ISSN 2169-0464 (Online)
ISSN 2169-0472 (CD-ROM)
ISSN 1941-191X (Print)

Journal for the Advancement of Performance Information and Value

VOLUME 4, ISSUE 1

Journal for the Advancement of Performance Information and Value

VOLUME 4, ISSUE 1

TABLE OF CONTENTS

EDITORIAL BOARD

Complexity and the Process of Selecting Project Team Members

D. N. Antoniadis (PhD, MSc)
UK Power Networks
London, UK

The sub-process of selecting team members, as in people not organizations, is not applied. It is however a fact that interconnections and boundaries are formed between individuals within a team and teams as a whole within the project and these cause complexity. Complexity characteristics have been identified and if project practitioners understand how these affect the process of selecting team members they will be able to manage its affects. A study was conducted with construction project practitioners from six organizations, which included questionnaires and interviews and investigated the level of implementation of team member selection and the level of actions taken / techniques used to manage the effects of complexity of interconnections. The results concur with previous findings that existing techniques are not implemented but also confirm that the process is not considered as means to manage the effects of complexity. Based on these findings a framework was developed which not only promotes the process and a number of the existing techniques but also enables practitioners to take appropriate action(s) for the management of the effects of complexity of interconnections using its characteristics.

Keywords: complexity, team selection, interconnections, projects, project management.

Introduction

The transient and dynamic environment of construction projects requires the pulling together of individual effort within a team to deliver work packages or for the whole project. Interconnections are formed as individuals and teams from different companies are brought together to deliver the project. These interconnecting structures between the parties result in complexity (Lucas 2000a). Within construction, the management of the category of interconnections complexity is often ignored or at best addressed informally (Lillieskold & Eklstedt 2003). The informal approach to managing the interconnections complexity is due to the lack of clarity on the nature and influences of the characteristics of such complexity in construction (Antoniadis et al. 2006). It is crucial, therefore, to identify and understand the characteristics of complexity, how these are interpreted in the project management environment and what actions / techniques can be used to manage its effects.

Through the process of selecting team members, one of the project management processes with which the project management outcome is measured (Collins & Baccarini 2004); it is acknowledged that individuals and teams form interconnections. Since these interconnections could potentially lead to the creation of complexity it provides justifiable grounds to accept the notion that the selection of team members is critical in managing the effects of complexity which stem from the sub-process of team selection.

In any environment, not only that of construction, the process of selecting team members has been identified as a critical one for forming teams and one of the main supporting techniques is that of personal profiling (Belbin 2004). In the general as well as that in project management literature selection of teams has been presented as a rational activity (Galbraith & Lawler III 2003, Liker 2004, Slevin & Pinto 2004, Turner 1999, Walker 1996). This school of thought considers the selection sub-process as a number of steps which should be implemented to place members within a team. Thompson (1996) and Lawler III (1993) approach the selection of teams from a different perspective by identifying a number of themes or team member characteristics that individuals must exhibit as personal attributes to enhance their suitability for selection into the team. These personality attributes give rise to the formation of boundaries between individuals and within teams, and needs to be managed (Katz & Lazer 2002). However, the construction industry does not pay enough attention to the sub-process of team selection and remains fixed to the rational, resource oriented and transactional approach (Green 2006, Hinds et al. 2000, Ogunlana et al. 2002).

The paper presents the results from a two part investigation, survey and interviews, into the selection of team members and complexity. The survey results indicate and confirm that current techniques for selecting project team members are not implemented for any of the project team levels. The interviews provide evidence that actions taken for managing the effects of complexity, are not to the required level. Using the interview results and contributions from the interviewees a framework was developed which enables project management professionals to manage the effects of complexity for the sub-process of selecting team members.

Review

In the following sections a review of the areas under investigation will be conducted and the multi-method research approach will be described. Following that the results and analysis of the findings from the two-part investigation will be presented and the paper will close with discussion, presentation of the framework developed and conclusions. The review section will be divided into two sub-sections. The first will cover the project management sub-process of team selection, its importance to the project and the current status. The second will cover and assess the area of complexity and its characteristics in the context of project management and in particular the sub-process investigated.

Selection of Team Members

Construction projects are characterized as a temporary endeavor performed in a dynamic environment. The dynamic nature of construction projects creates complications affect the overall performance of the project. A number of authors make references to the dynamic nature of project environments, and recognize the intricacies that arise from the ever-changing conditions projects display during their delivery (Moore 2002, Morris 1994, Muller & Turner 2007, Walker 1996). Antoniadis (2009) having conducted a review of project management definitions suggests that a more 'modern' one should be considered and proposes the following:

> '*The management of transient, dynamic and complex adaptive systems/agents, so as to deliver the expected change within certain parameters that are established by seemingly ordered and stable environments*.'

The definition highlights the fact that project management requires a change in the paradigm and behavioral as well as organizational issues to become the drivers in delivering projects (Courtney & Winch 2003, Slevin & Pinto 2004). These issues form an integral part of the factors that need to be addressed in the selection of the individuals in project teams. Also, both contribute significantly in establishing a favorable team environment consistent with good performance throughout the project. This is reinforced by the marked shift in the industry towards collaborative working and also by the fact that emerging procurement arrangements frequently employ non-pricing criteria to assess contractors (Kadefors 2006). Selecting project team members and the career development of Project Managers (PMs) and project personnel have an important influence in the current collaborative environment (Bourgeon 2006). Also, as highlighted by Walker (1996) effective team selection and formation is a critical determinant for the achievement of project objectives.

The shift towards the behavioral paradigm suggests emphasizes the importance of sub-processes such as selection of project team members which is crucial in the formation of teams (Belbin 2004). This is also highlighted by the comprehensive definition of a team given by Cohen & Bailey (1997) 'a *team is a collection of individuals who are independent in their tasks, who share responsibility for outcomes, who see themselves and are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationships across organizational boundaries*'. Assigning individuals to project teams molds the social capital of the organization and therefore we should consider the influence and impact of people allocated to teams as well as the form in which such social capital should be viewed (Katz & Lazer 2002).

However, team formation creates boundaries which consequently generate interconnections. These interconnections / interactions contribute positively or negatively to the network and cultivate a culture of cohesion, trust, sanctions, and other socio-organizational conditions that influence team performance (Katz & Lazer 2002). Therefore, defining the boundaries of the project team, the selection of the team members and the span and integrity of the boundary should form an important consideration in the management of projects. Although it might not be possible to eliminate the evanescent nature of projects, it should be possible to address the transient effect on the boundaries formed through the selection of team members and achieve an acceptable level of performance.

Five key activities are identified for selecting team members (Galbraith & Lawler III 2003, Liker 2004, Slevin & Pinto, 2004, Turner 1999, Walker, 1996). These are:

1. Understand the project needs,
2. Identify and appoint the right project manager,
3. Select team members that meet the needs of the project,
4. Supplement the team with experts to cover gaps in project needs, and
5. Monitor team performance.

From the individual's side and as part of a team, they should:

a. Be creative, open minded and 'forward looking' (Thompson 1996),

b. Be good team players, '*collaborate as members of team*' (Thompson 1996),
c. Use '*judgment*', (Thompson 1996),
d. Be well respected among peers, stakeholders, and other business leaders,
e. Have the '*ability to adapt to change*', (Thompson 1996),
f. Be able to understand, or at least be able to consider, the environment and provide feedback to the team (Antoniadis 1998).

Currently some selection techniques, for certain roles, are used and these are based on job-task and behavioral competencies (Crawford 2005). However, Cheng et al. (2005) emphasize that it is important to understand that competencies are an attribute of both the job holder and the job itself.

Human interaction and team formation is a complex phenomenon (Dal Forno & Merlone 2005). This interaction together with the very short period contractors have to put together the team and the employment of command and control approach to human resource management (Green 2002) obviously does not help the process of selecting project team members. Usually, up to contract award, only the PM would be identified based on a subjective assessment (Ogunlana et al. 2002). The remainder of the team below the PM level would be represented as a lump sum of money and the 'system' would not consider issues relevant to project staffing (Ogunlana et al. 2002). Case studies (Green 2006, Hinds et al. 2000) have shown that selection is race biased and at lowest levels projects are '*structured around nationalities*' (Green 2006).

Concern has been raised regarding lack of implementing the process of team selection as well as how much the management '*scripts*' influence those who do the work (Green 2006). These findings are disquieting, if one is to consider implementing team work principles. Unless of course the team is only considered to be the units at the management system level (Walker 1996). Thus despite all the literature, including the APM BoK (2006) and PMBoK (2000), one could question the level of application of team selection techniques at project level in current practice.

Complexity

It has been well established and for a number of years (Bertelsen 2005, Thompson 1967, Williams 2002) that project management exists in a complex environment and most importantly that '*our project management knowledge base … does not apply to complex projects*' (Turner 2005). The application of complexity theory and in particular the study of complex adaptive systems is to enable the systematic review of the inter-connections (Baccarini 1996, Lucas 2000a). In projects it is important to define the type of complexity considered (Baccarini 1996). The importance of defining complexity of interconnections in projects is that it can be applied to the numerous project management sub-processes. Selecting project team members, who will resource the various teams and will interconnect, becomes a very critical Project Management sub-process. Baccarini (1996) points out that project complexity influences the selection of project inputs, including the expertise and experience requirements of management personnel.

Analyzing and understanding the effects of the complexity characteristics will enable, the decision-making process, response and output from appropriate actions, improvement of

management of complexity and above all improvement of confidence in the appropriateness of the process. Various characteristics and facets have been described of typical complex systems. For example Davidson Frame (2002) produced four facets of complexity, a) size, b) variety, c) difficulty and d) change. Williams (2002) highlighted uncertainty and structural complexity and at a lower level the interdependence of elements. Kallinikos (1998), on the organization side, identified dynamism, Geraldi (2008) defined patterns of complexity and Crawford (2005) has indicated uniqueness and lack of clarity / definition of scope, goals and methods.
Lucas (2000b) however, having analyzed three systems theories has identified 18 distinct complexity characteristics of which 16 have been considered most relevant to construction project management. The generic description of the characteristics and the authors' conversion of these into project management phraseology are shown in Table 6 (Appendix 1). Antoniadis et al. (2006) classified and grouped these characteristics into three main headings - conditional, developmental and behavioral. Parameterization of these characteristics will enable better identification of actions, improved definition of the boundaries and the interweaving / reciprocity between the project management sub-processes.

As construction moves more towards virtual projects and project team members will be working from different locations, this will demand greater individuality, and consequently creating the need for more teamwork (Edum-Fotwe & McCaffer 2004). As interconnections and networks of communications between team members increase complexity increases, therefore the process of selecting team members and forming teams becomes critical.

The above result in a number of questions being raised in terms of managing complexity of interconnections in projects:

- Do construction companies – clients or contractors – or their PMs consider any team selection techniques?
- Do they follow / implement any of the existing techniques?
- Do they consider complexity of interconnections or its characteristics when selecting team members?

Research Method

The review provided strong indications regarding the implementation of appropriate team member selection techniques in construction projects. This coupled with the established view that construction projects are immersed in a complex environment led in the formulation of the following hypotheses as part of a wider research into complexity in construction.

Hypothesis 1: Project team members are selected using personal profiling
Hypothesis 2: Complexity characteristics are considered when selecting project team members.

The breadth and depth of the issues and the topics under investigation demanded the design and implementation of a multi-methodology research design. In order to investigate hypothesis 1 it was considered appropriate to conduct a postal survey. In terms of hypothesis 2 and because of the intricacies of the subject of complexity and its characteristics it was considered appropriate to conduct open-structured but closed response interviews. The interviews investigated the current

understanding of complexity, its characteristics, and the implementation of techniques that will manage the effects of complexity.

Questionnaires for both hypotheses were prepared and piloted with 10 professionals from three organizations and minor corrections were made. In order to consider both sides of a project the stratified sampling technique was followed with the two main strata – client and contractor. The strata comprised of three major construction client organizations and three major construction companies. For hypothesis 1 postal questionnaires were issued to the Project Management divisions which encompassed professionals from Site Manager to Project Director level. For hypothesis 2, the investigation on complexity, 31 interviews were set up from the organizations that participated in the survey and again with the same levels of professionals.

Hypothesis 1 was operationalized by establishing a level of understanding of awareness, guidance received and implementation of personal profiling techniques for selecting team members and thus formulating three sub-hypotheses which investigated implementation of personal profiling techniques for selecting team members and possible variance between client and contractor PMs in the approach followed. Therefore the following sub-hypotheses were defined:

- Sub-hypothesis H1.1: Companies provide guidance and implement personal profiling techniques when selecting PMs.
- The null hypothesis is that organizational guidance given for using personal profiling to select PMs is not implemented (zero use).
- Sub-hypothesis H1.2: Companies provide guidance and implement personal profiling techniques when selecting site team members.

- The null hypothesis is that organizational guidance given for using personal profiling to select site team members is not implemented (zero use).
- Sub-hypothesis H1.3: There is a difference between client and contractor PMs in the use of personal profiling techniques as selection criteria for project team members to the lowest project organizational level.
- The null hypothesis is that there is no (zero) difference in the use of the personal profiling techniques between client and contractor PMs.

The survey addressed also issues regarding the organizational depth to which selection techniques are implemented. That is, if practitioners implement selection techniques to the lowest project team organizational level.

Similarly hypothesis 2 was operationalized by establishing a response greater than 75 points (from a scale of 0 to 100) of the average weighted effectiveness of the actions taken towards managing the effect of each complexity characteristic. Therefore for each complexity characteristic the following sub-hypothesis was investigated:

- Sub-hypothesis H2.1: The average weighted effectiveness of the actions taken to manage the effects of the complexity characteristic, when selecting project team members, exceeds a level of 75 points in a scale of 100 points.

- The null hypothesis is that the average weighted effectiveness of the actions taken to manage the effects of each complexity characteristic, when selecting project team members, is less than 75 points in a scale of 100 points.

It should be noted that whilst conducting the interviews participants were asked and contributed towards:

- The improvement of the 'translation' of complexity characteristics to project management phraseology, as well as
- Considering and adding actions that need to be taken towards managing the effects of each complexity characteristic.

For hypothesis 1 the following five moderating factors – duration, budget, location, type, and procurement method – were considered in order to understand if these influence the sub-process of selecting team members and respondents were asked to identify the level of influence of each moderating factor, using a Likert scale 1 – 5, from 'Very Little' to 'Critical'.

Results

The implementation of the multi-methodology research design was over a period of ten months from May 2007 to February 2008. Apart from the research steps described above it included, two sets of presentations on the aims of the research to the respective heads of the project management divisions, progress reporting during the period of postal questionnaires and presentations to the interviewees.

Postal Questionnaires

The questionnaire was issued to 180 randomly selected project management professionals from within the two strata and 91 valid responses were returned (51%) of which 57% were from the client strata and 43% from the contractor strata. The sample of respondents represented 32% and 8% of the Client and Contractor project management populations within their organizations respectively.

Responses were entered in SPSS (v15) and descriptive as well as inferential statistics methods were used for the analysis of data selecting a significance level of 95% in order to minimize further the sampling error. As the postal questionnaire data were basically ordinal or nominal and associations were sought between one dependent variable and more than two independent variables the parametric technique used was that of Chi^2. The Chi^2 test was used to test for sub-hypotheses 1.1, 1.2 and 1.3 and increase the validity of the arguments. From the responses received 7% were at Director level, 37% at Senior PM level, 46% at PM level, 7% at Assistant PM level and 3% at Site Manager level.

In order to establish the level of current understanding of the project environment prevailing conditions respondents were asked to indicate, in a Likert scale 1 – 5, statements to which they agreed the most or the least. The results in terms of percent response were as follows:

- More to most Static: 22% - More to most Dynamic: 64%,
- More to most Simple: 17% - More to most Complex: 50%,
- More to most Friendly: 49% - More to most Hostile: 16%.

Results regarding levels of awareness, guidance given and implementation of techniques of personal profiling for selecting team members are summarized and presented in Table 1.

Table 1

Response regarding levels of awareness, guidance and implementation of personal profiling techniques for selecting team members

Question	Results	
	Response	**Percent**
2q2: Are you aware of any known techniques/methods of personal profiling?	Yes	71
2q1: Does your organization offer you guidance in selecting project team members?	Yes	68
2q5: In your company, is personal profiling considered, as part of the selection process, when appointing Project Managers to a project?	Yes	9
2q10: Do the site supervisors use any selection process techniques?	Yes	14
2q4: Please indicate for which project team members personal profiling has been carried out, within your company.	None / No	73
2q11: Indicate which of the following techniques/methods your supervisors use/consider for selecting team members	None	78

It should be noted that the majority of responses to question 2q2 indicated that the known techniques were those of Belbin and Myers Briggs. Respondents were also asked to identify, using a Likert scale 1 – 5 - from very little to critical, the current criteria used for selecting team members from PMs to project team members. The results are shown in Table 2 as a percent of response.

In terms of the moderating factors, results indicated that these are considered either critical or very important in terms of influencing the selection of team members sub-process (Antoniadis, 2009).

