holt et al., 2000, Nesan and Holt 2002, Nesan, 2004). Briefly, the factors are as follows:

1. Leadership: goal disaggregation/devolution encouraged at all levels.

2. Empowerment system: empowerment implementation system to enable (1).

3. Resources: built into the system to enable realisation (continual training) towards new goals.

4. Involvement: embracing all to ensure that the system works.

5. Education/training: Continuous education for the entire organisation.

6. Teamwork: Diverse groups implement goals described under ‘leadership’ within parameters of ‘system/resources’.

7. Process improvement: align individuals’ strengths with the purposes of empowerment, making all employees 'process owners'.

8. Measurement: continual performance measurement as the cornerstone of monitoring an empowered organisation.

9. Recognition: a motivator placating the aspirations of individuals and rewarding enthusiasm for change and improved performance.

Case study work on (itinerant workforce) employee empowerment is especially useful in gathering the data needed for such an investigation (Marin-Garcia et al., 2010); case studies relate to off-site construction companies in south-west Asia seeking enhanced productivity. *Company A* employed 250-300 workers, 87 of whom were employed directly by the company, 175-200 were from a manpower supplier, and 7 were independent contractors. *Company B* directly employed 1400 workers; in 2010 the company won an award for providing the best environment for its employees in a competition encompassing seven countries. Company B was also the second-highest producer in that country, and it has gained ISO 9001 quality management certification.

The representation of the samples/target-respondents of this study is: general manager, production manager, operation manager, middle production operators/foremen and lower production operator(s). Selection of these respondents ensured an awareness of the productivity trend and the ability to accurately rate the employee empowerment factors with respect to respective daily productivity based on their knowledge and experience in the off-site construction industry.

Company A sample:

1- General manager (12 years of experience)
2- Production manager (6 years experience)
3- Quality manager (10 years experience)
4- Quality inspector (4 years experience)
5- Safety manager (13 years experience)
6- Production line manager (8 years experience)
7- Production Forman (4 years experience)
8- Production repair manager (14 years experience)
9- Production line manager (4 years experience)
10- Production technical manager (5 years experience)
11- Production technician (9 years experience)
12- Production technical supervisor (8 years experience)
13- Operation manager (10 years experience)

Company B sample:

1- General manager (15 years of experience)
2- Production manager (7 years experience)

3- Operation manager (15 years experience)
4- Quality manager (15 years experience)
5- Quality inspector (6 years experience)
6- Production line engineer (3 years experience)
7- Production line engineer (2 years experience)
8- Production Forman (11 years experience)
9- Production Forman (12 years experience)
10- Production technical coordinator (10 years experience)

Note that as the sample size is small; caution is recommended in any generalisation of the results of this study.

The case study features a mix of qualitative data from semi-structured interviews with the key engineering and construction industry stakeholders. The interview questionnaire consists of two sections:

- The first section of the interview questionnaire is for the relative current usage of the 9 factors of employee empowerment, leadership (4 questions), empowerment system (4 questions), resources development (3 questions), involvement (4 questions), education and training (7 questions), team work (6 questions), process improvement (10 questions), measurement (3 questions), and recognition (2 questions). In addition, under each factor of employee empowerment, a question such as, “how does the factor affect labour productivity?” was asked in order to understand the effect of the employee empowerment factor on labour productivity. All questions were 5-point

Likert scale ranging from 5 (extremely effective usage) to 1 (no effective usage).

- The second section of the interview questionnaire consists of 18 questions related to the well-established Blake and Mouton managerial grid leadership self-assessment questionnaire. The managerial grid is based on two dimensions: concern for people and concern for production. This tool (Black & Mouton, 1964), allows 5 leadership styles to be identified based on the interaction of the scores of the two dimensions namely: authoritarian leader, team leader, country club leader, middle-of-the-road leader, and impoverished leader.

