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Abstract

With the understanding that ‘happy workers are productive workers’, research findings indicate that the extraordinary construction management needs of megaprojects such as ECOPARK Hanoi Vietnam require a new set of construction management strategies such as the biophilic construction site model (BCSM). The BCSM is a greening construction site model that derives its relevance from the biophilia hypothesis and a proven track record for improving the social intelligence of the workplace, worker wellbeing and performance towards cost-effective applications. The study involves an exploratory research survey aimed at examining the impact of the BCSM in eliminating the toxicity of psychosocial stress and establishing a nourishing environment on the worksite derived from nature. The methodology involves a focus group study of workers and management on construction sites which includes triangulation. The findings indicate that the ‘informal dynamic rock garden’ is a suitable form of ‘healing garden’ adaptable to construction sites including the specific recommendation for the inclusion of plants within the site offices, welfare facilities, and worksite in order to improve worker wellbeing and performance.

Keywords: Biophilia, ergonomics, health and safety, mega projects, social intelligence.

Introduction

The vision of creating a healthier more sustainable society gives rise to the ‘research question’ of how not to design workplaces / worksites that minimize human wellbeing in furtherance of the construction management body of knowledge (CMBOK). The aim is to achieve the cost benefit of megaprojects by applying the inherent benefits of nature on construction sites, which include the psychotherapeutic influence on the H&S and wellbeing of workers. The objective examines the impact of the BCSM in eliminating the toxicity of psychosocial stress and establishing a nourishing environment on the worksite derived from nature. Empirical data drawn from the biophilia hypothesis, states that ‘humankind has an innate emotional affiliation to all organisms in nature’ (Wilson, 1984; Kellert and Wilson, 1993). This is indicative of the need for re-energizing human symbolic values with nature in a green environment such as a ‘landscape inspired construction site’ according to the biophilic construction site model (BCSM). This is arguably one of the most pressing and potent needs facing the management of construction projects / mega projects in recent times (Obiozo et al., 2011; Obiozo and Smallwood, 2014). Flyvberg (2014) indicates that megaprojects are in dire need of such an innovative construction
management strategy in order to overcome the inherent problems associated with the four sublime factors classified as technological, political, economic, and aesthetic. The research findings also emphasized the need to integrate the values and benefits of mega projects alongside the Triple bottom line (TBL) in harmony with the local communities and environment that benefit from it in a manner that is sustainable and cost-effective (Flyvberg, 2014). These are attributes that are associated in this research with the term ‘happy workers’. The various parameters and structure of the research design include the following aspects:

- **Independent variables**: the construction site environment is identified as an independent variable that would have a decisive influence on the performance of workers and their productivity on project;
- **Dependent variable**: the performance and productivity of workers on the project is a dependent variable that is measured by the cost effectiveness and timeliness of a project that is within the scheduled timeline for delivery;
- **The methodology applied**: is the exploratory greening construction site survey method which includes the Biophilic Construction Site Model (BCSM) strategy. It involves an exploratory research survey and comparative analysis of construction sites in progress; Case Study 1 (CS-1): ECOPARK, Ecological City, Hanoi, Vietnam, and Case Study 2 (CS-2): BHP Billiton Wessel’s Mine Central Block Project, specifically the M&R Cementation Construction Project Site, located at Hotazel in the Northern Cape Province of South Africa. The findings derived from CS-1 are validated and measured against the findings on CS-2. The method of data collection and analysis includes triangulation, which is both qualitative and quantitative. It includes a focus group study of construction workers and management; interviews, observations, a formal and an informal questionnaire survey, photo elicitation, and a review of historical and technical data, and
- **Validation of findings**: A generalizable model was derived from which recommendations and suggestions were made for the inclusion of an informal dynamic rock garden design on construction sites with particular reference to the inclusion of plants within construction sites, site office premises, welfare facilities and material sheds.