Table 2

Response regarding the importance of criteria for selecting the project manager and the project team members (in % of responses)

	Criteria for Selection of Project Manager						**Criteria for Selection of Project Team Members**				
Criteria	VL	L	I	VI	C		VL	L	I	VI	C
Availability	3	8	36	36	17		2	5	40	32	21
Capability	1	3	20	53	23		2	1	20	60	17
Technical Skills	1	13	50	33	3		2	4	34	48	12
Management Skills	1	3	36	52	8						
Leadership Skills	1	9	30	43	17						
Experience	1	4	45	33	17		2	3	49	38	8
Previous Performance	1	14	41	35	9		4	10	46	32	8
Project Environment	2	28	50	16	4		10	23	48	18	1
Personal Development	23	42	28	7	0		27	39	30	4	0
Personal Profile	45	31	21	3	0		53	28	18	1	0
Note: VL = Very Little, L = Little, I = Important, VI = Very Important, C = Critical											

Interviews

Two part interviews were conducted with 31 practitioners. The first part consisted of questions regarding perception of complexity within their organization and actions taken. The second part involved the explanation of complexity characteristics, their application in project management and particularly the selection of team members, and the implementation of actions which will indicate management of complexity as this can be generated if its characteristics are not considered. The group of interviewees included from Project Directors (4) to Site Managers (3), with the majority been at the level of Project Manager (10).

In response to the question if their organizations give a definition of complexity 90% of the interviewees indicated that no definition exists. Also 58% indicated that no tools or techniques are used to identify complexity. From those that responded positively 62% indicated that risk management is used as a tool to identify complexity, with the remainder saying programmes (as in planning) and grouping of projects where some of the techniques used.
Figures 1 and 2 indicate, respectively, interviewees' responses regarding 'how complexity is identified in their organizations' and which factors they consider as source of complexity.

For the second part – the complexity characteristics - and as mentioned above, the interviewee response represents the level by which current project management measures taken cover the level of actions required to manage the effect of the corresponding complexity characteristic for the sub-process of selecting team members. Figure 3 provides an overall indication of the average weighted effectiveness of the actions taken to manage the effect of each complexity characteristic when selecting team members. For example for 'autonomous agents' (Table 1) the

overall average of actions taken covers only 16 points of the required level of actions / activities which will ensure the achievement of 100 points for managing the characteristic of autonomous agents.

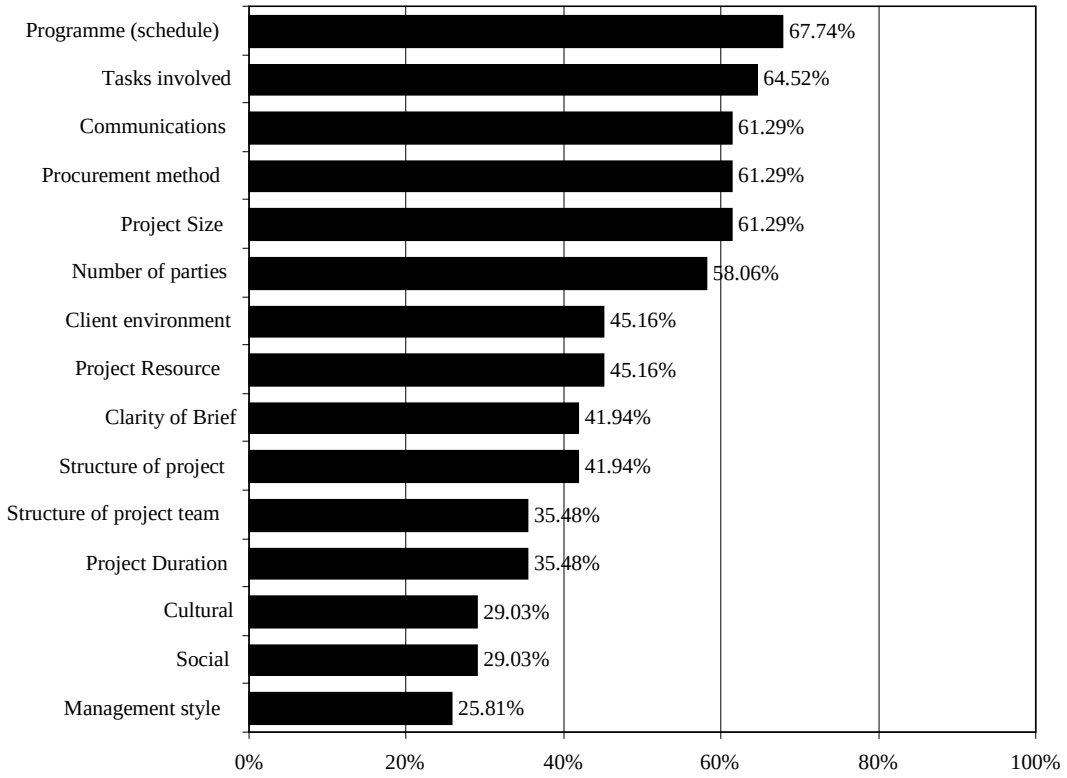

Figure 1: Percent Response Regarding the Identification of Complexity in Projects.

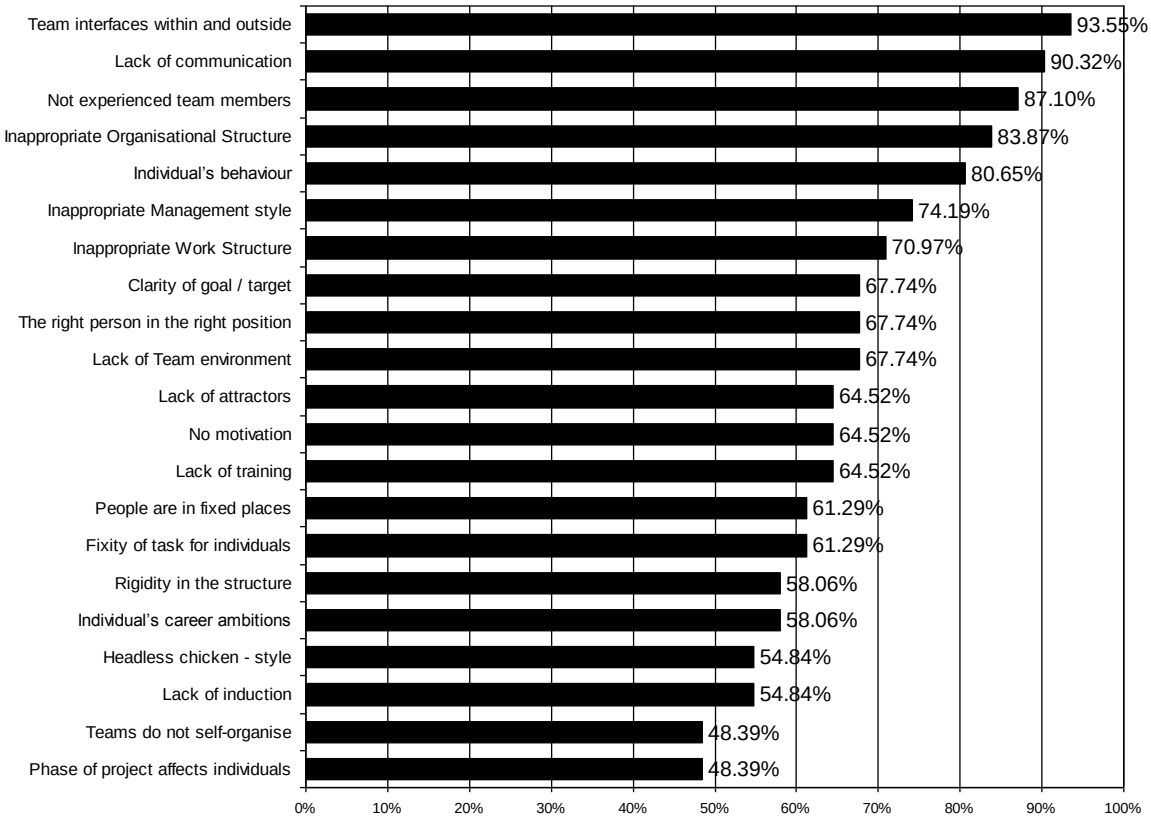

Figure 2: Factors Identified as a Source of Complexity.

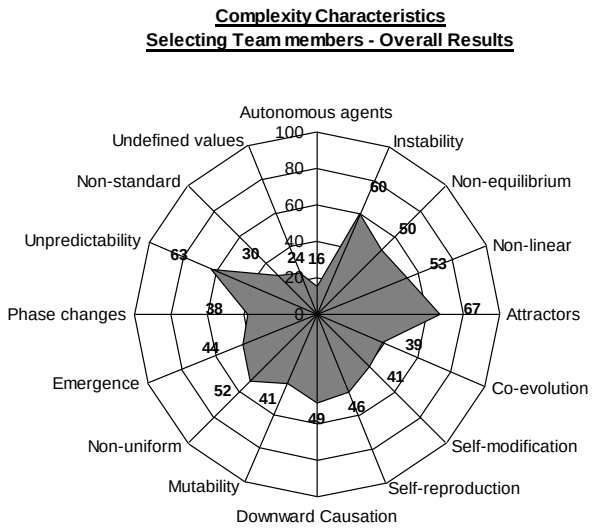

Figure 3: Average Weighted Effectiveness of Actions for Managing Complexity Characteristics.

It should be noted that all proposed actions for all the characteristics were reviewed with the interviewees and any additional actions were included in the listings and considered in the overall weighting.

Analysis

The responses regarding prevailing conditions at the time the research was conducted confirmed the commonly accepted changes that have occurred in construction for the last decade as a response to the Latham (1994) and Egan (1998) reports. That is, an environment which is becoming more friendly, due to different contractual arrangements, but one which remains dynamic and complex.

Postal Questionnaires

The significance of these responses, in terms of the consequences to the selection of team members, is that despite the change to a more friendly environment, awareness (71%) of and guidance given (68%) on personnel profiling this is not considered when selecting PMs (91%) nor any other team members (86%), as shown in Table 2. In particular, 73% of the respondents indicated that personal profiling is not carried out at all for any project team member and 78% indicated that no techniques are used for the lowest project team level by supervisors. This is despite the fact that in one of the participating organizations the internal project management process indicates that Belbin or Myers Briggs should be used when selecting the project team members. The results obtained are triangulated by very recent literature (Keegan and Turner, 2003) and also confirm Green's (2006) conclusion.

Standard, subjective criteria (Ogunlana et al. 2002) continue to be used when appointing PMs, as shown in Table 2, and in a descending order of percentage - Capability, Management skills, Leadership skills, and Availability were considered 'very important'/'critical', with Personal profiling and Personal development not considered. For all the other project team members (Table 3), respondents indicated that the highest criteria for selection were, again in a descending order of percentage, Capability and Technical skills as very important, with again Personal profiling and Personal development not considered.

From the statistical analysis for testing sub-hypotheses 1.1 to 1.3 the following was established:

- Performing a Chi^2 test between 2q1 and 2q5 (Table 3) the value of 'p' was 0.124 much greater than 0.05, which indicates that the null hypothesis cannot be rejected therefore the results are not statistically significant to accept hypothesis H1.1. Thus although guidance is given personal profiling techniques are not used for selecting the PMs.
- Performing a Chi^2 test between 2q1 and 2q11 (Table 4) the value of 'p' was 0.55 much greater than 0.05, which indicates that the null hypothesis cannot be rejected therefore the results are not statistically significant to accept hypothesis H1.2. Thus although guidance is given personal profiling techniques are not used for selecting site team members.
- Performing a Chi^2 test between 1q1 and 2q13 (Table 5) the value of 'p' was 0.602 much greater than 0.05, which indicates that the null hypothesis cannot be rejected therefore the results are not statistically significant to accept hypothesis H1.3. Thus there is no difference in the implementation of personal profiling techniques between client and contractor PMs.

Table 3

Crosstabs – chi^2 results for testing of sub-hypothesis 1.1

2q5 * 2q1 Cross tabulation			2q1		
			Yes	**No**	**Total**
2q5	Yes	Count	8	0	8
		% of Total	8.9%	.0%	8.9%
	No	Count	40	22	62
		% of Total	44.4%	24.4%	68.9%
	Don't Know	Count	14	6	20
		% of Total	15.6%	6.7%	22.2%
Total		Count	62	28	90
		% of Total	68.9%	31.1%	100.0%

Chi-Square Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.178(a)	2	.124

1 cell (16.7%) has expected count less than 5. The minimum expected count is 2.49.

Table 4

Crosstabs – chi^2 results for testing of sub-hypothesis 1.2

2q11 * 2q1 Cross tabulation			2q1		
			Yes	**No**	**Total**
2q11	Interview, Agency Interview, Recommendation	Count	14	4	18
		% of Total	15.4%	4.4%	19.8%
	None / No	Count	47	24	71
		% of Total	51.6%	26.4%	78.0%
	Interview & Profiling	Count	1	1	2
		% of Total	1.1%	1.1%	2.2%
Total		Count	62	29	91
		% of Total	68.1%	31.9%	100.0%

Chi-Square Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.197(a)	2	.550

2 cells (33.3%) have expected count less than 5. The minimum expected count is .64.

Thus, despite the fact that techniques supporting the selection of team members are available and although it is accepted that the project environment is more complex and dynamic, these formal techniques are not used. Also, despite awareness and guidance given, project management practitioners from both sides – client and contractor, theory is not converted into practice and routine team selection criteria are used and even these are only used down to the level of Team Leader (Table 4).

Table 5

Crosstabs – chi^2 results for testing of sub-hypothesis 1.3

1q1 * 2q13 Cross tabulation 2q13: Indicate to what organizational level did you, or others on your behalf, carry out personal profiling			**2q13**			
			Discipline & Team Leaders	**Supervisors & Team Members**	**None**	**Total**
1q1	Client	Count	25	20	7	52
		Exp. Count	26.9	19.4	5.7	52.0
		% of Total	27.5%	22.0%	7.7%	57.1%
	Contractor	Count	22	14	3	39
		Exp. Count	20.1	14.6	4.3	39.0
		% of Total	24.2%	15.4%	3.3%	42.9%
Total		Count	47	34	10	91
		Exp. Count	47.0	34.0	10.0	91.0
		% of Total	51.6%	37.4%	11.0%	100.0%
Chi-Square Test	Value	df	Asymp. Sig. (2-sided)			
Pearson Chi-Square	1.014(a)	2	.602			
Only 1 cell (16.7%) has expected count less than 5. The minimum expected count is 4.29.						

In terms of the effect of the moderating factors responses indicated that only those of project type and budget are slightly considered to influence the sub-process. This indicates that the transactional and technical character of the industry has a small effect on the sub-process, however, not to a critical level.

Interviews

From the general complexity part, the interview responses, and from the details in Figure 1 - responses to the questions '*How does your organization identify complexity in projects*' - it is obvious that mechanistic sub-processes, for example, programme (68%), tasks involved (technical) (65%) and project size and procurement method (61%), are considered as the main identifiers of complexity. Social/soft factors such as the project resource (people), team structure, culture, and the management style are considered as very low in the reasons for identifying complexity. However, the relatively high response towards the two non-mechanistic reasons - communications (61%) and number of parties (58%), indicates that there is a shift towards identifying complexity caused by the number of interconnections / interfaces.

When the interviewees were asked about '*factors/sources of complexity which originate from the project organization*' (Figure 2), emphasis shifted from the mechanistic to the behavioral causes and apart from communication (90%), team interfaces (94%), inappropriate structure (84%) and individuals' behavior (81%) are noticeable in terms of frequency of response. From the results it is also noticeable that there is a distinct difference of view between individuals and companies views regarding the management style. Although companies do not identify that complexity could be arising from management style (26% see Figure 1) the majority of interviewees (74%)

indicated that source of complexity could be the management style followed. This actually can be explained by how individuals' perception could be different to those of their organizations. Other factors, identified by a significant number of respondents, include (Figure 2), technical competence (87%), lack of team environment (68%), if the right person is not in the right position (68%) and even people being in fixed places (61%). Also 65% of interviewees identified lack of motivation and lack of 'attractors' (Table 1) as having a significant impact and causing complexity.

With regard to taking appropriate actions to manage the effects of complexity through its characteristics, from within the selection of team member sub-process, interviewees (Figure 3) indicated that very little is done and that no consideration is given to using any techniques. In particular the characteristics of autonomous agents (16%), undefined values (24%) and non-standard (30%) have received very little management actions, whereas those of attractors (67%), unpredictability (63%) and instability (60%) had some actions taken which could be considered as partly managing the effects of complexity.

The results on the average weighted effectiveness of the current level of actions taken for each complexity characteristic indicate that none has reached the 75 points level of acceptance and thus hypothesis 2.1 is refuted. Therefore hypothesis 2 cannot be accepted indicating that complexity characteristics are not considered when selecting project team members.

Discussion

The results confirm earlier findings and provide statistical confirmation that practitioners of project management and of different levels and sides – client and contractor, in the UK construction industry, do not implement the process of selecting team members and its supporting techniques. Practitioners are aware and guidance is given in using personal profiling and other team member selection techniques, however these are not used. Therefore the importance, influence and criticality of the individual as a team member, are not considered and as such the relationships, behaviors, and boundaries formed when coming together to deliver a project, are neglected.

It is important that, as soft criteria become more prominent in the procurement process, both sides of the project – client and contractor, should focus on techniques beyond simple team building exercises and enable practitioners to practice what they are trained on. Selection of team members should become more prominent and does not have to start just before a project commences. It could be considered as part of the recruitment process with individuals' personal profile being generated from his/her early days in the company. From the individual's side, and in order to alleviate their fears, personal profiles should not become reasons for exclusion but rather as reasons for training and improving skills.

The findings also confirm the gulf that exists between theory and practice or the theory-to-practice transformation. This becomes even more profound when one considers that the general view is that the current environment is friendlier.

Considering the evanescent nature of projects and the interconnections established when individuals come together to form teams, it is obvious that these will cause complexity, however this is not taken into account by the industry.