Cronbach's coefficient alpha was used to determine the internal consistency of items under each employee-empowerment factor. Content validity of the instrument was verified with five experts (two academic staff and three General Managers in the field of off-site construction).

It is restated that the main objective of this study is to investigate the relationship between employee empowerment and labour productivity.

The analysis of employee empowerment factors proceeded in three stages. In the first stage, the objective is to assess the employee empowerment factors in terms of its perceived relative usage to the organisations investigated and in terms of its relative importance to labour productivity. As the number of questions asked for each employee empowerment factor was not the same, to make the relative current usage of each factor comparable for the 9

employee empowerment factors, the mean score was calculated by summing the responses of the corresponding interview questions and then dividing by the number of corresponding questions. Thus, the mean score of each employee empowerment factor represents the relative current usage of the factor. The mean scores on employee empowerment were compared for the two companies. The two-sample t-test was employed to determine if the difference in the mean scores for each of the employee empowerment factors between the two companies was statistically significant. The two-sample t-test was also employed to determine if the relative importance usage of employee empowerment to labour productivity is statistically significantly different between the two companies. A p-value less than 0.05 indicates the difference was statistically significant. The normality assumption of the t-test was examined.

The analyses of Organisations A and B also examined the degree to which those most highly rated employee empowerment factors that were important for productivity, tended to be perceived as the most important characteristic of the organisation.

The second stage of the analysis examined the correlation between ratings of the current usage of each employee empowerment factor (e.g., ‘Leadership’) and the rating of the importance of that factor for productivity (e.g., ‘Importance of Leadership for Productivity’), again to address the main focus of the study, to investigate the relationship between labour productivity and employee empowerment. Pearson’s product-moment correlation was used to

measure the strength and direction of the relationship. Visual inspection of scatterplots of the joint distributions was used to ensure none of paired variables exhibited a nonlinear relationship. The third stage of the analysis explored the relationship between leadership style and the importance of the employee empowerment factors. The purpose here was to investigate if the importance of each of the employee empowerment factors were different among different leadership styles.

4. Results and discussion

Reliability of the instrument

For the factors of employee empowerment, the Cronbach's alpha ranges from 0.502 to 0.845, indicating the reliability of the instrument as acceptable (the reliability of the instrument is acceptable according to Nunnally (1978))

Stage I: Assessing the employee empowerment factors in terms of its perceived relative usage to the organisations investigated and in terms of its relative importance to labour productivity

The objective of stage I analysis is to assess the employee empowerment factors in terms of its perceived relative usage to the organisations investigated and in terms of its relative importance to labour productivity. The two-sample t-test was employed to investigate if there was a difference in the mean scores on each of the employee empowerment factors between the two companies. The two-sample t-test was also employed to determine if the relative importance of employee empowerment to labour productivity is statistically significantly different between the two companies. In the present

sample, the skewness was found to be <1 for all measures except for the factor 'Importance of Empowerment for Productivity', which produced a skewness of –1.2. Thus, the data satisfied the normality assumption, validating the use of the two-sample t-test (Fife-Schaw, 2007).

Table 1 shows the analysis results of the two sample t-tests for the comparison of relative current usage of employee empowerment factors and its relative importance to labour productivity between company A and company B.

Table 1. Comparison of relative current usage of employee empowerment factors, in terms of its relative importance to labour productivity between the two companies

The results of assessing the employee empowerment factors in terms of its perceived relative usage to the organisations investigated shows that statistically significant differences on the relative usage of the employee empowerment were found between the two companies as follows:

- The first statistically significant difference on the usage of employee empowerment factors between the companies was for 'Importance of Resource Development for Productivity' ($t = 2.741$; $p = 0.012$), and 'Resource Development Average' ($t = –3.640$; $p = 0.002$). Company B possessed significantly more material resources than Company A. In detail, Company A was experiencing financial problems, causing a three-month delay in paying employees' wages, in addition to material shortages. Discussion during the interview with one of the managers revealed that Company A ownership had involved two countries; the economy of one country had collapsed (potentially as a result of the GFC in 2008) and had withdrawn financial support. During that same period the

other country had bought the remaining market share, and Company A was now owned by one country. In addition, both Companies A and B had access to limited human resources due to low potential employee numbers together with ongoing absenteeism of their current employees. For example, at one point 22 workers from Company A went absent on a single day because of the delays to their wage payment. In another example, Company B allowed its employees to be released (they were free to leave the company) and, as a result, around 200 employees had left the company in the previous four months.