**Mega Projects and the Four Sublime – the Case for the Innovative Strategy of the BCSM**

Flyvberg (2014) defines megaprojects as large scale complex ventures that typically cost one billion US Dollars or more and take many years to develop and build, involve multiple public and private stakeholders, are transformational and impact millions of people. Kallianpukar and Browning (2013) states that workplace, wellbeing, and performance are not independent but are more or less complimentary and dependent components of a financially and psychologically healthy workplace which is in alignment with contentions from Snow (2010). Wellness is defined as a set of organised activities and systemic interventions offered through corporations / worksites, in corroboration with Hedge (2000), which states that healthy comfortable employees are invariably more satisfied and productive.

**The Biophilic Design Concept of the BCSM and ‘Green Ergonomics of Tranquillity’**
The theory of ‘biophilia’ addresses the ‘innate emotional affiliation of humankind to all organisms in nature’ (Wilson, 1984). It is substantiated with empirical findings from different supportive and scientific fields covering a wide spectrum of scientific fields and researchers from the built environment articulated in the edited book Kellert and Wilson (1993). One of the driving objectives of the ‘biophilia’ theory referred to as ‘nature in space’ states that access to actual nature such as live plants and animals has the strongest positive effect on people’s physiologies. By implication, there is every indication that the incorporation of human access to nature into the built environment such as the construction site can improve H&S, ergonomics, wellbeing, and happiness of workers to a large extent (Obiozo et al., 2011; Kallianpukar and Browning, 2012).

Another aspect identified as the ‘nature of the space’ includes a spatial design that evokes the natural landscape and advocates for the development of interiorscapes within interior spaces such as site offices, welfare facilities; lunch break retreats, material sheds; on construction sites, by the inclusion of indoor plants. This factor also includes the development of a landscape inspired construction site that evokes the feelings of a savannah; grassland with a cluster of bushes or trees that evokes the H&S factor of prospect and refuge, and ‘green ergonomics of tranquility’ (Miyake, 2003; Kallianpukar and Browning, 2012). Miyake (2003) indicates that the factor known as the ‘green ergonomics of tranquility’, substantiated with a range of empirical evidence, is defined by the International Ergonomics Association (IEA) as addressing a comfortable living space / environment whose content exudes a truly peaceful and relaxed environment.

The natural solution of ‘green ergonomics of tranquillity’ include stress reduction through the impact of nature; nature-psychophysiology; construed as a process by which a person responds psychologically, physiologically and very often with behaviour to a situation that is demanding or threatens H&S and wellbeing (Hedge, 2011; Finneran and Gibb, 2013). Miyake (2003) identifies nature-psychophysiology in its concept and futuristic prospect for the furtherance of CMBOK to include the following: visual elements – nature view; auditory elements – sounds of nature; and olfactory elements – smell and aroma from nature. Miyake (2003) substantiated this fact with corroborative evidence from a range of recent empirical findings which include: effects of wooden odours; negative ions, nature sounds and favourite music using psychophysiological measures, and effects of indoor foliage plants. Miyake (2003) also cited Miyakzaki (1991) as having identified a kind of wooden odour associated with the Japanese Cypress which softened some negative emotions such as tension, anxiety, fatigue, and confusion in stress conditions in corroboration with the relaxation effect of wooden odour.

**Research Methodology**

**The BCSM Strategy / Greening Construction Site Survey**

The empirical determinant in the realization of the objective is modelled on the recommendation of EU-OSHA (2012) derived from a report given by European Survey of Enterprises on New and Emerging Risks (ESENER) on the analysis of the management of psychosocial risk stated as follows: In the management of psychosocial risks the same analytical strategy is applied relative to the management of general risks to H&S, namely:

- Employing the conceptual framework of OSH management to investigate the possibility of generating an empirical construct which will efficiently summarize
features of OSH management within a particular area of psychosocial risk. Such an empirical construct will be, effectively, a single variable capturing the scope of the management of psychosocial risks, and

- To model the relationship between that variable (in the status of dependent variables) in a multivariate setting. Thereby, there is a need to identify the significant predictors of OSH management in the area of psychosocial risks and provide the policy makers with options for intervention (EU-OSHA, 2012).