This is confirmed by the interview results which indicated that complexity is not defined and no tools are used that will enable the management of the effects of complexity. Individuals and companies, as shown in Figures 1 and 2, have a different perception of identification / sources of complexity. The former apportion more weight to soft issues whereas companies concentrate more on the 'harder'/control processes, with the exception of communications. This could be considered as conflicting, since it is the individuals that make up the companies, however, it enforces the fact that companies concentrate on the control processes and have not yet managed to identify 'actions/activities' with which they can address the soft issues. In terms of actions taken to manage the effects of the characteristics of complexity, as discussed and agreed with/by the interviewees, it is profound that not enough actions are taken to enable the management of the effects of complexity. Nonetheless, it was encouraging that interviewees gave positive feedback to using the complexity characteristics as a tool to manage its effects.

It is evident that, in terms of selecting team members, simple activities that will enable the management of the effects of complexity of interconnections are not channeled through to the management of projects. Therefore the potential exists where, by defining and understanding complexity of interconnections and its characteristics and implementing existing techniques, a framework can be developed with which to manage the effects of complexity for the sub-process investigated.

Proposal

Complexity theory acknowledges the failure to comprehend the whole through an understanding of the individual, and instead it endeavors to understand the whole through the interaction of its parts. Therefore, and since interconnections exist everywhere in social, cultural, technical, behavioral and other inter-relationships, we need to consider carefully complexity of interconnections in projects. Relationships were also established, earlier, between projects and complex adaptive systems, in terms of how these consist of many relatively independent parts which are highly interconnected and interactive (Breuner 1995) and which are considered under the theory of complexity (Lucas 2000a, Stacey et al. 2002). Therefore, accepting that projects are streams of disturbances (Wild 2001) with incubating pathogens (Busby & Hughes 2004), allows all the parties to understand that they are 'in for a ride', and therefore the project management definition given earlier should be considered.

Plan of Action

Complexity in construction projects, but also more generally, requires a structured approach, the establishment of a simple plan of action and the availability of a framework which will enable practitioners to manage its effects.

The plan of action described in Figure 4 below is based on the simple and extensively implemented cycle of, define, identify/understand, utilize tool/means available, implement actions, monitor/follow up actions and review/improve.

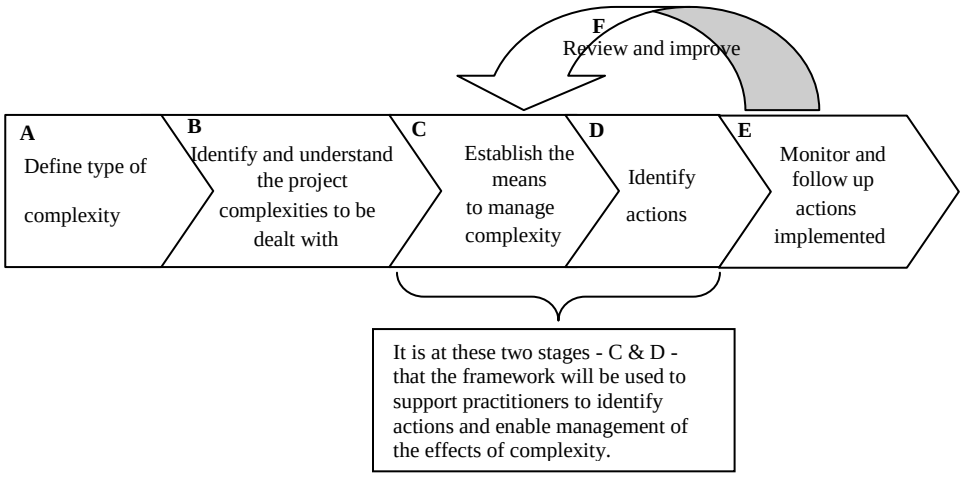

Figure 4: Action Plan for a Structured Approach to Managing Complexity.

With regard to complexity of interconnections and in terms of the tools/means to be used (steps C and D), during the research period the decision matrix process was used to evaluate three options and select the best suitable solution (Antoniadis 2009). The framework developed is a tool that enables the management of the effects of each complexity characteristic through the specific process, in the case of this paper the process of selecting team members. The framework allows Project Managers and Team Leaders:

- To ascertain the level of managing its effects at specific points in time,
- To propose specific actions which will minimize the effects of each complexity characteristic,
- For the actions to be monitored, reviewed and improved, and
- Through its flexibility, implementation at all project levels.

Since it is focused on the process it is not restricted by the type of project and/or the management style(s). The simple and holistic approach offers practitioners an innovative and straight forward handling of the effects of complexity of interconnections on projects through each project management process. As described in Figure 4 deployment of the Framework for Managing Complexity of Interconnection (F4MCI®) occurs during steps C and D. A detailed description of the objective, the scope and how is to be implemented is given in the following sections.

The Framework – F4MCI®

The objective is to enable the Project Manager (PM) and her/his Team Leaders (TLs) to manage the effects of complexity of interconnections on the project through the respective project management processes.

Scope

The scope of the F4MCI® is to measure the effect current actions have on the management of complexity, through its characteristics, and prompt the PM and TLs to consider, through its reporting mechanism, further actions that will enable the management of the effect of each characteristic for the benefit of the project.

The How

Each complexity characteristic has been translated into project management phraseology and against each one a set of questions and actions have been established and validated by project management professionals. As the PM and TLs respond to each question the F4MCI® measures and records the effect of the actions taken. Reports produced, together with the questions/actions, prompt the PM and TLs to consider and implement further actions that will enable them to manage complexity. The F4MCI® also enables them to establish a short term/continuous improvement plan.

What is the F4MCI®

The F4MCI® is part of a wider set of simple software tools that deal with complexity of interconnections for each one of the project management sub-processes which are used to measure the project management outcome. These sub-processes are (Collins & Baccarini 2004):

a) Selecting project team members
b) Nanaging the team (the style adopted)
c) Effective use of resources
d) Conflict management
e) Structuring the project team
f) Monitoring and control
g) Reporting

Who and When Should Use the F4MCI®

The F4MCI® software is used by the PM of the project and all the TLs of the teams that will participate in the delivery of the project and at the very early stages, within four to six weeks and as and when teams are formed.

How is the F4MCI® Used

The user(s) (PM/TLs) go through each characteristic and are required to respond to questions by indicating (ticking of boxes) the actions taken that will enable the management of the effects of the characteristic. Each question has a weighted measure for managing the effects of the characteristic and the users' selection(s) are evaluated. For a number of responses and for reporting purposes, the user(s) is required to indicate the reason for making the respective selection. As the user(s) progress through the 16 characteristics all the responses are gathered and recorded. At the end of each 'run' the software produces a graphical as well as a tabular report indicating the average weighted level of managing the effects of each complexity characteristic. The execution/run of the F4MCI® is performed at certain frequency and within a certain period. The intervals between successive 'runs' of the tool are used by the PM/TLs to implement the actions identified / required and also to resolve issues, as required, with management.

What is the Output and How is to be Used

The F4MCI® outputs/reports, when the execution is completed, are a radar graph indicating the average weighted level of managing the effects of each complexity characteristic, and a report which indicates if the level achieved is acceptable. A sample of the radar graph and the report are shown in Appendix 2, Figures 5 and 6. An additional report which is generated from all the comments made, regarding '*reasons for taking respective actions*', is used as a feedback mechanism. All three reports produced enable the user(s) to review and discuss actions required to be taken in order to improve the response/management of the each characteristic and therefore complexity of interconnections.

Conclusion

Literature review and the results obtained indicate that in construction industry project practitioners, from both sides - client and contractor, do not use any techniques for the selection of team members and therefore there is need for an alternate / higher initiative that will improve the process. Also, as generally accepted and shown from the results, the construction environment is more complex and dynamic. However, neither tools are available to practitioners, nor consideration is given to complexity and its characteristics when selecting team members. In fact determination and management of complexity remains within various mechanistic tools which have been established within the construction industry.

Since the mid-90s, the Latham and Egan reports, a number of drivers have been suggested and are known, however, as shown by the results these recommendations have produced very few results in terms of selecting team members. Although techniques for personnel profiling have found their way into company processes very few actions are implemented and even fewer have influenced / affected this soft side of the project management processes.

Having linked the complexity characteristics to project management it is of interest to all parties to implement actions that will minimize or maximize the effects of complexity on the numerous project management sub-processes. Thus, considering the sub-process of selection of team

members under the complexity perspective and implementing the proposed framework and the established actions it will allow for the management of complexity. At the same time it can be proven a much more plausible carrot / encouragement for project management practitioners to implement the process.

In a friendlier and more dynamic environment, where both clients and contractors allow for a more open and extended front end project period, selecting the appropriate PM and team members based on already established profiling techniques is feasible and achievable. Additionally in a complex environment the implementation of actions identified through the framework developed (F4MCI®), for the selection of team members process, and understanding complexity and its characteristics will enable the management of its effects.

References

Antoniadis, D.N. (1998). *Organising for build operate transfer projects*. Unpublished MSc dissertation, Reading University, UK.

Antoniadis, D.N., Edum-Fotwe, F.T. and Thorpe, A. (2006). Project reporting and complexity: *In Boyd D, editor. Proceedings of 22nd Annual Conference ARCOM, UCE, Birmingham, UK*, September 2006, 123-133.

Antoniadis, D.N. (2009). *Managing complexity in project teams*. PhD Thesis, Loughborough University, UK.

APM Book of Knowledge (2006). 5th Edition, London: APM Publishing.

Baccarini, D. (1996). The concept of project complexity – A review. *International Journal of Project Management, 14*(4), 201-204.

Belbin, R.M. (2000). *Beyond the team*. Oxford: Butterworth-Heinemann.

Belbin, R.M. (2004). *Management teams. Why they succeed or fail*. Oxford: Elsevier Butterworth-Heinemann.

Bertelsen, S. (2005). Construction management in a complexity perspective. *In Proceedings of 1st International SCRI Symposium, University of Salford, UK*. 30-31 March 2005.

Bourgeon, L. (2006). Staffing approach and conditions for collective learning in project teams: The case of new product development projects. *In Proceedings of 6th Annual Conference of the European Academy of Management, EURAM Conference, Oslo*. 17–20 May 2006.

Breauner, E.F. (1995) *Complexity and organisational structure*. Master's Thesis at MIT Sloan School of Management. URL www.fieldbook.com/breuner.html (visited 2012, September 5).

Busby, J.S. and Hughes, E.J. (2004) Projects, pathogens and incubation periods. *International Journal of Project Management*, 22(5), 425-434

Cheng, M.I., Dainty, A.R.J. and Moore, D.R. (2005). What makes a good project manager? *Human Resource Management Journal, 15*(1), 25-49.

Cohen, S.G. and Bailey, D.E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management, 23*(3), 239-290.

Collins, A. and Baccarini, D. (2004). Project success – A survey. *Journal of Construction Research*. 5(2), 211-231

Courtney, R. and Winch, G.M. (2003). Re-engineering construction: the role of research and implementation. *Building Research & Information, 31*(2), 172-178

Crawford, L. (2005). Senior Management perceptions of project management competence. *International Journal of Project Management, 23*(1), 7-16

Dal Forno, A. and Merlone, U. (2005). Network dynamics when selecting work team members: A comparison between experimental and computational results. *In Proceedings from North American Association for Computational Social and Organizational Science (NAACSOS), 26-28 June 2005, Notre Dame, Indiana, USA*. URL http://www.casos.cs.cmu.edu/events/conferences/2005/2005_proceedings/DalForno.pdf (visited 2008, February).

Davidson Frame, J. (2002). *The new project management, tools for an age of rapid change, complexity and other business realities*. 2nd Edn, SF: Jossey-Bass.

Edum-Fotwe, F.T. and McCaffer, R. (2004). The leadership factor for managing in future virtual construction projects. *In: Pantouvakis JP, editor. 3rd Scientific Conference on Project Management (PM-03) "Clustering in Construction Project Management", 24-25 Sep-04, Thessaloniki, Greece*. (1), 90-98.

Egan, J. (1998). *Rethinking construction – The Egan Report*.

Galbraith, J.R. and Lawler III, E.E. (1993). *Effective organisations: using the new logic of organizing: organising for the future*. In: Galbraith JR, Lawler III EE and Associates, editors. Organising for the future. The new logic of managing complex organizations. SF: Jossey Bass.

Geraldi, J.G. (2008). The balance between order and chaos in multi-project firms: A conceptual model. *International Journal of Project Management, 26*(4), 348-356

Green, S. (2002). The human resource management implications of Lean construction: critical perspectives and conceptual chasms. *Journal of Construction Research, 3*(1), 147-165

Green, S. (2006). *The management of projects in the construction industry: context, discourse and self-identity*. In: Hodgson D, Cicmil S, editors. Making Projects Critical. Hampshire: Palgrave Macmillan.

Hinds, P.J. Carley, K.M. Krackhardt, D. and Wholey, D. (2000). Choosing work group members: balancing similarity, competence, and familiarity. *Organizational Behavior and Human Decision Processes, 81*(2), 226-251.

Kadefors, A. (2006). Procuring innovative project management – Contractor selection in partnering. *6th Annual Conference of the European Academy of Management, EURAM Conference, Oslo*, 17–20 May 2006. URL www.euram2006.no (visited 2008, July).

Kallinikos, J. (1998). Organized complexity: Posthumanist remarks on the technologizing of intelligence. *Organization, 5*(3), 371-396

Katz, N. and Lazer, D. (2002). Building effective intra-organizational networks: the role of teams. *Research Paper, Centre for Public Leadership, J.F. Kennedy School of Government*, Harvard University.

Keegan, A. and Turner, R.J. (2003). *Managing human resources in the project-based organizations*. In: Turner RJ, editor. People in Project Management. Hants: Gower.

Latham, (1994). *Constructing the team*, Department of Environment, UK.
Lawler III, E.E. (1993). *Creating the High-Involvement Organisation*. In: Galbraith JR, Lawler III EE and Associates, editors. Organising for the future. The new logic of managing complex organizations. SF: Jossey Bass.

Liker, J.K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.

Lillieskold, J. and Eklstedt, M. (2003). *Managing complex IT – projects – A need for a tool addressing technical and organizational complexity*. The Royal Institute of Technology, Industrial Information and Control Systems, Stockholm, Sweden.

Lucas, C. (2000a). The Philosophy of Complexity. URL www.calresco.org/lucas/philos.htm (visited 2005, February).

Lucas, C. (2000b). Setting the scene – Science, Humanity and Interaction. URL www.calresco.org/setting.htm (visited 2005, February).

Morris, P. (1994). *The management of projects*. London: Thomas Telford.

Moore, D. (2002). *Project Management: Designing Effective Organisational Structures in Construction*. Malden MA: Blackwell Science.

Müller, R. and Turner, R.J. (2007). Matching the project manager's leadership style to project type. *International Journal of Project Management, 21*(1), 21-32

Ogunlana, S., Siddiqui, Z., Yisa, S. and Olomolaiye, P. (2002). Factors and procedures used in matching project managers to Construction projects in Bangkok. *International Journal of Project Management, 20*(5), 385-400.

Project Management Institution. (2000). A Guide to the Project Management Body of Knowledge. *Project Management Institute*, Pennsylvania, USA.

Slevin, D.P. and Pinto, J.K. (2004). *An overview of behavioral issues in project management*. In: Morris PWG and Pinto JK, editors. The Willey guide to managing projects. New Jersey: John Willey and Sons.

Stacey, R.D., Griffin, D. and Shaw, P. (2002) *Complexity and management: fad or radical challenge to systems thinking*. London: Routledge.

Thompson, P. (1996). *The role of project management in our changing society*. In: Cartwright S, & Gale A, editors. Effective teamworking in the Project Management environment. London: Tudor Business Publishing.

Thompson, J.D. (1967). *Organisation in action*. New York: McGraw Hill.

Turner, R.J. (1999). *The handbook of project based management*. London: McGrawhill.

Turner, R.J. (2005). Editorial: Project management research conferences 2006. *International Journal of Project Management, 23*(8), 573-574.

Walker, A. (1996). *Project management in construction*. London: Blackwell Science.

Williams, T. (2002). *Modelling complex projects*. London: Chichester-Willey.

Wild, A. (2001). *Construction projects as teams or situations: Criticising the "techniques of communication" approach*. In Akintoye, A. (Ed.) 17th Annual ARCOM Conference, 5-7 Sep-2001, Vol. 1, 495-504.