- The second statistically significant difference on the usage of employee empowerment factors between the companies was for 'Involvement Average' ($t = –2.592$; $p = 0.017$). This was because Company B is an ISO-9000 certified company with clear job descriptions for each employee, and the extent of 'Involvement' was higher at foreman level than in Company A because his knowledge level was higher than his equivalent in Company A. The extent of 'Involvement' of both companies at lower worker levels was poor, especially in Company A where the level was below that in Company B. However, no significant differences were found between the companies in their rating of the 'Importance of Involvement for Productivity' category, because both managers was involved in most of the decision-making, even at lower levels, in order to achieve the daily productivity target.
- The third statistically significant difference on the usage of employee empowerment factors between the companies was found in the 'measurement' ($t = –2.675$; $p = 0.014$). . This was for two reasons:

Company B had significantly higher scores than Company A because it had introduced a system of quarterly evaluations for its employees whereas Company A did not. Also Company B employed a quality control manager on each production line, making measurement checking and approval very simple and accurate, while Company A had only three quality control managers; however, no significant differences were found between the companies in rating the 'Importance of Measurement for Productivity' category. This was because Company A had an online system which allowed each constructed element to be tracked from the early design stage until the element was ready for delivery. This allowed Company A to resolve any problems with any element more easily and quickly than Company B, especially in aspects of measurement. Although Company B did not have a comparable online system, as mentioned above they employed quality control managers at every stage of each production line.

No significant differences were found between the companies in any of the other employee empowerment factors. Specifically, no significant differences were found for the factors of 'Leadership', 'Empowerment', 'Education and Training', 'Teamwork', 'Process Improvement' or 'Recognition'. Firstly, regarding the 'Leadership' factor, at top management the managers in both companies had at least a Master's degree and a minimum of seven years' experience in off-site construction, and a very high knowledge level. Secondly, for 'Education and Training', top management in both companies supported or believed in on-site job training rather than special programs for

their employees. Both companies adopted similar policies regarding ‘Empowerment’, ‘Teamwork’, ‘Process Improvement’ and Recognition.

Exploratory analysis of ranking of employee empowerment factors and its importance ratings for productivity

Any employee empowerment factor rated as very important for productivity should also preferably be rated as being the most important characteristic of the organisation, so exploratory analyses were carried out to explore the extent to which this was the case. Tables 2 and 3 show the mean ratings of perceived current usage of employee empowerment factors and the importance of these factors for productivity, for the two companies, ranked from highest to lowest.

Table 2. Company A: Ranked level of current usage of employee empowerment factors and their importance to productivity

Table 3. Company B: Ranked level of current usage of employee empowerment factors and their importance for productivity

In Company A, the factors rated as being the most important for productivity were also rated as being the most important characteristic of the company: namely ‘Team Work’, ‘Leadership’ and ‘Empowerment’.

In Company B, some discrepancy between the ratings of the importance of the employee empowerment factors to the organisation and its relative effects on labour productivity were found. The two factors with the highest importance ratings were ‘Resource Development’ and ‘Involvement’. While ‘Resource Development’ was the most highly rated as a characteristic of Company B, ‘Involvement’ received a relatively low rating. This pattern raised the question

of whether Involvement was as highly emphasised and practised in Company B as the ratings of importance suggest it should be. The answer to this was that involvement at lower levels of the company was very low, but the foreman of Company B was involved in most decisions, whereas in Company A only the line manager had the power to make decisions, and the foreman was not involved.