CS-1; ECOPARK Ecological City, Hanoi, Vietnam

Ecopark is reputed to be the largest green township development in Northern Vietnam covering a total development area of 499.9 hectares as shown in Figure 1(a), and is located within 10km from the center of Hanoi and 20min drive from the city [Figure 1(b)]. The project is divided into 9 phases and as a mega project has a total estimated investment capital of up to 8.2 billion US Dollars (Savills, 2011). It has over 110 hectares in green areas and lakes interspersed with ongoing construction processes of the various facilities and with various aspects of interior scape within the reception / front office locations, site offices, and welfare facilities. The encounter of the green construction site / BCSM element of study has deep and lasting impressions on visitors as testified by participants of the CIB W107 Conference who visited the Ecocity construction site (Savills, 2011). It presents a harmonious integration of a network of trees, lakes, gardens, and quiet pathways forming a beautiful landscape which according to Than (2011) and Savills (2011) is intended to intertwine daily life and nature at all stages of the project life cycle; design, construction, and end user / occupant [Figure 1(a)]. For this reason, the construction of the Ecocity being true to its concept began with the infrastructure and landscape phase, which according to Than (2011) was intended to enable the construction workers to operate in a holistically green environment deriving the benefits thereof for enhanced health, wellbeing and productive performance [Figure 1(c) and (d)].

Photo elicitations

Figure 1. The ‘green construction site’ and location map of the ecological city (under construction November, 2011).

Figure 1: (a) presents a model of Ecopark showing the trees, rivers, lakes, gardens, and quiet pathways forming a beautiful ‘landscape inspired construction site’ weaving through the facilities, infrastructure and tree lined road network; (b) presents a location map of Ecopark, showing the Ecocity as being within 10km from the center of Hanoi, and connected by six direct access routes; (c) shows an island with a developed tree at a road intersection and in clear view of the building under construction enveloped with green shade netting, and (d) shows the ongoing construction site within a fully developed green wooded area (Source: Field survey; during the CIB W107 Conference in 2011).
Observation and Comments

Client’s perspective

Tuan (2011) identifies the client’s perspective in the position paper presented at the conference which states the following:

“…the construction workers are regarded as intrinsic not exclusive in the determinant of a productive construction management program and control of complex mega projects. In this case, the greening and landscaping of the construction site is considered the primary focus of the master plan from the conceptual design stage, through the construction processes, towards the final realization of the end product / finished project; a green environment for the end users and the local populace / nation and the global community. For this reason, the construction processes began with the landscaping and infrastructure as shown in Photos 1 and 2. This vision was implemented as articulated in the government proposal and policy for the masterplan developed into a ‘green construction site’. It has a laudable and generalizable ‘green ergonomics of tranquility’ as its theme in giving priority and consideration also for the H&S and wellbeing of workers (Tuan, 2011).

CIB W107 participants and scientific committee

The scientific committee of the CIB W107 adjudged the vision and mission as effective on all aspects. The chairman stated: “This is a featured case of innovation and sustainable construction….to transform from planning into being is a difficult process. We highly assess the achievement of Ecopark. The green city deserves to be a featured study model for many countries (Dang, 2011)”, and has fulfilled the aim of an innovative strategy in green building design and construction that is cost effective; an eventual payback on investments on the immediate and futuristic bottom line, and sustainable according to the TBL considering the size, magnitude and impact of the Ecocity as a megaproject of its kind.

Validation of Research Findings at CS-1

CS-2: BHP Billiton Wessel’s Mine Central Block Project; M&R Construction Site

The measurement of this variable is validated with the similarity of a comparable case study, namely CS-2: the BHP Billiton Wessel’s Mine Central Block project site of M&R and Synntech Project management. The greening construction site survey conducted during the peak of the summer season of the arid interior climate of the Northern Cape Province of South Africa revealed the application of the BCSM strategy. In this case, the biophilic design concept includes both the theory of biophilia and feng shui principles of wellness intervention as shown in Figure 2.