Appendix 1

Table 6

Complexity characteristics and relevance to construction (Lucas 2000b)

Group	Characteristics	Lucas' description of characteristic and authors' adaptation relevant to construction
Conditiona 1	Autonomous agents	*Complex systems are generally composed of independent or autonomous agents (not the identical parts often assumed in science). All of these agents are regarded as equally valuable in the operation of the system*

		Each and every individual and group / company contributing to a project is considered to be an autonomous agent and regarded as equally valuable in the operation of the system.
	Instability	*Over the long term stepped evolution or catastrophes will exist (similar to punctuated equilibria). Sudden swaps between attractors become possible as the system parameters approach the boundaries of the attractors*
		Stepped evolution(s) or catastrophes do occur in projects. Attractors appear (currently unintentionally) and become system parameters, which will attract other team members and avoid chaotic behavior of the project system.
	Non-equilibrium	*Energy flows will drive the system away from an equilibrium position and establish semi-stable modes as dynamic attractors*
		The various 'pulls', contractual, behavioral, stakeholder influences, company politics, and management pressures, to mention but a few that occur in projects from the multiple contributors which, depending on the situation, will establish semi-stable modes with 'players' (attractors) who will attempt to influence the project at the opportune moment.
	Non-linear	*Complex system outputs are not proportional to their inputs*
		Individuals seen as complex systems that work in a project and outperform themselves when faced with challenging conditions and under a good environment encouraging team work, understanding and noticing individuals' contribution, establishing team work rather than group work or individualistic behavior.
	Attractors	*Self-organization relates to the presence in the system of dynamical attractors*
		Simple systems (individuals) come together and many times self-organize to form more complex systems which are pulled by the presence of the dynamic attractors of the moment. So we have individuals that could easily not be the line managers, who because of their capabilities, abilities, and behavioral attributes become 'attractors'.
Developmental	Co-evolution	*The parts are regarded as evolving in conjunction with each other in order to fit into a wider system environment*
		This is self-evident in the Project Management world. Individuals within teams and teams within projects co-evolve and initially attempt to understand each other in order to understand the requirements and fit into the wider project environment

	Self-modification	*Parts can change their associations or connectivity freely - either randomly or by evolved learning procedures*
		Individuals and teams form and change their associations as they are evolving and learning during the project life-cycle. As new teams enter the project environment new associations are created between individuals and teams. Managing and coordinating the self-modification of individuals and teams to the benefit of the project, through learning, will improve the project outcome.
Developmental	Self-reproduction	*Usually these systems have an ability to clone identical or edited copies*
		The structure is set up to be the same throughout the project – cloned / copied, despite the fact that different teams may require different organizational structure or style of management.
	Downward Causation	*The existence and properties of the parts themselves are affected by the emergent properties … of the whole*
		The existence and skills (including characteristics) of individuals and teams within the project are affected by higher level systemic features of the whole. A number of structures that are set up at project level that indicate the systemic features of the project affect the existence, the properties / requirements of the project parts themselves.
	Mutability	*Random internal changes (mutations) or innovations typically occur in these systems.*
		It is typical of random mutations to occur in Projects. Project Management has to identify and manage them. Considering the 'individual' as a system, it is highly likely that random internal changes will occur during the life cycle of the project and these will have an effect on the project through the individual's performance. These internal changes could be beneficial or detrimental and could be caused by either internal, to the project, reasons (e.g. team members' behaviors), or the individual's employer (e.g. promotion or demotion), or personal.
	Non-uniform	*Each part evolves separately, giving a diversity in rule or task space*
		The individual parties evolve separately and give diversity in projects. This again has to be identified and managed rather than controlled and stopped. Each person brings its own attributes to the project at the level it operates. Diversity improves the outcome, as the individual(s) are attempting to achieve a higher status, or benefit.
	Emergence	*The properties of the overall system will be expected to contain functions that do not exist at part level*

		Emergence describes the power of the whole delivering a lot more than the individual parties to the project. The usual 2+2=5. The project takes from each part and combines all properties to produce a holistic system that will deliver the project.
	Phase changes	*Feedback processes lead to phase changes, sudden jumps in system properties*
		As far as the project and the individuals are concerned this characteristic highlights the importance of feedback processes. Phase changes / sudden jumps, depending on the approach taken, could have a detrimental or beneficial influence in the individuals' attributes. These could either be the standard project phase / stage changes that are based on feedback to higher management levels, or even within the standard PM processes that could lead to the sudden jumps described by this property.
Behavioral	Unpredictability	*In such interacting systems a chaotic sensitivity to initial conditions can occur*
		It represents the importance of the initial project conditions which if not managed appropriately could lead to chaotic conditions occurring later on.
	Non-standard	*… initially homogenous systems will develop self-organizing structures dynamically*
		Each system that comes to the project will self-organize dynamically with the other project systems and change from its initial homogeneous status. Complexity requires for systems to have the characteristic of 'non-standard' in order to be able to evolve from homogenous systems into dynamic self-organized ones.
Behavioral	Undefined values	*The meaning of the system's interface with the environment is not initially specified and this must evolve*
		Identifying the system's/project's interfaces with the environment as the external stakeholders this characteristic advocates the need for the evolution of the interfaces as the project progresses. In terms of selecting the team members, and for several roles within the team, the influencing factor of the project interfaces should be identified and introduced in the selection criteria process.
Note: Lucas' (2000b) description of complexity characteristics are shown in italic.		

Appendix 2 - F4MCI® Reports from Running the Selection of Team Member Module

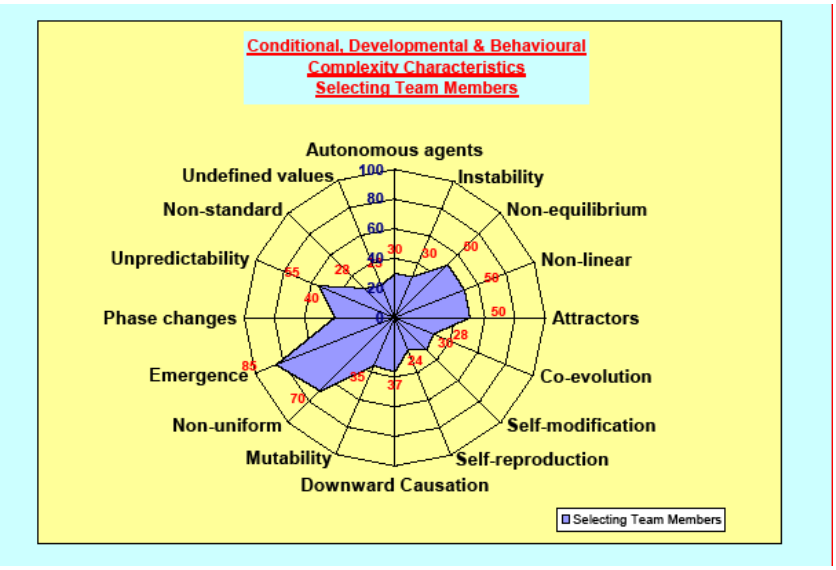

Figure 5: Radar Graph Report from F4MCI® for Selecting Team Members.

Selecting Team Members		
Characteristic	Score	Comment on management of complexity characteristic
Autonomous agents	30	is not managed, more actions required
Instability	30	is not managed, more actions required
Non-equilibrium	50	is not managed, more actions required
Non-linear	50	is not managed, more actions required
Attractors	50	is not managed, more actions required
Co-evolution	28	is not managed, more actions required
Self-modification	30	is not managed, more actions required
Self-reproduction	24	is not managed, more actions required
Downward Causation	37	is not managed, more actions required
Mutability	35	is not managed, more actions required
Non-uniform	70	is not managed, more actions required
Emergence	85	is managed, some more actions are required
Phase changes	40	is not managed, more actions required
Unpredictability	55	is not managed, more actions required
Non-standard	28	is not managed, more actions required
Undefined values	23	is not managed, more actions required

Figure 6: Report from F4MCI® for Selecting Team Members.

Women in Construction in South Africa: Investigating the Feminine Footprint of the South African Construction Industry

Aghaegbuna Ozumba (University of the Witwatersrand)
School of Construction Economics and Management
EBE Faculty
Johannesburg, South Africa

Chineme Ozumba (University of the Witwatersrand)
Department of Demography and Population Studies
Humanities Faculty
Johannesburg, South Africa

The article presents an exploration into the performance of the South African construction industry with regard to its feminine footprint. Focus of the study is female employment and promotion, and the impact on levels and types of work, with regard to population characteristics. Democratic South Africa has enabled public and private efforts to transform the nation from the previous apartheid legacy, which includes discrimination against women. Consequently gender mainstreaming in post-apartheid South Africa has enabled interventions that aim to emancipate women, especially in the area of labor. However, the country is behind the set goals in terms of women and work, especially in male-dominated environments such as the construction industry. The situation is explored through a purposive sample of literature related to women and work, and women in construction in South Africa. This is combined with analysis of labor statistics. The major limitation is the secondary nature of data used for the study. Findings at this stage suggest sub-optimal growth in female employment. There are also appreciable disparities between the informal and formal sectors, and between the levels and types of work, according to population characteristics.

Keywords: construction, development, employment, gender, women.

Introduction

Research interest for the paper concerns the effectiveness of the gender-positive environment created as one of the outcomes of South Africa's democracy of seventeen years. Specific focus is given to the employment situation of women in the local construction industry.

South Africa has a history of strong racial and gender conflict, and oppression (Underwood, n.d.). Firstly, in apartheid South Africa, gender based discrimination at the workplace was institutionalized. Married women and women of non-European descent were not allowed to be formally employed. Secondly, women were not employed or promoted to management levels in their places of work (Bezuidenhout et al. 2008). Thirdly, African (black) women especially were much more constrained than the rest. They were corralled in forced settlements and forbidden from accessing the cities or working in any formal business. They could only perform informal work as farm hands and in related jobs (Meer 1985). Since 1994 the nation entered into a democratic era (GCIS 2011a). Gender main mainstreaming policies in relation to employment and promotion of women only came into existence after the inception of democratic rule (The South African Department of Labour 2010). However, the impact of previous dispensations is

still evident (Underwood n.d., GCIS 2011a). Therefore, it is arguable that apartheid era South Africa, had enabling environment for high occurrence of gender based discrimination in the work environment. It is also arguable, that gender mainstreaming interventions instituted in post-apartheid South Africa, would address inequalities of the past. Thus effectiveness of the new gender-positive environment could be measured through indicators of women empowerment. Critical areas include population characteristics, in relation to employment and promotion of women.

Since the end of apartheid rule in 1994, gender related human resource management policies and legislations have been introduced. These legal vehicles include the Employment Equity Act and the national policy framework for women empowerment and gender equality. However some sectors of the economy such as construction have not experienced commensurate change in their feminine footprint, especially in the employment and promotion of women. As of September 2009, women comprised 44.87% of the employed population in South Africa. At the same time, only about 13% of employees in the construction industry were women (Statistics South Africa 2009). Currently, the female work force in South Africa is concentrated in the services industry at 31.20%. However sectors such as construction, mining, utilities and transportation have low proportions of the female work force. Out of a total female working population, which is above nine million, only 1.87% is in construction (Statistics South Africa 2011).

From the above statistics, gender related legislation and Human Resource (HR) policies in South Africa seem to have had minimal effects on the employment of women in sectors such as construction. For the local construction industry causative factors could include insufficient adoption of gender mainstreaming, inadequate implementation, or lack of commitment on the part of the private sector. There could be other reasons such as lack of qualified persons (female graduates), more women leaving the industry, and lack of succession plans between lower and higher levels of work. Furthermore it is possible that interventions referred to earlier have not created an environment that is enabling enough, to transform the industry's feminine footprint. Research presented in the article therefore investigates the feminine footprint of the South African construction industry, on the backdrop of gender mainstreaming efforts in the country. The approach is a combination of literature review and survey data analysis, from which inferences are drawn.

Relevant Concepts in the Study

The perspective of 'Feminine Footprint' considers women's issues in its totality, but with specific focus in each instance. Theory discussed here centers around issues of women's liberation in Africa, and particularly female employment in South Africa using the construction industry as a context. Issues relating to female employment are centered about the intersections of feminism, women and work, and gender and development. Specific focus on female employment issues in the local construction industry also concern Human Resource Management (HRM) policies, legislation and implementation.

Feminism

The history of Feminism is notable in Europe and America, where initiatives have been taken against marginalization of women since the nineteenth century. There have been three waves of feminism. Consequently the following issues have been addressed: women's rights to education, employment, property rights, women's suffrage, economic rights, as well as sexual and reproductive rights (Karl 1995); social and legal norms that affect women (Rowbotham 1996); ending institutionalized oppression of women; empowerment of women for participation in decision making at all levels of society; and transformation of society through women's participation and perspectives (Karl 1995). Following from the above, feminist efforts and impact put gender and development on the global stage.

Gender and Development

The Gender and Development (GAD) concept emerged from the 1985 United Nations (UN) Women's Conference in Nairobi. GAD focused on issues of subordination in social relations between men and women (Pearson 2000). The major outcome of GAD is the promotion of women's advancement nationally and internationally. Associated events with landmark outcomes include: World conference on Equality, Development and Peace in Mexico, 1975; the decade for Women and Development, 1976-1985; appraisal of the 1975 world action plan for women advancement in Copenhagen, 1980; International treaty on Convention on the Elimination of All forms of Discrimination Against Women (CEDAW) in September 1981 (UN 1995); and the emergence of 'Forward Looking Strategies for the Advancement of Women' (FLS) in Nairobi, 1985 (Jahan 1995). Furthermore the Beijing conference of 1995 resulted in a declaration, which addressed critical areas of discrimination against women including, education, health, economy, women's human rights and the situation of the girl child (United Nations Department of Public Information 1997). The above mentioned developments have had positive impact on the advancement of women, with the emergence of new challenges. Research shows that the feminine footprint of the global labor market has improved. However the increasing population of employed women experience poor terms and conditions of work (United Nations Research Institute for Social Development (UNRISD) 2005). Possible inferences at this point include: that women are probably less paid; women are fewer in professional, technical and managerial types of work; and that women do not enjoy succession to higher levels of work or pay.

Women and Work

With regard to work, women's effort could be grouped into reproductive work, economically productive work, and community managing work. These groupings respectively refer to women's biological roles for children and family; work done in exchange for payment in cash or in kind; and the mostly voluntary or unpaid community management work. In contrast, most work undertaken by men for the general good is usually rewarded in some way (Moser, 1993). The suggestion here is that there are culturally embedded perspectives with regard to gender and labor. Furthermore there could be fundamental differences in perceptions and management of human resource across human cultures, which are gender-based.

Human Resource Management

Human Resource Management (HRM) could be seen as influencing the employee population of an organization, different from the organization's ownership (Wojtkiewicz 1985). More recently HRM is described as the procedure for achieving balance between growth and development for any organization; and the same for its employees, within the organization's capacity (Grobler et al. 2006). HRM is essentially aimed at improving effectiveness of employees in an organization (Heneman et al.1986). The process of HRM moves from policy to practice. As such policies are developed, interpreted and then implemented (Grobler et. al. 2006). Presently the advent of globalization has impacted the practice of HRM appreciably. Recent developments include global expansions of companies; mutual awareness of cultural differences; Asian economic growth; outsourcing of production to less developed countries; impact of information and communication technologies; labor issues such as leave allowances, remunerations and compensations (Friedman 2007). Specifically, in the US influence of diverse cultures are felt. There is push towards strategic HRM and speculation on future directions. In the UK more regulations are emerging. There are more incentives through compensation regimes and flexible working conditions. In Japan, traditional practices remain strong but human resource (HR) practices are gradually changing in response to global factors (Česynienė 2005).

The Feminist footprint in Africa and South Africa

Preceding arguments suggest that cultural peculiarities and history are strong influences on women and work. It is therefore arguable that African countries have good grounds for women's liberation. Across the African continent there are records of African women leaders of resistance movements, as early as the 7th century. Examples include the Berber Queen, Kachine of the Maghreb; 9th century Magajiyas of Daura; 16th century Queen Amina of Zazzau; and 19th century Nehanda of Zimbabwe. Moreover, early 20th Century has records of Igbo (Ibo) women leading resistance in the Aba women's riots (Net Industries 2010, Oxford University Press 'OUP' blog 2007, Trask 2004). In South African history, prominent women activists include Charlotte Maxeke, Lillian Ngoyi, Helen Joseph, Sophie du Bryun, Bertha Gxowa, Amina Cachalia, Albertina Sisulu, and Winnie Madikizela-Mandela (Mlambo-Ngcuka 2006). The formal feminist movement in South Africa started with the 1990 Malibongwe conference in Holland, which gave birth to the 'Statement on the Emancipation of Women in South Africa'. This was followed by adoption of 'Women's Charter for Effective Equality' by Women's National Coalition in 1994 (African National Congress n.d.). Local feminist efforts have since brought constitutional changes in the areas of gender equality and socio-economic rights (Hassim 2005).

Prior to the Malibongwe conference, apartheid South Africa institutionalized gender-based discrimination at the workplace. Denial of employment by legislation existed and promotion to management level was non-existent. The severity of such circumstances was felt more by racial definition (Bezuidenhout et. al. 2008). The infamous Bantu education policy was a major tool for incapacitating the African (black) workforce (Christie & Collins 1982, South African History online n.d.). However post-apartheid South Africa has seen the emergence of legislation, strategies and interventions to empower women in the work place. There is the Act 66 of 1995

(Labour Relations Act); Act 108 of 1996 (South African Constitution Act); Act 75 of 1997 (Basic Conditions of Employment Act and Amendments 42/1996, 27/1998, 2/2002); and Act 97 of 1998 (Skills Development Levies Act). The focus of complimentary legislation is on health and safety, and workers' compensation for injuries and diseases (The South African Department of Labour 2010). Despite such positive developments, South Africa had poor global HRM rankings in the year 2000 (Grobler et. al. 2006). In response, certain legislation has been amended, while new ones have been put into effect. The Basic Conditions of Employment Act was amended. New legislation include: The Employment Equity Act of 1998 and The Promotion of Equality and Prevention of Unfair Discrimination Act of 2000. The South African national policy framework for women's empowerment and gender equality was instituted in 2002. The framework aims to provide equal opportunities to previously disadvantaged groups in South Africa, especially women (Public Service Commission 2006).