One of the lowest-ranking factors in both companies was the ‘Recognition’ factor, as seen in Tables 2 and 3. Most of the interviewees expressed the view that very high wages, paid on time, was for them the most important recognition factor. The design manager of Company A stated that the application of a production bonus scheme for their employees had resulted in a sharp increase in production, but also in a huge number of defects that exceeded the normal daily work load of the repair department.

The second-lowest-ranking factor in both companies was ‘Education and Training’. Both companies at top management level supported on-the-job training rather than special programs for their employees, arguing that training programs interrupted production work. Also, neither company funded education nor training to any significant extent; for example, a production line manager at Company A said that their employees were being trained every day as they worked, and new workers are trained on the job by experienced workers.

However, on-site job training in both companies may be criticised for several

reasons: firstly, a production line manager in Company A had found that effective daily training was not possible for new workers with a poor understanding of English; secondly, the quality control manager at company B said that language difficulties together with inexperience at the lower job levels severely impeded communication between managers and workers, and among workers. In both companies, some 14 nationalities are represented, resulting in and poor communication within the labour force due to language difficulties, and significant misunderstanding of cultural differences and ways of thinking. However, the manager of the continuous improvement department in Company B argued that lower-level workers were cheap, with very limited knowledge and experience. With that attitude prevailing, education and training at the lower levels of the workforce in either company will be very difficult to achieve.

In the case of Company A, language and communication difficulties occur at production level. When interviewed, the production line manager for the structural section dealing with P.Stress, Double-T and Columns lines at Company A, said:

> ‘I have a medium level of communication between my subordinate because he speaks Arabic and the East Asian worker speaks a little Arabic. The production line manager(s) for the Panel section is European. They speak only English and two European languages and their accent is very difficult to understand, so they have problems communicating with the East Asian worker. The safety manager is European too, and has the same difficulties. He tries to figure out the

> problem regarding safety to make sure the production line is safe. He put signs [including pictures and written text] in each workstation in three languages – Arabic, English and East Asian. The safety manager was surprised to find that 40% of the workers at the lower level cannot even understand the written language. This is because [they lack] knowledge of their language.'

This was followed by an interview with the repair department manager, who was from the same East Asian country as the workers in his section. He spoke a language that most of his subordinates also spoke as either their first or second language, and consequently he had no difficulty in fully communicating with his lower-level workers. As a result, the factory was still operating well because most of the foremen were East Asian and could communicate very well with their subordinates. Because their knowledge and experience were not equal to those of the line manager, some communication difficulties recurred; the problem was not critical, however, because a foreman and the line manager both speak some English.

Company B, on the other hand, had fewer communication difficulties because most of its workers speak some English.

Second stage: Correlation of current usage of employee empowerment factors 'Scale Average' and its relative importance to labour productivity 'Importance' ratings

Correlation coefficients were employed to measure the strength and direction of the linear relationship between each employee empowerment factor and its rating in importance for productivity. Table 4 lists the results of the analyses, in order of correlation from highest to lowest.

Table 4. Correlation of current usage of employee empowerment factor with importance for productivity

This finding supports previous research into this area which links psychological empowerment to performance (Tuuli and Rowlinson, 2009a). Several employee empowerment factors were correlated significantly ($p < 0.05$) to the ratings of their importance for productivity. Particularly strong and significant positive correlations were found between 'Resource Development' and 'Importance of Resource Development for Productivity' ($r = 0.786$; $p < 0.001$), 'Involvement' and 'Importance of Involvement for Productivity' ($r = 0.743$; $p < 0.001$), 'Process Improvement' and 'Importance of Process Improvement for Productivity' ($r = 0.707$; $p < 0.001$), and 'Recognition' and the 'Importance of Recognition for Productivity' ($r = 0.692$; $p < 0.001$).