The BCSM Whole Construction Site Element of Study

Photo Elicitations

Figure 2. CS-2, M&R Cementation Construction Site.
Figure 2: (a) shows the courtyard including the four cardinal trees surrounded by rose bushes and the giant water jug fountain located at the entrance to the construction site presenting a welcome ambience to the workforce and visitors; (b) shows the giant water jug fountain as the focal point of the landscaped garden with walkway radiating from it and connecting the different sections within the site office premises from the entrance location at the initial phase, with provision for future expansions during the setting out of the construction site as a ‘green performance index’ and an aspect of ‘green ergonomics of tranquility’ by the M&R H&S Department; (c) shows the warm glow radiating from the sunny shading device over the site office containers and shading the walkways connecting the different containers as the workers moved from M&R to Synntech Project management offices and to the project site and other parts of the Wessel’s mine central block project, and (d) shows the workers’ extension exhibiting the impact of the ‘green performance index’; the grass lawn was planted and maintained by the workers in appreciation of the management effort, and maintained with grey water from their washing even in the height of the summer season and with the existing reticulation problem (Source: Field Survey).

The Questionnaire Survey

The BHP Billiton greening construction site survey comprising M&R, Synntech Project Management, and Bashewa and Olivier Construction firms; constituting 68 respondents; 33, 9, 10 and 15 respectively. A Likert type scale was used for the self-administered questionnaire, which ranges from 1 to 5, 1 being strongly disagree and 5 being strongly agree. A mean score (MS) based upon the percentage responses to the five-point scale was computed to enable the result to be ranked (R) as shown in Tables 1 and 2.

Table 1 indicates the respondents’ degree of concurrence with respect to the cost effectiveness of the psychotherapeutic value of the BCSM element of study. It is notable that only one (20%) of the five functional values, namely ‘increased work effectiveness’ has a MS > 3.00, which indicates that there is agreement as opposed to disagreement. However, four (80%) of the functional values have MSs ≤ 3.00 i.e. disagreement as opposed to agreement – ‘improved comfort’, ‘greatly reduced turnover’, ‘rapid payback in investment’, and ‘absenteeism cut in half’. ‘Rapid payback in investment’ and ‘absenteeism cut in half’ with MSs = 2.63 are ranked joint third, however as the former has a lower standard deviation it is ranked third. In terms of the various ranges four (80%) of the functional values; ranked first to fifth; have MSs > 2.60 ≤ 3.40, which indicates that the agreement is between disagree to neutral / neutral. Included in this range are, ‘increased work effectiveness’, ‘improved comfort’, ‘greatly reduced turnover’, and ‘rapid payback in investment’.

Table 1. Measure of cost effectiveness of the psychotherapeutic value of the BCSM element of study

<table>
<thead>
<tr>
<th>Psychological wellbeing attribute (Psychological factor)</th>
<th>Unsure</th>
<th>Strongly disagree...Strongly agree</th>
<th>MS</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased work effectiveness</td>
<td>0.0</td>
<td>4.4</td>
<td>30.9</td>
<td>16.2</td>
</tr>
<tr>
<td>Improved comfort</td>
<td>4.4</td>
<td>5.9</td>
<td>20.6</td>
<td>42.7</td>
</tr>
<tr>
<td>Greatly reduced turnover</td>
<td>2.9</td>
<td>10.3</td>
<td>11.8</td>
<td>27.9</td>
</tr>
<tr>
<td>Rapid payback in investment</td>
<td>4.4</td>
<td>10.3</td>
<td>13.2</td>
<td>22.1</td>
</tr>
<tr>
<td>Absenteeism cut in half</td>
<td>5.9</td>
<td>8.8</td>
<td>14.7</td>
<td>33.8</td>
</tr>
</tbody>
</table>

Source: Field Survey.
Table 2 indicates the measure of ‘green ergonomics of tranquility’, which includes the socio-psychotherapeutic value (psychosocial factors: ergonomics, communication, H&S and wellbeing) of the BCSM element of study as a motivational factor toward cost effective performance as indicated in Table 1.