Women in Construction in South Africa

Following developments mentioned in the preceding paragraph, the government has also instituted numerous programs to address female employment, especially in the construction industry. Firstly, there is the Emerging Contractor Development Programme (ECDP), which targets all emerging contractors while giving preference to female emerging contactors. Secondly, there is the Affirmative Procurement Programme (APP), which has been administered by the Department of Public Works (DPW) since 1999, and facilitates wider access to government contracts. Thirdly, the Contractor Incubation Programme (CIP) was started in 2004 as part of the ECDP, and aims to further develop emerging contractors. Consequently there has been an improvement in the number of female contractors. Women-owned contracting companies have attained 48% proportion in the Construction Industry Development Board (CIDB) register. Despite the interventions highlighted above, statistics show that men still dominate construction, with over 50% proportion (Didiza 2008). In line with creating an enabling environment, there are complimentary efforts by voluntary organizations towards leveling the playing field for women in construction. There is notably the South African Women in construction (SAWIC), and Kuthaza. SAWIC was inaugurated in 1997 with the vision of improving women's roles in construction and housing sectors through the propagation of lucrative business enterprises. Efforts of SAWIC include technical and entrepreneurial capacity-building and creating networks and partnerships for women in construction (SAWIC 2009). Kuthaza targets contractor development, talent development and bridge building. Formerly known as Women for Housing, it was inaugurated in 1995 (Kuthaza 2009).

It is arguable at this juncture that growth in the proportion of women in the South African construction industry could be attributed to female emerging contractors. Nevertheless, these interventions are designed to level the playing field for women in construction generally. However, the figures remain low despite such interventions. Women made up 44.87% of the employed population in South Africa as of September 2009. Women in construction comprised only 13% (Statistics South Africa 2009). In related research, reasons proffered for poor feminine footprint in construction include: discrimination in employments and promotions, and lack of support structures for female staff (Dainty et al. 1999, Fielden et al. 2001). Therefore on the background of the literature reviewed, there is a need for investigations into the feminine footprint of the South African construction industry. For the purpose of the article, trend of

employment is used as a backdrop for examining the following: Formal and informal sectors of the industry; the trend across levels and types of work; and the influence of population characteristics on women in construction.

Methodology

Methodological requirements for moving the research forward were deemed to be basically exploratory. Based on the data requirements for further investigations, secondary data analysis was chosen for the research. The South African Labour Force Surveys (LFS) data sets from Statistics South Africa (Statssa) were utilized. Access was obtained through the Statssa online database, (www.statssa.gov.za/). A number of steps were adopted for the methodology, in order to explore the data set adequately. Analysis of the trend was performed, using time series analysis. Ex post facto design was used to investigate the overall impact of a specific independent variable (in this case, gender mainstreaming), on dependent variables (female employment and promotion) in the South African construction industry (Leedy & Ormond 2010). Descriptive cross-sectional analysis was employed to describe the current situation, and also to analyze the outcomes for relationships with population characteristics. Bivariate and regression analyses were performed as steps to further interrogate the data set (Remenyi et al. 2011). By examining the trend, development of female employment in construction over time is ascertained and highlights are identified for cross-sectional analysis. The trend also shows indicators of the rate of response of the construction industry to issues and interventions highlighted in the literature review. From the initial descriptive analysis, population characteristics were investigated for relationships with the employment status of women. The trend analysis was performed for the time frame of 2000 - 2011. Further detailed trend analysis showing women in levels of work within the construction industry was performed for the time frame of 2007 - 2011. The reduced scope in this case was due to research limitations.

Data Description, Presentation and Analysis

The data set used for analysis is a combination of nominal and ordinal level data. Two groups are used to categorize levels of work, namely high and low levels. High level of work comprises managerial, professional and technical people, while low level of work is made up of the opposite. Specific types of work consisted of senior official and management; professionals; technical and associate professionals; clerks; service works, shop and market sales people; skilled, craft and related trades; plant and machine operators and riggers; and elementary occupations. Population characteristics selected for analysis are age, marital status, province, education, and population group. Under age, there are six groups ranging from 29 years to 60 years and above. Marital status is made up of married, living with somebody, never married, divorced, and widow. Education has four groups ranging between none and tertiary; and all nine provinces in the country are represented. Furthermore, for the population group, African, white, Indian and colored categories are represented.

Results in Figure 1indicate that the number of people employed fluctuates over the years. Any element of growth is however accounted for mostly by male employees. Population of men fluctuates closely to the total employed population at each point in time, while the women population trails behind in volume. Between 2006, 2007 and 2008 there were sharp increases in

employment, which were accounted for mostly by men. Between 2000 and 2011 the rate of increase for females in construction has been about 5.88%. In 2010 women made up 11.29% of people in construction while men were about 88.71%. As of 2011, the figures have not changed significantly, with men still about 87.51%, while women make up 12.49%.

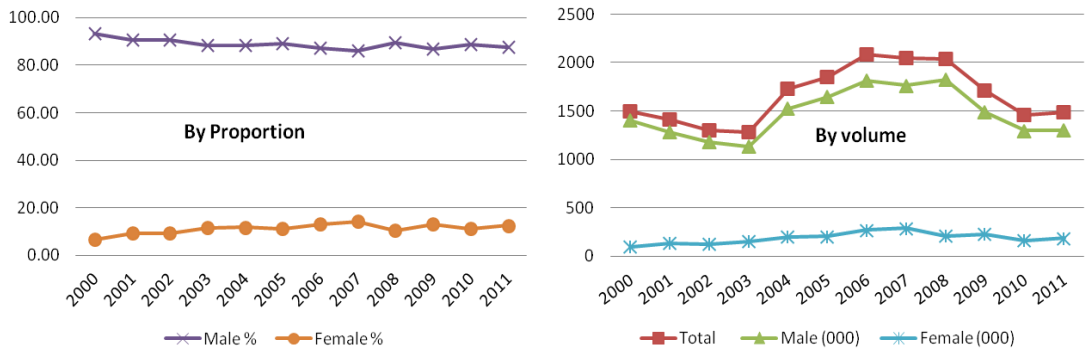

Figure 1: Trend of employment in the S.A. construction industry, by gender in volume and proportion for (2000-2011).

Results presented in Figure 2 show the wide margin referred to earlier, remaining relatively the same in both formal and informal sectors. Proportions for both males and females in the formal sector suggest a closing of the gap especially from the middle of 2008 onwards. Conversely the gap in the informal sector is widening over time. Even more significant is that from 2008, the proportion of women in the informal sector declines and stays below 10%. As of 2011, the proportion of women in the informal sector was 3.91% of the population. Furthermore fluctuations are noticeable in both sectors; with the informal sector experiencing more fluctuations.

Figure 2: Trend of women proportions in formal and informal sectors of S.A. construction industry (2000-2011).

Figure 3 shows results of analysis on proportions of women in levels of work categorization in the formal sector, as discussed in the methodology section. Low level work category (non-managerial/professional/technical), is consistent at high proportions and rising. Also high level of work (managerial/professional/technical) is consistent at low proportions and decreasing. In

addition the chart suggests a widening gap between the two levels of work. Between 2007 and 2011, the volumes of female employees each year show that more women are working in the low level category of work. Furthermore, trend analysis for women in specific types of work within the construction industry was performed for the time span of 2006 - 2011. Elementary occupations remain generally within the same proportion for females. The highest rise in proportion was recorded for clerks in 2009. Generally proportions of the higher level work types seem to be declining over time.

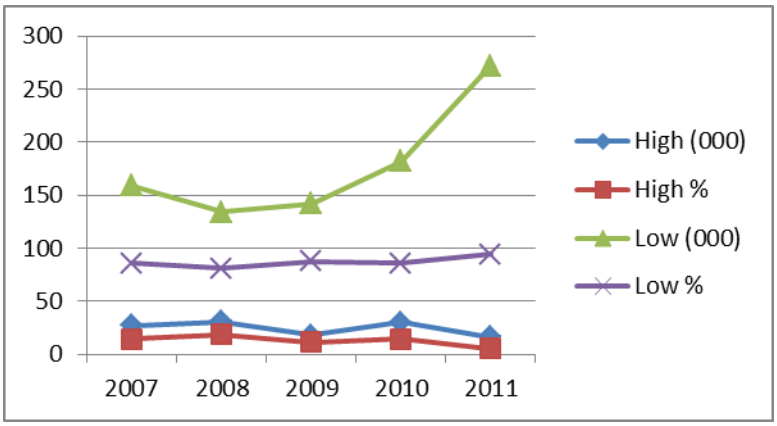

Figure 3: Trend of women by levels of work in the formal sector of S.A. construction industry (2007-2011).

Cross-Sectional Analysis of 2011 Data for Women in Construction in South Africa

In light of the above results, a cross-section of 2011 LFS data was evaluated. The data was collected from a sample of 138,000 women who were doing some form of work in the construction industry. Initial analysis used details of specific types of work as specified in the data description. The results are as follows: majority of construction employees in elementary occupations, about 53%, are women. Only 14% of these women are employed in skilled crafts and trades. Other work types have less than 10% women proportion. Particularly, only 2% of the professionals are women. Senior and management positions have 7% women proportion, while technical and associate professionals have 5% female employment. Furthermore, population characteristics including: educational level, population group, marital status, province, and age group were analyzed. Most respondents, at a proportion of 56.52%, have secondary education; 25.69% have primary education; and10.87% have tertiary education. In terms of population group, people of African descent make up the largest group at 76.09%. They are followed by the people of European descent with a wide margin of 13.77%. Colored and Indian or Asian people make up 8.7% and 1.45% of the sample respectively. For marital status, single women who never married make up the largest sub-group with 47.1% of the sample population. Married women or those living with a partner are 37.68%, followed by widows and divorced women. Under provinces, KwaZulu-Natal (KZN) accounts for highest proportion of women in construction within the survey sample, with a value of 39.13%. KZN is followed by Gauteng province with 13.04%, and Eastern Cape with 10.87%. With regard to age groups, women in the range of 40-49 years of age are highest in number at 29.71%. Women in the 20-29 years and 30-

39 years of age share the same proportion of 23.91%. Women who are 50-59 years of age are the least in number.

Bivariate Analysis on 2011 Data on Women in Construction in South Africa

Bivariate analysis was performed on the LFS data to determine the significance of population characteristics selected for analyzing the LFS sample, using STATA 11 statistical software. High and low levels of work were used as outcome variables, as described in the methodology section.

For educational level, the highest concentration (84.62%) of the population is in the secondary education category, and is located under lower levels of work. For population groups, about 26% of the people of European descent (white) are in the higher levels of work; while only 7.62% of African people (black) are in the same category. For those married or living together, and those who are single; the greater percentages of each sub-group lie within the lower levels of work. In addition the entire proportions (100%) of widows and divorced women are in lower levels of work. The Gauteng province has the highest proportion of women in higher levels of work; with a proportion of (38.89%). This figure is still appreciably less than half the proportion of women in construction within the province. Three out of nine provinces, namely Northern Cape (NC), Free State (FS), and North West (NW); have 100% of their women in lower levels of work. For the age variable, 100% of older women (50+ years), are in lower levels of work. Women of 20 – 29 years of age are the highest proportion in higher levels of work. Investigating educational level further shows that Africans (black) and Europeans (white) are at the extremes. The black female population group have about 16,000 people who are without formal education. White women make up 25.87% of tertiary educated women working in construction. More black women are found in primary and secondary education levels, than in the tertiary level. Furthermore, the distribution of educational levels seems to be between higher and lower levels of work.

With regard to probability values (p-values) measured for various predictors in the bivariate analysis, Table 1 below shows that the three predictor variables which have significant values are: Education, province and population group of individual women. They are therefore considered as having some degree of association with levels of work for women in construction.

Table 1

Showing significant predictor variables from the bivariate analysis

	Educational level	**Population group**	**Province**
p-values	0.016	0.046	0.017

Multivariate Analysis of Significant Predictor Variables from 2011 Data on Women in Construction in South Africa

In order to further determine the significance of the selected population characteristics on women in the two levels of work (high and low levels), regression analysis was performed. A number of procedures were followed in order to validate results further, as described in (Remenyi et. al. 2011). Two software packages were used, namely Stata 11 and Microsoft Excel 2010. Stata 11

was used to perform logistic regression, while Excel was used to perform linear regression. Coefficients of regression and associated p-values are used to assess the significance of predictor variables at a 95% confidence interval, which is normal for such social science related research. Table 2 below shows results of logistic regression. Educational level was found to be the only significant population characteristic, with a p-value of 0.009. With high level of work as the outcome of interest, educational level has a regression coefficient of 1.31 at 95% confidence interval. Therefore, for every value increase in educational level, outcome in terms of levels of work is influenced by up to 1.31 times the value increase in educational level.

Table 2

Showing Logistic Regression Results for Selected Predictors

Work Type *(reference: Non Manag/Prof/Tech)*	**Coefficient**	**p-values**	**95% CI**	
*Educational Level	1.31	0.009	0.3327	2.2767
Population Groups	0.31	0.149	-0.1110	0.7334
Province	0.97	0.408	-0.1326	0.3263
Constant	-5.67			
N	138			

*=Significant at 95% confidence interval

With regard to the relationship of women in types of work with education and population group, education is the significant variable with a p-value of 0.009 and an appreciable coefficient of 1.28. When regressed separately, population group is significant with a p-value of 0.022, but a low coefficient of 0.47. Table 3 below shows result of linear regression on educational level, with level of work as reference. By visual comparison, results of Table 2 and Table 3 validate each other, meaning that results of both analyses are within the range of accuracy. As further steps in ascertaining the strength of relationship between the predictor variable (educational level) and outcome variable (levels of work), hypothesis testing is performed. The hypothesis testing investigates if the regression model for the predictor substantiates a significant proportion of the variance in the outcome variable. The hypothesis used here is a test of significance, using p-values. Use of p-values is based on the assumption that the null hypothesis is true. The hypothesis test ascertains the predictive strength of the regression model, at 5% level of significance whereby (alpha = 0.05). Null and alternative hypotheses are stated, along with the decision rule (Remenyi et. al. 2011).

Null hypothesis Ho: There is no predictive ability in the regression model
Alternative hypothesis Hi: There is predictive ability in the regression model
Decision rule: if p-value of predictor variable is less than alpha then reject null hypothesis; otherwise do not reject null hypothesis.

As shown in table 3 the p-value of 0.002127 is well below alpha value of 0.05, which supports rejection of the null hypothesis. As a result the alternative or research hypothesis is supported. Therefore, it can be concluded that there is predictive ability in the regression model for educational level, with reference to levels of work for women in construction.

Table 3

Showing linear regression results for educational level

	Coefficients	*t Stat*	*P-value*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.07245841	-1.10223	0.27231	-0.202459725	0.057542904
EDU_LEVEL	0.110166359	3.131952	0.002127	0.040605687	0.179727031

As a final confirmation, Analysis of Variance (ANOVA) result for the linear regression model is used to test for statistical fit of the regression model. Table 4 below shows the ANOVA result. The final confirmation is performed by ascertaining if the R2 value (square of correlation coefficient) is statistically significant, by using the associated level of significance of the F-statistic in the ANOVA (Remenyi et. al. 2011).

The associated significance level of the F-statistic is 0.002126557, which is 0.21%. Therefore, there is only a 0.21% chance that the regression model does not have predictive value. In other words, the ANOVA table indicates a statistical fit of high significance at the 0.21% level.

Table 4

Showing ANOVA table for regression with educational level predictor

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.95158188	0.951582	9.809122	0.002126557
Residual	136	13.19334566	0.09701		
Total	137	14.14492754			

Findings and Conclusion

Firstly, the trend analysis suggests that the gender-positive environment in post-apartheid South Africa has increased female employment in construction generally. While female employment has increased over time, the rate of increase suggests a very slow improvement. Over time, the proportion of men employed suggests a downward trend while the proportion of women employed suggests an upward trend. However, the value of these proportions or absolute values of women employed at each point in time remain very low compared to men. Therefore women have consistently constituted a small proportion of employed people in the South African construction industry. The margin of 75.02% between current proportions of men and women suggests a wide lacuna and very slow pace of development for women in construction. Though there is long-term trend of convergence, the proportion of women increased minimally. The trend of convergence is more obvious in the formal sector of the industry. The trend in the informal sector moves from convergence to divergence, whereby the proportion of women employed declines, in comparison to proportion of men. A higher degree of fluctuation is evident in the informal sector, while more women seem to be gaining employment in the formal sector. Secondly, increase of the proportion of women in the formal sector is suggestive of impact, from the enabling environment of regulations, policies, and other interventions. Thirdly, the thinning out of the proportion of women in the informal sector could be as a result of cross movement of people between the two sectors. It could also result from more women leaving the industry, after

failing to make it into the formal sector. Transitions from the informal to the formal sector require a measurable increase in skills, education and / or upgrading to formally registered contractor status. The recent negative economic climate, though transient could account for movement in either direction, or out of the industry. Fourthly, the trend of increase in female employment does not necessarily yield much value for the female workforce, since most female employees fall within the elementary occupations type. In addition, while the majority of educated women in construction are in the lower levels of work, only females with secondary and tertiary education are in the higher levels of work.

Furthermore, both race and education have strong relationships with types of work for women in construction, with education being the stronger predictor. Race being a predictor, albeit reduced, confirms findings from literature about South Africa's history. Moreover, fewer women are employed in the managerial and professional work categories. Also, there seems to be further reduction of racial barriers to female employment in construction, but a sub-optimal development in the educational status of the women. Similarly, it is arguable that there is little or no succession to higher levels of work for women in the formal sector of construction, mainly due to race and educational barriers. Traditionally, race was the major dividing issue in South Africa. In the apartheid era, race was directly linked to educational status, and as such access to higher level skills, and consequently more employment opportunities. Therefore, there is still a visible racial divide in the types and levels of work for women in the South African construction industry. Findings at this stage lead to the question of commitment on the part of the industry, in implementing gender mainstreaming policies. There is also the question of how enabling the environment has been for increase in female employment and promotion. It is also arguable that certain types of work in the South African construction industry have become 'employment safe havens' or 'labor quarantines', for previously disadvantaged women in the country. In the article, employment safe havens refer to the situation where previously disadvantaged women are concentrated in lower levels and types of work because it is easier to be employed and retained at such levels. Similarly labor quarantines refer to the situation whereby previously disadvantaged women experience a ceiling in promotion from such lower work levels and types, due to population characteristics.