Significant but somewhat weaker correlations were found between 'Education' and ''Training' with 'Importance of Education and Training for Productivity' ($r = 0.440$; $p = 0.036$), 'Teamwork' and 'Importance of Teamwork for Productivity' ($r = 0.433$; $p = 0.039$), and 'Leadership' and 'Importance of Leadership for Productivity' ($r = 0.421$; $p = 0.045$).

Sample correlations between 'Empowerment' and 'Importance of Empowerment for Productivity' ($r = 0.394$; $p = 0.063$), and 'Measurement' and 'Importance of Measurement for Productivity' ($r = 0.362$; $p = 0.090$) were not statistically significant.

Variation in the 'Measurement' factor resulted in Company B having significantly higher scores than Company A, as explained in the discussion of the results presented in Table 1. A similar result showed that 'Empowerment' was not statistically significant. This may as well be due to the small variation in the data for this variable (Marin-Garcia et al., 2010).

Some concern has been raised regarding the notable lack of knowledge about empowerment in organisations in general, both at the conceptual level and in practice (Seibert et al., 2004; Logan and Ganster, 2007; Huq, 2010), and the construction industry is no exception. In the present work, most of the interview participants did not fully understand the concept of empowerment. The interviewer took the time to ensure that the participant understood the concept. Empowerment research is piecemeal and fragmented in the construction industry (Tuuli and Rowlinson, 2010b). Academic construction researchers have also expressed alarm at the lack of published research on the outcome of empowerment implementation and its consequences in practice at organisational level (Sackey et al., 2011).

Stage 3: Exploratory analysis of employee empowerment factors and

'Leadership Style'

The results of this study are consistent with the findings of Tuuli et al. (2012), in that those managers working in areas with a greater need for interpersonal communication in the workplace tended to indicate that they favoured person-orientated leadership. More importantly, the link between this style of leadership and a higher awareness of employer empowerment was also evident from the data. Among the 23 subjects, only two had authoritarian leadership styles, while the other 21 had team-leader styles. Given the homogeneity in leadership styles, it was not possible to carry out inferential tests of statistical significance for the relationship between leadership style and employee empowerment factors in this sample. Therefore, only descriptive statistics were computed for the analysis of leadership styles and employee empowerment factors.

The means and standard deviations for the current usage of employee empowerment factors and their importance to productivity for participants with 'Team Leader' and 'Authoritarian' leadership styles are listed in Tables 5. While this analysis must be regarded with caution, as there were only two subjects with 'Authoritarian' styles, some suggestive trends were noted. 'Authoritarians' had markedly lower ratings than 'Team Leaders' for virtually all the topics tested. Overall, the authoritarian managers did not value nor see the importance of or need for most of the processes and practices that were valued by the Team Leaders.

Table 5. Exploratory comparison of employee empowerment factor and leadership styles

5.Conclusion

Most academic studies of off-site construction remain largely anecdotal and lack an empirical objective means of clearly defining the parameters that lead to positive gains; there has been little research that has comprehensively analysed and charted the full range of latent conditions related to the productivity of off-site construction, including its limitations and ways of improving it. In addition, the present study has found that there is a lack both of knowledge and skills in lower-level employees, many of whom experienced difficulty in understanding the empowerment concept. As a result, future studies on off-site construction should link the application of a skills base, perhaps in the form of a skills–efficiency matrix, with empowerment techniques to provide a means to empirically measure such a link.

The novel use of an operational management approach in this work has demonstrated a way of measuring productivity in off-site construction. It offers insights that can improve the production performance of the industry; in particular, the study presented here argues that a focus on employee empowerment might bring about improvements in productivity and product quality, thereby maximising the benefit of off-site construction methods.

All of these considerations have led to the conclusion that empowerment is somewhat dynamic and requires ongoing analysis from first principles; any multi-dimensional research should include nine main characteristics: leadership, empowerment system, resources development, involvement,

education and training, teamwork, process improvement, measurement, and employee recognition.

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