Table 2. Measure of ‘green ergonomics of tranquility’ - socio-psychotherapeutic factor towards cost effective performance

<table>
<thead>
<tr>
<th>Emotional factors – organisational value and team spirit</th>
<th>Unsure</th>
<th>Strongly disagree...Strongly agree</th>
<th>MS</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced aesthetic appeal of the construction site</td>
<td>1.5</td>
<td>4.4 8.8 17.7 33.8 26.5</td>
<td>3.44</td>
<td>1</td>
</tr>
<tr>
<td>Improved job satisfaction</td>
<td>1.5</td>
<td>0.0 4.4 25.5 42.7 17.7</td>
<td>3.40</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced fraternal communication / interaction</td>
<td>1.5</td>
<td>1.5 7.4 39.7 26.5 17.7</td>
<td>3.31</td>
<td>3</td>
</tr>
<tr>
<td>Enhanced sense of personal wellbeing</td>
<td>1.5</td>
<td>2.9 11.8 19.2 44.1 13.2</td>
<td>3.27</td>
<td>4</td>
</tr>
<tr>
<td>Increased organisational pride / mission</td>
<td>1.5</td>
<td>4.4 07.4 22.1 44.1 11.8</td>
<td>3.22</td>
<td>5</td>
</tr>
<tr>
<td>Reduced and healing of work / environment stress</td>
<td>0.0</td>
<td>10.3 8.8 25.5 35.3 14.7</td>
<td>3.13</td>
<td>6</td>
</tr>
<tr>
<td>Satisfied with management health / welfare concerns</td>
<td>4.4</td>
<td>5.9 7.4 221 38.2 13.2</td>
<td>3.10</td>
<td>7</td>
</tr>
<tr>
<td>Reduced stress and fatigue</td>
<td>0.0</td>
<td>10.3 11.8 29.4 32.4 8.8</td>
<td>2.95</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Field Survey

It is notable that seven (86%) of the socio-psychotherapeutic values have MSs > 3.00, which indicates that in general there is agreement as opposed to disagreement. These values are ranked first to seventh – ‘enhanced aesthetic appeal of the construction site’, ‘improved job satisfaction’, ‘enhanced fraternal communication / interaction’, ‘enhanced sense of personal wellbeing’, ‘increased organizational pride / mission’, ‘reduced and healing of work / environment stress’, ‘satisfaction with management’, and ‘health and welfare concerns’. However, eighth ranked ‘reduced stress and fatigue’ has a MS ≤ 3.00 indicating disagreement as opposed to agreement. In terms of the various ranges first ranking ‘aesthetic appeal of the construction site’ also has a MS > 3.40 ≤ 4.20, which indicates that the agreement is between neutral and agree / agree. Thereafter, the rest of the functional values ranked second to sixth have MSs > 2.60 ≤ 3.40, which means that the agreement is between disagree to neutral / neutral. Included in this range are, ‘improved job satisfaction’, ‘enhanced fraternal communication / interaction’, ‘enhanced sense of personal wellbeing’, ‘increased organizational pride / mission’, ‘reduced and healing of work / environment stress’, ‘satisfaction with management health and welfare concerns’. Only one of the values, namely ‘reduced stress and fatigue’ has a MS > 1.80 ≤ 2.60, which indicates that the extent of the agreement is deemed to be between strongly disagree to disagree / disagree.

Results and Analysis

The findings from the questionnaire survey corroborate with the management report, personal observations, and the formal and informal interviews as expressed in the photo elicitations, namely that the whole construction site BCSM element of study at CS-2 is a cost effective and a motivational incentive towards ‘green ergonomics of tranquility’. This
indication is significant in terms of the following findings: The MSs of the functional values in Table 1 significantly indicate that the psychotherapeutic measure of the BCSM element of study has contributed between a moderate to a major extent to generally improved cost effectiveness and successful delivery of the project, with ‘increased work effectiveness’ (MS = 3.07) ranked first. In Table 2, nearly all the values have MSs > 3.00, which indicates that generally there is agreement as opposed to disagreement in terms of the impact of the implementation of the BCSM on the ‘improved socio-physiological wellbeing’ factor towards enhanced performance and cost effective project delivery. The ‘green performance index’ as a motivational incentive was established in Table 2, with first ranked ‘enhanced aesthetic appeal’ (MS = 3.44) being among the socio-psychotherapeutic values.