Besides race and education, there may be other equally strong predictors. While all possible population characteristics were not included, educational level consistently returned significant results. Therefore educational level presently constitutes one of the most influential factors for employment and promotion of women in construction within South Africa.

Conclusion

Research presented in the article represents work done so far in this regard. Origin and development of gender equality has been chronicled, showing the fundamental bases that enable female employment in South Africa. In light of interventions from the public and private sectors, the feminine footprint of the South African construction industry has been investigated to and appreciable extent. Findings suggest that gender-related interventions in the country have had minimal impact on the state of female employment in construction. Nevertheless, there are other factors which might have had additional impact on the situation. Moreover, literature suggests that much of the increase in females employed in the South African construction industry can be

accounted for by increase in female emerging contractors. All members of this group are not necessarily involved in the technical aspects of construction. It is therefore important to investigate the proportions of women in different levels of work within the group. It is also important to investigate the degree of gender equity and female empowerment practiced in such enterprises. In light of the findings and discussion above, the following propositions are made as a guide to further research:

1. Besides education; age range and province of origin or residence still have strong predictive ability on levels of work for women in construction in South Africa.
2. Population group (race) is a strong predictor for employment and levels of work for women in construction in South Africa.
3. Population group (race) is a strong predictor for promotion to higher levels of work for women in construction in South Africa.
4. There is no effective succession plan for women in construction from lower levels of work to higher levels.
5. A large percentage of the management class could be made up of political appointees, who are not necessarily of any relevant technical background.
6. In higher levels of work there are sub-groups made up of legislators and government officials, which do not truly reflect industry development in terms of women and work.
7. There is disparity between the volume of female graduates and women being employed at graduate level in the construction industry in South Africa.
8. Implementation of gender mainstreaming policies among women contractors is sub-optimal.
9. Female contractors lag behind their male counterparts in implementing gender mainstreaming.

Furthermore, there is need to compare South Africa with other countries of the world. It is also important to investigate the progress and experiences of female graduates of construction related disciplines in the country.

Limitations on the research were due to the secondary nature of data utilized for analysis. Unavailability of certain information such as levels of work for earlier years placed further limitations on the research. Also, largely undefined sample sub-groups with labels such as ‘other’ made it difficult to approach higher degrees of accuracy in the analysis. In light of findings thus far, it is recommended that there should be increased monitoring of adoption and implementation of gender related policies and legislation among construction industry employers in South Africa. Furthermore established female contractors should be used as vehicle for improving the feminine footprint through special incentives.

References

African National Congress (n.d.). A Progressive Women's Movement of South Africa Theme: Women marching for equality, peace and development. URL http://www.anc.org.za/wl/docs/pwm/progressive.html (visited 2010, July 3).

Bezuidenhout, A., Bischoff, C., Buhlungu, S., Lewins, K. (2008). Tracking progress on the

implementation and impact of Employment Equity Act Since its inception. Sociology of Work Unit, University of the Witwatersrand, commissioned by the Department of Labour, South Africa. URL www.uif.gov.za/.../Employment%20Equity_DoL_Report%20SWOP%20Final%2031102008.pdf (visited 2010, March 3).

Česynienė, R. (2005). The most recent trends and emerging values in human resource management: Comparative analysis. *Engineering Economics, Work Humanism.* 4 (44), 44-50. URL http://internet.ktu.lt/lt/mokslas/zurnalai/inzeko/44/1392-2758-2005-4-44-50.pdf (visited 2012, April 3).

Dainty, A. R. J., Neale, R.H., Bagilhole, B. M. (1999). Women's careers in large construction companies: Expectations unfulfilled? *Career Development International*, 4 (7), 353-358. URL http://www.emeraldinsight.com/Insight/ViewContentServlet?contentType=Article&Filename=PublishedEmeraldFullTextArticle/Articles/1370040702.html (visited 2008, March 24).

Didiza T. (2008). Address delivered by Minister of Public Works on the occasion of SAWIC summit, the Ranch Polokwane, URL http://www.info.gov.za/speeches/2008/08042110451001.htm (visited 2008, March 24).

Fielden, S. L., Davidson, M. J., Gale, A., Davey, C. L. (2001). Women, equality and construction. *Journal of Management Development*, 20 (4), 293-305, URL http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=Published/EmeraldFulltextArticle/Articles/0260200401.html (visited 2008, March 24).

Friedman, B. A. (2007). Globalization implications for human resource management roles. Employ Respons Rights Journal, 19, 157–171. Springer Science + Business Media, LLC. URL http://runebergendorff.dk/opendir/Globalization%20Implications%20for%20HRM%20Roles,%0Friedman.pdf (visited 2012, March 4).

Government Communication and Information System (GCIS) (2011a). History: South African government information URL http://www.info.gov.za/aboutsa/history.htm (visited 2011, December 15).

Grobler, P., Warnich, S., Carrell, M. R., Elbert, N. F., Hatfield, R. D. (2006). Human resource management in South Africa, 3rd Ed, 6, London, Thompson Learning.

Hassim, S. (2005). A Virtuous circle? Gender equality and representation in South Africa, State of the Nation address 2004-2005, URL www.hrscpress.ac.za/user_uploads/tblPDF/200513stateofthenation2004-2005 1611200411022 2AM.pdf (visited 2009, July 23).

Heneman, H. G., Schwab, D. P., Fossum, J. A., Dwyer, L. D. (1986). Personnel/human resource management, 4th Edition, Homewood Illinois, Irwirn.

Jahan, R. (1995). The elusive agenda: mainstreaming women in development, London, New

Jersey, Zed Books Ltd.

Kuthaza (2009).Who we are, URL http://www.khuthaza.org.za/index.php/kuthaza/ (visited 2010, March 25).

Karl, M. (1995). Women and empowerment: Participation and decision making, Zed Publishers, London, New York, ch. 2, 336.

Leedy P. D., Ormond J. E. (2010). Practical research planning and design, Pearson Education Inc., New Jersey, ch.10, 229-245.

Meer, F. (1985). Women in the apartheid society, URL http://www.ipoaa.com/women_in_apartheid_society.htm (visited 2012, April 2).

Mlambo-Ngcuka, P. (2006). Mlambo-Ngcuka: Progressive women's movement launch, Address by the Deputy President, Ms Phumzile Mlambo-Ngcuka at launch of the Progressive Women's Movement, Bloemfontein, URL http://www.polity.org.za/article/mlambongcuka-progressive womenx2019s-movement-launch-06082006-2006-08-06 (visited 2009, March 7).

Moser, C. O. N. (1993). Gender planning and development: Theory, practice and training, Gender Roles: the family and households, Routledge, London, New York, ch. 2, 28-35.

Net Industries (2010). Africa and African diaspora feminism-history, URL http://science.jrank.org/pages/9344/Africa-African-Diaspora-Feminism-History.html (visited 2010, June).

Oxford University Press Blog (2007). Feminism in Africa: An interpretation, URL http://blog.oup.com/2007/03/womens_history_/ (visited 2010, March 6).

Pearson, R. (2000). Introduction: Interrogating development: feminism gender and policy, Pearson R. and Jackson C. (Eds) Feminist Visions of Development, Gender Analysis and Policy. Routledge, London, 1-16.

Public Service Commission (2006). Gebder mainstreamin initiative in the Public service, URL http://www.pmg.org.za/docs/2007/070822gender.pdf (visited 2009, September 13).

Remenyi, D., Onofrei, G., English, J. (2011). An introduction to statistics using Microsoft Excel, Reading, Academic Publishing Ltd.

Rowbotham S. (1996). Mapping the women's movement, in Threfall M. [Ed] Mapping the Women's Movement: feminist Politics and Social Transformation in the North' London, New York: Verso 1996, 1-16.

SAWIC (2009). URL http://www.sawic.org/aboutus.html (visited 2010, March 23).

Sigcau, S. (1999) *'Women in the built environment' Keynote address by the Minister of Public*

Works Ms Stella Sigcau at the launch of SAWIC', Business Trust Dbsa Auditorium, Midrand, www.info.gov.za/speeches/**1999**/000725545p5016.htm (visited 2010, March 26).

South African History online (n.d.). Bantu education policy, URL http://www.sahistory.org.za/topic/land-labour-and-apartheid (visited 2012, July 7).

Statistics South Africa (2009). Employment by industry and sex, Statistical Release P0211: Quaterly Labour Force Survey September 2009, URL http://www.statssa.gov.za/publications/P0211.pdf (visited 2009, June 15).

Statistics South Africa (2011). Gross Domestic Product fourth quarter: 2009, URL http://www.statssa.gov.za/PublicationsHTML/P04414thQuarter2009/html/P04414thQuarter200.html (visited 2012, April 3).

Trask, D. (2004). Through the lens of history: Biafra, Nigeria, the west and the world, American Historical Association, Washington, American Historical Association, URL http://www.historians.org/tl/lessonplans/nc/trask/cover.htm (visited 2010, March 6).

The South African Department of Labour (2010). Legislation, URL http://www.labour.gov.za/legislations (visited 2010, March 25).

Underwood, P. (n.d.). An overview of South Africa. South Africa, Centre for Information Literacy, URL http://www.dissanet.com/ifla/pdf/LIASA%2015%20Overview.pdf (visited 2011, December 6).

United Nations Research Institute for Social Development (UNRISD) (2005). Gender equality striving for justice in an unequal world executive summary, URL http://www.unrisd.org/research/gender/report (visited 2009, November 1).

United Nations Division for Advancement of Women Department of Economic and Social Sciences (1995). Employment Article 12, Convention on Elimination of All forms of Discrimination against Women, URL www.un.org (visited 2008, May 2).

United Nations Department of Public Information (1997). Fourth World Conference on Women, URL http://www.un.org/geninfo/bp/women.html (visited 2012, July 9).

Wojtkiewicz, R. (1985). Demography and personnel/human resource management, CDE working paper 85-4 Meetings of the Population Association of America. Boston, MA, March 29.

Education and Simulation of Best Value in an International Academic Setting: A Case Study

Kristen C. Barlish (Arizona State University), (M.Sc., Fulbright Scholar) and Kenneth T. Sullivan (Arizona State University), (PhD)
Performance Based Studies Research Group
Phoenix, Arizona, USA

Alberto De Marco (Politecnico di Torino), (PhD)
Department of Management and Production Engineering
Turin, Italy

An innovative education and simulation of the Best Value (BV) business model was carried out in a Project Management (PM) course at an International Engineering University in Italy. The BV model has been applied in a variety of organizations and projects to minimize risk and increase performance; however, its use in education at the University level is less explored. The BV educational sessions held in the PM course revealed that BV is instructive because it educates students regarding PM concepts via an industry-applied model, and is transformational as it promotes a change in perspectives of the students and the instructors. The simulation was a course group project that utilized the BV concepts and tools, which revealed that BV is flexible because students realized their increased knowledge via the project, the project was easier to administer as compared to previous years, and it was multicultural as it was easily used in a course with individuals from numerous cultural backgrounds. The performance information of the course revealed that, compared to previous years, the project was clearer, evaluations saved time and limited subjectivity, and the students' performance increased overall. The BV business model contributed to positive transformative learning experiences.

Keywords: best value, business model, international, simulation, education.

Introduction

Best Value (BV) concepts have been gaining worldwide attention as a business model and methodology to minimize risk on projects via supplier selection, pre-planning and measurements of project deviations. The BV system was originally developed at the PBSRG at ASU in 1994. The system has been tested on more than 975 procurements in $4.6 billion in procured services and construction, with a 98% client satisfaction rate, and variety of project savings and benefits with utilization of the BV System such as reduced changes (PBSRG 2012). Historically, BV concepts have been utilized for the execution of construction, service and commodity contracts, with effects such as improved efficiency and quality (Sullivan 2011). As a business model, BV has been well tested in various organizations and sectors as well as three large universities (Mselle 2009); however, it has not been tested in an international academic setting.

Background of Research

With the goals of exploring the application of models for performance and transparency internationally, a lead research assistant with the Performance Based Studies Research Group (PBSRG) at Arizona State University (ASU) achieved a Fulbright Grant to investigate this

opportunity. The Fulbright Scholar (FS) sought to educate, create simulations, and hopefully test these concepts via the BV business model. The FS was given nine months to carry out the research at the Politecnico di Torino in Turn, Italy, from September 2011 until June 2012. The FS outlined three goals for the research period:

1. Education and simulation of the BV business model in academics
2. Hosting of general educational sessions regarding models of performance and transparency, and obtaining participant feedback
3. Feasibility testing and possible implementation of the BV business model in the Italian Industry

More specifically, the first goal was investigation into the use of performance and transparency models, expressly the BV business model, in the academic setting in this international university. The researcher carried this out with the assistance of the Research Group for Engineering and Systems Logistics (RESLOG) group in the Department of Engineering Management and Production at the Politecnico di Torino. The measurements and results from goal one are presented in order to determine if the goals of performance and transparency as promoted by the BV business model are achievable in an international academic setting. The specific academic setting was in the 2011 fall term Project Management (PM) course with 118 students, from more than 25 different countries, given at the Politecnico di Torino by Professor Alberto De Marco and his collaborators.

Objective

The purpose of the ensuing simulation is to illustrate how well the BV business model is able to be taught in an international, academic course as a tool to educate students and teachers about valuable, real-world applicable project management and procurement skills. The simulation is carried out via real-world style group projects in order to promote transformational learning. The performance of the simulation and its participants are analyzed. The ensuing simulation provides a testament the following characteristics of the BV business model: 1) instructive; 2) transformational; 3) flexible; and 4) multicultural.

The main questions of the BV model immerge as:

1. Question 1: Can it be used in an academic setting; is it instructive?
2. Question 2: Will it transform student and instructor perspectives?
3. Question 3: Is it flexible enough to still produce positive results?
4. Question 4: Will it work in a multicultural setting?

The background of the course is first described, then characteristics of the BV business model in the academic simulation are discussed, followed by an explanation of the methodology of the simulation, an analysis of the performance measurements, and finally lessons learned.

Background

The academic setting of this simulation was at an Italian University for Engineering and Architecture Disciplines with about 30,000 total students. The University is composed of a variety of engineering students from around the world, with 12% international students due to its numerous bilateral agreements and international collaboration with other universities (Politecnico 2012). The particular course targeted for the simulation was a PM course open to students in a variety of engineering disciplines, such as Industrial Engineering, Management Engineering, Mechanical Engineering, Electrical Engineering, etc. The students are typically from other similar European Academic systems, with most students at a graduate level (Politecnico 2012). The course provides higher education in the discipline of PM and is not directed at any one particular sector or field of engineering, thus it is cross-disciplinary. The large size and international composition of the university, coupled with the cross-disciplinary structure of the course made this the ideal academic setting in which to test BV concepts via a simulation.

The PM course provided students with a foundation in PM principles as outlined by De Marco (2011). Additionally, the Project Management Institute (PMI) served as a main resource of inspiration and direction on PM-related principles and content for the course. As defined by De Marco (2011), "Project Management is a professional practice involving a variety of disciplines to support the tasks required to effectively complete a project. Managerial activities include decision making, problem solving, planning, scheduling, directing, coordinating, monitoring, and control." The dominant concepts of the course were the PM fundamentals of: 1) human resources (people) and organizations; 2) financial considerations; 3) soft skills and characteristics of a Project Manager (communication, leadership, quality, integration, etc.); 4) hard skills of a Project Manager (planning, time scheduling, cost accounting, estimation, etc.); 5) measurement/monitoring/reporting techniques; 6) procurement management; 7) delivery methods; 8) cost structures; 9) award methods; and 10) uncertainty (risks and mitigation). The course consisted of formal instruction, a group project, and a final exam. The BV business model was both instructed and used in the group project to simulate a real-life project.

Characteristics of the Simulation

The characteristics under analysis of the BV business model are reviewed and described to provide a common understanding of these principles and how they were measured.

Instructive

In order to be used in an academic setting, a model must foremost be instructive and foster learning in the students. Learning is a complex process, with both internal and external sources, influences, and impacts; however, learning in the field of management is highly correlated with an "experience factor." Learning can occur by: "1) elaborating existing frames of reference (or meaning perspective), 2) learning new frames of reference; 3) transforming habits of mind; and 4) transforming points of view, which can occur if people try on another's point of view" (Kitchenham 2008). Furthermore, there are a variety of methods that are used for instruction, such as: traditional lecturing, computer simulations, internships, and information-technology (IT)

related methods; however, each has its barriers. The students and the learning environment will be the primary decision factors as some of these methods are limited in their: degree of reality, ability to promote group related teamwork, and time constraints (Brown 2000). The BV business model is used in this academic setting to promote learning of the course concepts via a simulation method, while not computer-based.

Transformative

Two main types of learning, action and transformative, emerge which closely parallel management education. As stated by McGill and Beaty, "Action learning is a process of learning and reflection that happens with the support of a group or set of colleagues working with real problems with the intention of getting things done" (2000). Transformative learning is defined as "a deep, structural shift in basic premises of thought, feelings, and actions" (Kitchenham 2008). In the field of management, projects or simulations are created as learning events. These "experiential" learning activities are consistent with the constructivist view of learning, stipulating that the purpose of teaching is not to transmit information but to encourage knowledge formation and development (Raelin & Coghlan 2006). The process of reflection is critical to this perspective as it is the essential link between past action and more effective future action (McGill & Beaty 2000). Learning is therefore a process that results in a change in perspective, enabling us to handle similar or new situations in the future. The BV business model as used in this simulation seeks to stimulate that change in perspective, through instruction (the PM lectures) and practical experience (the PM project).

Flexible

In order to create both action and transformative learning in a variety of settings, in this case both industry and academic, a system must have a certain degree of flexibility. The term "flexibility" may seem simple, yet its intuitively positive nature is a barrier to its definition in common terms and results in various generalizations. The variety of notions, generally positive portrayal, and perceived importance of flexibility are a hindrance on its general definition. By studying a variety of fields, such as Organizational, Strategic, and Operations Management Fellenz (2008) found that each differs in their constructs of the application of flexibility. Additionally, flexibility is often viewed as taking place in different hierarchies or levels within an organization (Fellenz 2008, Roberts & Stockpot 2009) and realized via specific resources (Gross & Raymond 1993). Some commonly associated characteristics of flexibility are: adaptability (Roberts & Stockpot 2009), ability to be used for a variety of tasks, responsiveness to change, and the ability to be easily transformed (Gross & Raymond 1993). Fellenz (2008) derived a common definition of flexibility from these convergences, which will be used here as, "Flexibility is a system's capacity for variability of one or more of its characteristics." To further explain flexibility in this context, it is important to define: 1) the focal object; 2) the variable aspect; and 3) their relationship to one another (Fellenz 2008). For the purposes of this paper, the focal object is the BV business model, the variable aspect is the academic environment, and their relationship is described as how the BV business model adapts to the academic environment while still producing consistent, positive results.

Multicultural

The participants in a learning environment can be from a variety of backgrounds and have a variety of experiences, which has the potential to produce a more diverse learning experience for the participants. Variety was described as one of the key terms of flexibility and therefore can positively contribute to learning (Gross & Raymond 1993). Similar to variety in experiences, variety in origin and culture of participants has the potential produce more robust results with a global perspective. In this BV business model simulation, students and instructors participating were from a variety of countries and backgrounds thus contributing to the multicultural aspect.

Methodology

The degree to which learning, transformation, flexibility, and diversity in culture take place, as well as students' understanding of key concepts conveyed, should be measured to determine if a particular system or method produced a change in perspective. After analyzing thirty nine empirical studies regarding transformative learning, Taylor (1997) found the main measurement techniques of learning to be: 1) interviews; 2) observations; 3) content analysis; and 4) ongoing measurements. In his evaluations of faculty-directed management consulting projects in an MBA program in Australia and the action learning approach, Lamond (1995) utilized a 5-question survey with the following questions: 1) The subject is relevant to my career; 2) The subject has helped me grow and develop professionally; 3) I have learned to think critically; and 4) I reconsidered many of my former viewpoints. In addition to a general evaluation of material, the measurement of learning requires a student feedback mechanism, such as a survey of key questions pertinent to measure the degree to which the group project assisted in learning as well as the resultant perspective transformation. Table 1 matches each characteristic to be measured in the simulation with a description and associated metrics.

Table 1

Best Value Model characteristics' matrix

Characteristic	Description	Metric
(I) Instructive	The instructive quality is exemplified by the degree to which the BV model facilitates the advancement in students' learning and understanding of key Project Management fundamentals.	Surveys: I-1, I-2: Students and Instructors Pre and Post Course
(T) Transformative	The BV model induces transformative learning by initiating a paradigm shift in students and instructors' understanding of industry perceptions/problems and behavioral concepts.	Surveys: T-1, T-2: Student and Instructors Pre and Post BV Education Session; T-3: Group Behavioral Post Course
(F) Flexible	The flexibility of the BV model is evidenced by its ability to be used both in academic and industry settings and its achievement of BV goals in both settings.	Surveys: F-1, F-2: Evaluators, Pre and Post Evaluations
(M) Multicultural	In a multicultural view, the BV model can be used internationally, with participants from a variety of environments.	Survey: M-1: Student Pre Course (demographics - type of student, nationality, and level of experience)

Simulation

The concepts of BV were simulated in this PM course via integration with the course project as well as into the curriculum via BV educational sessions for both students and instructors. Data to quantify the adaptive characteristics (instructive, transformative, flexible, and multicultural) of BV concepts was collected via surveys and interviews of both students and instructors prior and post both the project and BV educational sessions.

Description of the Course Project

While it may be common practice for educators to require a group project of a sort from their students, this course project implemented is characterized as more of an innovative simulation than a simple project due to its following attributes:

1. Industry-inspired documents - project Request for Proposals (RFP) documents and requirements were based off of actual past projects and were transparent;
2. Positive environmental factors – groups were composed of international members, and efforts were taken towards creating an "as realistic as possible" evaluation environment;
3. Practical BV tools - an industry business model and precise tools were utilized.

The purpose of the course project was for students to enact the PM principles taught in the course to further their learning. With the additional effects of the simulation, added goals were to create a learning environment wherein students could experience a real-life simulation of a competitive bidding process and overall project phases.

Industry-Inspired Documents

The scope of the project was formatted according to an industry RFP template that was modeled after a real project, which impacted the overall formatting, appearance, language, tone, and templates for attachments and exhibits. A comparison of the previous semesters' course project documents with the BV documents revealed some differences regarding clarity of the Request for Proposals (RFP), selection model, and overall mechanics of the project. The previous course project RFP was observed to be similar to a listing of technical specifications for the student teams and was more of an academic list of requirements. Students expressed lack of understanding with what was required in previous years. As a result, it was unclear what was required to fulfill the academic requirements. The proposed RFP for the BV academic simulation was created from a real-life project in order to replicate real world conditions of an industry project. As a result, students were treated more as vendors. In line with this simulation, it was required that all of the templates, attachments, and criteria be given and described to the level of detail requisite for vendors to compose a complete proposal. Moreover, the required criteria, format, and weighting were communicated at the beginning of the process.

Environmental Factors

Students were permitted to select up to five group members, with each group member representing a different country. Each group was treated and acted as a "vendor" or "proposer"

for this project. The project was first explained to the students and the Request for Proposals was released in the second class meeting (to simulate an industry "pre-bid" meeting). Students were introduced to the scope and requirements of the project, with the instruction that as course concepts were taught, they were simulated in the group project. Students were also notified that they would be treated as vendors instead of groups of students during all project-related meetings and discussions. The original course project required weekly meetings in which each vendor had twenty minutes to update an instructor on their progress.

The main BV tools were followed closely as outlined by Sullivan et al. (2009) and Kashiwagi (2011). The first specific BV tool was the Risk Assessment (RA) in which vendors would identify and prioritize the main risks on the project, and describe their solution and plan to mitigate this risk. The second tool was the Value Assessment (VA) in which vendors identified options for increasing the value of the project and associated impacts. The Work Plan (WP) was the third tool in which vendors were required to give an overview of their project execution plan. Interviews were utilized as a tool in which the evaluation committee would ask those highest-ranked vendors a uniform set of five questions related to the documents submitted. Lastly, the evaluation method served as a tool because it promoted comparative and anonymous ratings of vendors via an evaluation committee. The previous mechanics of evaluation were unclear and required multiple spreadsheets, explanations, and strained resources. Each student group submitted over 50 pages and an even larger electronic file with the previous evaluation method. The BV evaluations proposed to save time by performing an evaluation of only 3 pages per each group to determine the top 40%, conducting one-third fewer presentations with a more interview format, utilizing one spreadsheet for calculations, and were anonymous to minimize subjectivity. By utilizing these business model tools, a more holistic approach was taken. Table 2 shows a comparison of previous documents with BV. Even at the beginning stages, utilization of the BV business model in this course project provided:

1. Clarity – all required documents were communicated upfront, with easy-to follow descriptions and templates (RA, VA, WP, and interviews)
2. Time savings – evaluators would have fewer documents to evaluate
3. Limiting subjectivity – vendors would be evaluated without identifying information (anonymous) and would have fewer protests against the selection

Table 2

Comparison of previous course with BV

No.	Previous Documents to Evaluate	BV Documents to Evaluate
1	Price	Price
2	Contract Form, Payment Scheme, and Conditions	
3	Cash flow	
4	Time Scheduling	Duration
5	Crashing (time cost + gantt chart)	
6	Technical Report	Work Plan (WP) – 1 page
7	Project Plan (WBS, OBS, WBS/OBS, CBS)	
8	Risk Breakdown Structure/Risk Breakdown Matrix Techniques	Risk Assessment (RA) – 1 page and Value Added Assessment (VA) – 1 page
9	Qualifications	
10	Presentations (21 groups)	Interviews/Presentations (7 groups)

Description of the BV Educational Sessions

Educational sessions on BV concepts were held for two purposes: 1) ensure students properly understood the mentality and approach of BV and how to use it in their project; and 2) determine the possibility of incorporating BV concepts into course curriculum. Simply implementing the tools on the course project would not be enough for the students to experience more of a transformational learning experience in which they changed many of their former viewpoints. Therefore, the theory explaining BV and its concepts was conveyed to the students and instructors with the ambition to initiate a learning transformation. The topics were: the industry structure, the event model, and BV Performance Information Procurement System (PIPS) as informed by the literature (Kashiwagi 2011, Kashiwagi et al. 2009). These characteristics were measured via student and instructor surveys and interviews.

Survey Design

In line with what was described in the literature, the surveys were related to measurement of the performance of the BV business model in the course project as well as the BV educational sessions. The surveys were designed to measure the characteristics of the BV business model and are named accordingly: I = instructive, T = transformative, F = flexible, and M - multicultural. The questions asked were clear and direct, as informed by the literature and the aggregated years of professional and academic experiences of the authors in Engineering and Project Management. A ten-point scale, from 1 (strongly disagree) through 10 (strongly agree) was utilized for scoring purposes. Comments were also solicited from survey respondents at the end of each survey. In analyzing the results, where there occurred a mode difference from "pre" to "post" scores greater than 2 and/or a shift from 5 or below to 5 or above (or vice versa), this was considered a significant shift and the implications were discussed. All surveys and interviews were voluntary and completed by every individual present on the day the survey was distributed.

Instructional, Transformative, Flexible, and Multicultural Surveys

In the Course Surveys, I-1 and I-2, students rated their knowledge of PM fundamentals (Project Management and Contracting) and ranked their perceptions of the industry in general based on their prioritization of the most prevalent problems. For the multicultural aspect, students' demographics were taken from the survey respondents with regards to: 1) level of experience; 2) nationality; and 3) educational level. In the Course Surveys, I-3 and I-4, the instructor ranked students' understanding of PM topics from the previous year and how the course project assisted students in learning these topics as well as the instructors in teaching the topics. The course project evaluators were asked how comfortable they were with BV criteria in surveys F-1 and F-2 in order to determine the suitability of the BV criteria to this academic simulation. In surveys T-1 and T-2 students, instructors, and evaluators rated the degree to which they agreed with certain statements regarding performance and risk in the industry and also ranked their perceptions of the industry based on their prioritization of the most prevalent problems. Survey T-2 had an additional question regarding the degree to which participants had reconsidered many of their former viewpoints after this educational session. To further measure the degree to which

transformative learning takes place, students were asked to evaluate the degree to which the project and group members shaped their learning and perspectives.

Interview Design

Interviews were taken from both students and instructors in order to gain qualitative feedback with the potential for improving the course in the future and integrating BV concepts. Questions that were asked were simple and provided insight into the learning process that took place in both instructors and students. Additionally, every survey had a section that solicited feedback, comments, and lessons learned from survey participants.

Data Analysis

Each of the four (4) types of surveys is described below, along with an analysis of their results. Please also reference Table 1.

1. Instructional – Pre-Course (I-1) and Post Course (I-2) – Students and Instructors
2. Multicultural – Pre-Course (M-1)
3. Transformational – Pre-Educational Session (T-1); Post-Educational Session (T-2) – Students and Instructors; Post-Project (T-3) – Students
4. Flexible – Pre-Evaluation (F-1) and Post-Evaluation (F-2) – Evaluators

Instructional Quality Surveys

Surveys I-1 and I-2 substantiated students' growth in understanding of key PM fundamental topics and the associated instructors' perception of their learning. Please see Table 3 for complete results. Each column corresponds to a different survey mode, with values: Pre-Course Mode, Post-Course Mode, and Mode Difference in the survey. Survey I-1 revealed that, on average, students do not have a high initial level of comfort or knowledge of the PM fundamentals presented in the course survey. Students rated the following criteria in the discipline of Project Management based on a scale of (1-10), with: I have never heard this topic before (1); I am familiar with this topic (5); I am very familiar with this topic and I would be able to teach this topic to someone unfamiliar with the topic (10). The topic the students were most comfortable with was soft skills and the topic they were least comfortable with was delivery methods. At the conclusion of the course, students' level of knowledge raised overall in comparison to the initial levels. The most significant shift was in the criteria regarding delivery methods (7), as students experienced a very large growth in understanding this principle. From the course feedback section of the survey, students were overall pleased, with feedback such as: "This course had a positive impact on me. I learned topics totally unknown for me and I really appreciate the effort of the instructors," and "I can talk about concepts that at the beginning of the course I don't even know they exist. I like the methodology."

Survey I-1 uncovered that the instructor's perception of previous students' understanding of PM topics was average (5) to high (10). For students, the survey's instructions were: "Rate the following criteria in the discipline of Project Management based on a scale of (1-10): I have never heard this topic before (1); I am familiar with this topic (5); I am very familiar with this topic and I would be able to teach this topic to someone unfamiliar with the topic (10)." For the

instructor, the survey's instructions were: "Rate the following criteria based on a scale of (1-10): The students last/this year had a poor understanding of this topic at the end of the course (1); The students last/this year had an average understanding of this topic at the end of the course (5); The students last/this year had a good understanding of this topic at the end of the course (10)." The surveys' results illustrated that there was room for improvement in the students' learning from the previous year. Additionally, the instructor indicated that the project assisted their teaching of these concepts, while still having room for improvement. In the comments, the instructor indicated that, "I have learned that I was missing the professional aspect, the past was more focused on academic things (tools, scheduling, planning). Students did not act professionally, as I had hoped they would." In Survey I-2, the instructor's perception of students' learning and degree to which the project facilitated this increased or stayed the same overall. In the interview, the instructor commented, "I observed students' understanding in procurement management, awarding methods, and the concept of uncertainty improved this year via the course project simulation." Students' grades revealed higher average scores compared to the previous year.

Table 3

Surveys I-1 and I-2

No.	Criteria	Unit	Students (mode)			Instructors (mode)		
			Pre	Post	Difference	Pre	Post	Difference
1	Human resources	1-10	5.00	5.0	0.0	5	10	5
2	Financial considerations	1-10	5.00	5.0	0.0	10	10	0
3	Soft skills of a PM	1-10	5.00	8.0	3.0	5	10	5
4	Hard skills of a PM	1-10	5.00	8.0	3.0	10	10	0
5	Measurement/reporting	1-10	5.00	7.0	2.0	10	10	0
6	Procurement management	1-10	1.00	5.0	4.0	5	10	5
7	Delivery methods	1-10	1.00	8.0	7.0	5	5	0
8	Cost structures	1-10	5.00	7.0	2.0	5	5	0
9	Award methods	1-10	1.00	5.0	4.0	5	10	10
10	Uncertainty (risks and mitigation)	1-10	5.00	7.0	2.0	5	10	10
	Number of respondents		94	87		1	1	

Multicultural Survey

Also measured pre-course, Survey M-1 obtained students' demographics, in which students reported their educational level, nationality, and level of experience. Overall, eighty seven percent of students were Masters-seeking, and the remaining thirteen percent were Bachelor-seeking students. Overall, forty-eight percent of students had no experience at all, with thirty-three percent of students having three to nine months of experience, and nineteen percent having one year or more of experience. Figure 1 shows that the largest groups of international students came from Europe and Asia. While the university itself reported 12% international students, this course was even more of an international mix with 83% international students as only 17% of the students were stated to be from Italy (Politecnico 2012). The students represented a culturally diverse population, which was very beneficial to their learning, as noted by a student's feedback at the end of the course project, "The course has given me a broader perspective on PM and how all the pieces fit together in risk management, finance, scheduling, and resource management. The project played an important role in helping me understand the theory lectures and prepare

better for the final exam. The multinational composition of the teams was also a great experience! I think it was a great simulation of the real world experience!"

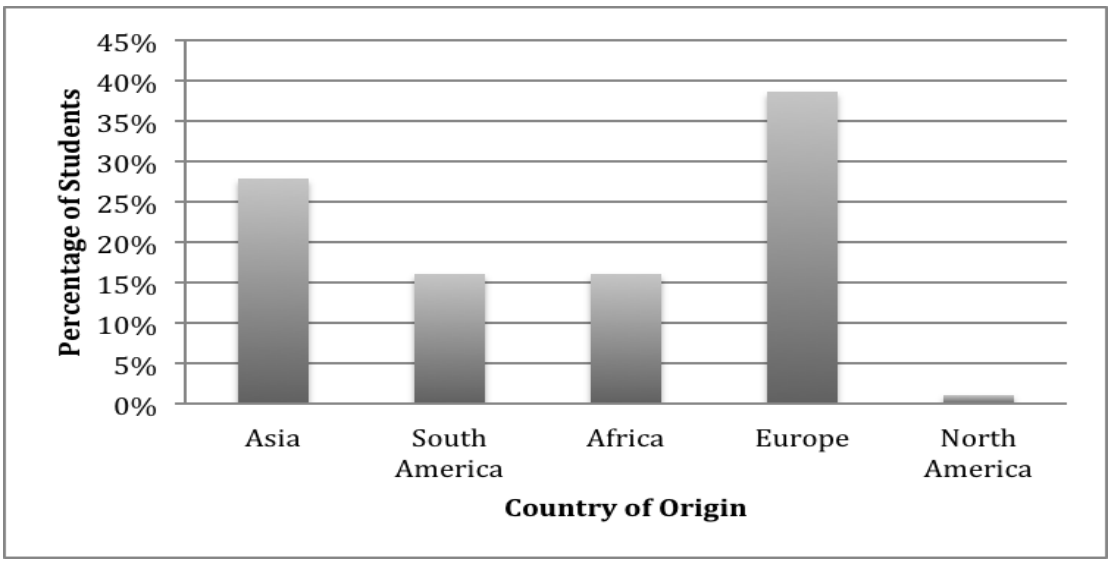

Figure 1: Origin of Students.