Analysis and Discussion

The BCSM and sustainable sites initiative

In reflection:

“Hidden away as flowing from an unknown source, tucked away and mysterious, appeals to the sense of mystery, addressing the superstitious in mind, and healing of the distortions, by creating a sense of a heavenly dimension on earth – that is healing and soothing – because it attacks the fear of the unknown. Soothes frayed nerves, music addresses bottom line, better invisible than visible, mysterious dimension, source of mystery, sense of heaven – the construction person is not just a rational person, but also an emotional person.”

(Derived from McCallum, 2005; Goleman, 2006).

The above reflection summarizes the fact that the empirical findings derived from CS-1 and validated by CS-2, unequivocally indicate that it is no longer enough to set up a construction project site without an innovative construction management strategy such as the BCSM in order to achieve the TBL in sustainable sites initiative, in fulfillment of the Brundtland commission of 1987 (Haslam and Waterson, 2013). A range of evidence from empirical studies have indicated that EI / SI advise that rational thinking has to be supported by emotional development to achieve the necessary balance towards self-satisfaction / actualization and effective optimal performance (Goleman, 2006). The corroborative evidence from the salient research findings and related sources indicate that if the right environment exists in a particular workplace, the rest of the challenging issues such as the problem of the four sublime factors of mega projects as articulated by Flyvberg (2014) will resolve itself in favor of successful cost-effective performance on construction projects (Joye, 2007, Goleman, 2006; Joye, 2007; McCallum, 2005; David, 2009; Rogers, 2012; Jones, 2011; Obiozo and Smallwood, 2014).

Suggestions for ‘Informal Dynamic Rock Garden Design’ on Construction Sites

In furtherance of further research related to the CMBOK, various suggestions are provided for the application / adaptation of ‘informal dynamic rock garden design’ on construction sites with particular reference to the inclusion of plants within construction site premises, site offices and welfare facilities; lunch break retreats, changing rooms; and material sheds as shown in Figure 3. In addition colour-psychophysiology could be achieved with colour dynamics and indoor plants and a trellis with climbing plants as partitions within site offices and welfare facilities. A simple outdoor shelter could also be created enhanced with
shade nets between site office containers under existing trees and furnished to create a lunch break retreat and site office.

Figure 3. Recommendations for adaptation of the BCSM on construction sites – water features, pot plants, and colour-psychophysiology.

Figure 3: (a) shows nature settings created with a natural fish pond for either ornamental / food fish on construction site premises with artificial birds; (b) shows an indoor table top water fountain within site offices and welfare facilities; (c) shows a simulation of water likened to a ‘Zen garden’ that could be achieved with raked sand including rocks positioned at strategic locations among green lawns and trees, which is also adaptable as a miniature table top rock garden contained in boxes within site offices and indoor spaces, and (d) shows an existing dump yard on construction sites converted into a green area as shown by the inclusion of plants and vegetation in a beneficial manner among the rocks to create an ‘informal dynamic rock garden’ respectively (Source: bubble design).

Conclusion / Recommendation

The empirical findings significantly define the factors involved in determining the objective of the research, which is to investigate the notion that ‘happy workers are productive workers’ in relation to the elimination of the hazard of psychosocial risk factors on construction sites based on the methodology; ‘greening the construction site’ or the BCSM strategy drawn from the ‘biophilic design concept’ that impacts on H&S, wellbeing and cost effective performance. To achieve this aim, the development of systems and products that use less energy were emphasized, relative to understanding and promotion of positive and sustainable behavioral changes in the exploration of corporate sustainability and ‘green ergonomics of tranquility’ interventions in construction (Miyake, 2003). The findings recommend the greening of construction sites and the BCSM as a cost effective solution to the problems of mega projects as highlighted by Flyvberg (2014) and as a site specific measure (Hedge, 2000). The recommendation indicates that this factor as applied in the BCSM strategy should be factored into the initial cost considerations and design of facilities such as construction worksites, as a determinant of increased user productivity, wellbeing, and H&S. Although gains in productivity are financially significant, empirical data relative to the study indicates that it is summarily a factor of beneficial investment in people’s wellbeing, H&S, and ergonomics which concurs with contentions from Heerwagen (2006).

References


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