Transformative Quality Surveys

Surveys T-1 and T-2 displayed that there was a shift in students' and instructors' perceptions regarding performance, industry problems, and risk in the industry after attending BV Education Sessions. Overall students and instructors experienced a corrected understanding of the industry after the educational sessions, as evidenced by their survey responses.

For the students' and instructors' complete responses, please see Table 4. The students experienced a corrected shift in understanding that the current environment of choosing vendors based solely on price does not result in a shift of risk to that vendor (as seen in No. 4). However, students experienced an incorrect understanding of the degree to which vendors currently pre-plan, report their risks, and level of owner management. The cause of this misunderstanding could have been the educational nature of the session, which provided students lacking experience with industry knowledge. Understandably, students could have mistaken the "ideal" condition in which the vendor performs pre-planning and risk management for the "current" condition with poor communication and low pre-planning observed to have taken place. Regarding questions No. 12-16, the shift differences were varied in their prioritization of the most prevalent problems, thus conclusions cannot be properly drawn from such a varied sample. In response to the question regarding the degree to which participants had reconsidered many of their former viewpoints after this educational session (No. 11), students mostly agreed with the statement (mode value of 10, average value of 7). This is significant because it illustrates that a transformative shift took place in the students' perspectives regarding performance and risk in the industry.

For the instructors and evaluators' complete responses, please see Table 4, instructions were given as: "For #1-11, please rate each of the criteria based on a scale of (1-10) with "10" as strongly agreed and "1" as strongly disagreed. Please rate each of the criteria to the best of your knowledge. For #12-16, please rank in order according to your perception of the prominence of the problems most prevalent in the Market (1 being top and highly prevalent, 5 being bottom)." The instructors and evaluators experienced a correct shift in understanding that performance in the industry is declining (No. 1); the current environment of choosing vendors based solely on price does not result in a shift of risk to that vendor (as seen in No. 4). However, instructors and evaluators experienced an incorrect understanding of the degree to which vendors currently report their risks (No. 6), similar to the students' responses. The cause of this misunderstanding could have been the educational nature of the session, which provided instructors and evaluators lacking experience with industry knowledge. Understandably, instructors and evaluators could have mistaken the "ideal" condition in which the vendor performs risk reporting for the "current" condition with a low amount of observed risk reporting to have taken place. It could be said that those participants lacking industry experience simply confused their preconceived notions or the "ideal" condition with reality due to their gap in experience. Also, it is possible that the educator did not properly denote the differences between the ideal condition of proper risk reporting and the vacant current industry practice of reporting, affecting the students' perceptions as well. Regarding questions No. 12-16, the shift differences were varied in their prioritization of the most prevalent problems, thus conclusions cannot be properly drawn from such a varied sample. In response to the question regarding the degree to which participants had reconsidered many of their former viewpoints after this educational session (No. 11), instructors and evaluators mostly agreed with the statement (mode value of 8, average value of 7). This is significant because it illustrates that a transformative shift took place in the instructors and evaluators' perceptions regarding performance and risk in the industry.

Table 4

Surveys T-1 and T-2

No	Criteria	Unit	Correct	Students (mode)			Instructors/Evaluators (mode)		
				Pre	Post	Difference	Pre	Post	Difference
1	Construction performance in the industry is declining	1-10	10	5	7	2	5	8	3
2	In the current market, Owners are required to expend more effort managing vendors	1-10	1	5	1	4	7	8	1
3	Low-Bid environment results in high quality	1-10	1	3	1	2	2	1	1
4	Low-Bid environment shifts risk to vendor	1-10	1	7	1	6	8	1	7
5	Proper and sufficient Pre-planning is performed by the majority of vendors	1-10	1	5	7	2	2	2	0
6	Vendors utilize a risk reporting mechanism	1-10	1	5	8	3	1	5	4
7	The majority of risks cannot be foreseen before they happen	1-10	1	3	2	1	2	4	2
8	Changing project delivery methods will mitigate a majority of the risks	1-10	1	5	5	0	5	5	0
9	The majority of risks are uncontrollable	1-10	1	3	3	0	2	2	0
10	Circle the real source of expertise in the construction industry (1 = owner; 2 = vendor; 3 = designer)	1, 2, or 3	2	2	2	0	2	2	0
11	I have reconsidered many of my former viewpoints after this education	1-10	10	n/a	10	n/a	n/a	8	n/a
12	Low bid/ Emphasis on price	1-5	n/a	5	2	3	2	2	0
13	Corruption	1-5	n/a	1	5	4	5	1	1
14	Not paying on time	1-5	n/a	4	4	0	1	2	2
15	Over-budget	1-5	n/a	5	2	3	2	3	3
16	Lack of Pre-planning	1-5	n/a	1	1	0	3	2	2
12	Low bid/ Emphasis on price	1-5	n/a	5	2	3	2	2	0
			Number of respondents	72	45		7	6	

To further measure the degree to which transformative learning took place, the Post Behavioral Group Survey (T-3) was distributed upon students' completion of the project. Please see Table 5 for complete information. The instructions were: "This portion is regarding the course project you completed for this course. Rate each of the criteria based on a scale of (1-10) with "10" as strongly agreed and "1" as strongly disagreed. Please rate each of the criteria to the best of your knowledge." The surveys revealed that project group members agreed that they experienced a transformative shift in their learning. Students reported that they are better able to think critically, have reconsidered many of their former viewpoints, and group members shaped their

learning and perspectives. This is significant because it substantiates the transformational effects BV can have. Additionally, students' comments revealed:

- "I know more the every phases and activities of project and at the same time the teamwork spirit also made me feel more professional."
- "In my opinion, the project showed a different way to learn. I liked it very much because it was the first time in the Master of Science at the Politecnico that I made a practical job."
- "Personally I was the project manager of my group and this had increased in a good way my level of knowledge in this field. It has been one of my favorite courses that I have ever had."

Table 5

Survey T-3

No.	Criteria	Unit	Post (mode)
1	Project Management is relevant to my career.	1-10	8.0
2	The project has helped me grow and develop professionally.	1-10	10.0
3	I have learned to think more critically as a result of this project.	1-10	8.0
4	I have reconsidered many of my former viewpoints after this project.	1-10	7.0
5	My group members have contributed to my learning.	1-10	10.0
6	I feel more confident in my knowledge of Project Management after completing the project.	1-10	8.0
		Number of respondents	87

Flexible Quality Surveys

Surveys F-1 and F-2 illustrated that evaluators initially understood the BV criteria implemented on the course project (RA, VA, WP, Interviews, and Evaluation Process) and their satisfaction was overall positive. Please see Table 6 for the complete dataset of average scores. The instructions were: "Pre: Rate each of the following criteria based on a scale of (1-10) with "10" being highly understood and "1" being completely misunderstood. Post: Rate each of the following criteria based on a scale of (1-10) with "10" being highly satisfied and "1" being very dissatisfied." Comparing Survey F-1 with Survey F-2, evaluators were more satisfied with the BV criteria; however, they expressed some concerns with the WP and Interviews. This suggests that there is a key difference between developing an understanding of a concept and applying that concept successfully, implementation can be challenging. Their initial comments showed that they were uncertain with their abilities to properly evaluate the documents; however, this was addressed with two simple workshops that were held for evaluators to evaluate similar sample documents and review them in order to practice the evaluation process. In survey F-2, the comments revealed that the WP may not be a useful tool because students had difficulty composing an overview of their projects. Furthermore it was suggested that more time and questions be added to the interview sessions. However, this was not feasible due to the availability of the evaluators, quantity of groups, and timing of the course. Evaluators were highly satisfied with the RA and VA approach, as one commented that this was a concise and dominant way to organize this information that would have been lost in previous year's project documents. As a final transformative question, the evaluators were asked if they revised their former viewpoints regarding evaluations, to which they overall replied positively.

Table 6

Surveys F-1 and F-2

No.	Criteria	Unit	Evaluators (average)		
			Pre	Post	Difference
1	The RAVA process overall	(1-10)	7.8	9.0	1.3
2	The Work Plan process overall	(1-10)	9.3	7.8	-1.5
3	The interview process overall	(1-10)	8.5	8.3	-0.3
4	The evaluation process overall	(1-10)	8.0	8.5	0.5
5	The BV process overall	(1-10)	8.0	8.5	0.5
6	I have revised many of my former viewpoints regarding the process of evaluating ("1" for disagree and "10" for agree)			8.3	n/a
	Number of respondents		7	7	

Results

BV concepts are instructive, transformational, flexible, and multicultural. This was proven via the course assessments, surveys, and interviews. Returning to the initial questions (1-4), it is found that all can be responded to with a positive reply.

Question 1: Can BV be used in an academic setting; is it instructive?

Yes, students reported an increase overall in their understanding of course concepts at the end of the course. Post BV educational sessions, students' scores illustrated an increase overall in understanding of BV concepts and movements toward comprehension of the goals of performance and transparency. Both students and instructors agreed that the BV business model improved their understanding of procurement management, delivery methods, award methods, and risk. In an interview, the instructor commented, "Students are stronger in these processes and understand better bidding, how competition can be overcome by vendors' actions, and no longer perceived procurement from a clients' perspective." Furthermore, a student stated, "According to me, the project practice made me know more about the skills of project management and through all the process of the project." As a result, frames of reference and perspectives were improved.

Question 2: Will it transform student and instructor perspectives?

Yes, student and instructor perspectives were transformed as displayed in the interviews and surveys. Upon completion of the simulation, a student reflected in stating: "One thing that I realized recently is that the teams working are very variable, working here with very capable teammates was a really growing experience. The knowledge about the management of one project to me now is very different in respect to the beginning of the course. Now I know that management is a really deep area of knowledge and is important to accomplish any target professionally or maybe personal too." The instructor reflected similarly in an interview by saying, "At the beginning, I was concerned with the following: decreasing emphasis on academic requirements, documents to be evaluated were not representative of the vendors' total capacity,

and using non-technical evaluators to evaluate the proposals. However, after completing the simulation I am surprised that these did not impact the overall outcome, my concerns vanished, and I am completely satisfied." Additionally, students, instructors, and evaluators all positively responded that "I have changed many of my former viewpoints" in a variety of surveys. The FS and the instructor are modifying the course next year for future implementation of BV concepts into the course curriculum and the project as a result of the simulation.

Question 3: Is it flexible enough to still produce positive results?

Yes, the BV business model was capable to vary in its environment and variables, yet still the projects and the overall simulation saw positive results:

1. Reduction of time to evaluate by 50% overall
2. Reduction in student disputes with grades by 75% overall
3. Improvement of students' grades measured from the previous year
4. Overall satisfaction of the execution of the project by the instructor 10 out of 10 (20% improvement from last year)

Question 4: Will it work in a multicultural setting?

Yes, students were from more than 25 different countries (83% non-Italian) with a variety of experiences and all worked together in teams utilizing the BV business model. In addition, the course instructors and evaluators (7) were from 3 different countries.

Conclusion

BV instruction promotes a movement towards transformative learning at the core of its theory, called the Cycle of Learning, with its similar stages of information: 1) perception; 2) processing; 3) application; and 4) change (Kashiwagi 2011). This transformative learning takes place in those that apply the BV system, both instructors and students alike because they: 1) perceive information that they did not originally observe; 2) process this new information, realizing that their actions can cause change; 3) apply the concepts, acting as a change agent; and 4) take action for change in greater contexts (Kitchenham 2008). In summary of the measured qualities of BV:

1. The instructive quality of the BV model was displayed via the students' and instructors' measured educational performance difference. The BV model is utilized by the industry in real-world applications, thus the instruction promoted learning about the field of PM.
2. The transformative quality was seen in the students' and instructors' survey responses that they have changed their perspectives, interview quotations recognizing a shift, and course curriculum changes. The concepts in the BV model caused the students and teachers to rethink their current beliefs and develop more accurate and realistic understanding of the industry via transformative learning, and the simulation further helped the students and teachers to realize this via action learning.
3. The flexibility quality of the BV model was illustrated on two levels:
    a. The students gained direct knowledge, which they perceived of value in their

future PM careers.

   b. The course was easier to run, evaluations took less time, and thus achieving similar results that the industry has seen in application of the model (time savings, ease of use, utilizing key information) were obtained in this academic simulation.

4. The multicultural quality was seen as BV concepts were readily adapted in a multicultural situation, with varying backgrounds of the students and the instructors, and the simulation was successful.

BV is more of a business model than a specific procedural model. Based on this reported experience, the BV model has proven to be a holistic approach in an academic setting. This simulation has demonstrated:

1. BV business model could be used in course simulations with results such as: increased transparency, consistency in application by the instructor with this easy-to-follow business model, creation of a more "real-world" simulation for students, more effective evaluation techniques, and increased student learning of BV concepts;
2. BV concepts can be implemented into the curriculum with results such as: better understanding of industry problems, clarity of concepts, and increased practical understanding;
3. Efficiency - The BV model increases or promotes more efficient performance by providing time savings and allocation of scarce resources;
4. Transparency – The BV model stresses requirements that are clear and open;
5. Quality - the culmination of the utilization of the BV model is an increase in quality of the finished product, better results than previous years or projects.

The sustainability of the BV business model in an academic setting must also be addressed in the next phases of implementation. The group is currently looking towards other testing carried out internationally in Botswana and the Netherlands (Adeyemi et al. 2009, Koreman 2011, Kashiwagi et al. 2009). Modifications to the course curriculum and project for next year are being investigated and will likely adopt many of the BV concepts into the course.

References

Adeyemi, A., Kashiwagi, J., Kashiwagi, D., Sullivan, K. (2009). New approach to teaching procurement in graduate education, *The Fourth Built Environment Conference, Zambia*, (17 - 19 May 2009).

Brown, K. (2000). Development of project management skills: a service learning approach. *Project Management Journal*, 4 (31), 53-58.

De Marco, A. (2011). *Project management for facility constructions: a guide for engineers and architects*. Berlin Heidelberg: Springer-Verlag.

Fellenz, M. (2008). Flexibility in management theory: towards clarification of an elusive concept. *Journal of Strategic Management Education*, 4, 65-89.

Gross, J.R. & Raymond, B. (1993). Total flexibility management: a managerial approach for developing flexible resources. *Industrial Management,* 35, 5.

Kashiwagi, D. (2011). *Information measurement theory: a revolutionary approach to risk management*. Arizona: Kashiwagi Solution Model.

Kashiwagi, D., Kashiwagi, J., Savicky, J. (2009). Industry structure misunderstood by industry and researchers. *Ned University Journal of Research*, 2.

Kitchenham, A. (2008). The evolution of John Mezirow's transformative learning theory. *Education.* 6 (2), 104-123.

Koreman, G. J. E. (2011). A cross-purchasing portfolio application of best value procurement: lessons learned from six cases at ballast nedam. *Journal for the Advancement of Performance Information and Value.* 3, (1), 128-145.

Lamond, D. (1995). Using consulting projects in management education: the joys and jitters of serving two masters. *The Journal of Management Development,* 14 (8), 60.

McGill, I. & Beaty, L. (2001). *Action learning: a guide for professional, management & educational development*. 2nd ed. Kogan Page Limited, London and Stylus Publishing, VA. URL http://books.google.com/books?hl=en&lr=&id=zU3p5db4yAgC&oi=fnd&pg=PR7&dq=action+learning&ots=Vo_s46cknL&sig=DgUgrHQapbnPhhom2WzdfuJ34E0 - v=onepage&q=action learning&f=false (visited 2012, January 31).

Mselle, P., Muatjetjeja, M., Kashiwagi, J., Sullivan, K. (2009). US embassy Botswana: research test of best value procurement. *Proceedings TG59 People in Construction, Port Elizabeth, South Africa.*

Performance-Based Studies Research Group at Arizona State University. (PBSRG). (2012). *Case studies and results*. URL http://pbsrg.com/about/results/ (visited 2012, January 31).

Politecnico di Torino. *Who we are.* URL http://www.polito.it/ateneo/siamo/welcome.en.html and http://international.polito.it/en/courses/italian_university_system (visited 2012, January 31).

Raelin, J. & Coghlan, D. (2006). Developing managers as learners and researchers: using action learning and action research. *Journal of Management Education*, 30 (5).

Roberts, N. & Stockport, G.J. (2009). Defining strategic flexibility. *Global Journal of Flexible Systems Management*, 10 (1), 27-32.

Sullivan, K. (2011). Quality management programs in the construction industry: best value compared with other methodologies. *Journal of Management in En*gineering, 27, 210.

Sullivan, K., Kashiwagi, J., Kashiwagi, D. (2009). Optimizing design delivery services for facility owners. *Journal of Facilities Management*, 8, (1), 26-46.

Taylor, E.W. (1997). Building upon the theoretical debate: a critical review of the empirical studies of Mezirow's transformative learning theory. *Adult Education Quarterly*, 48 (1), 34-59

Housing the Poor and the Sustainability Context in Brazil: A Study of the Brazilian Building Sector Challenges for the Future

Luis Felipe Bismarchi (University of Sao Paulo) and Maria Cecília Loschiavo dos Santos (University of Sao Paulo), (PhD)
Department of Environmental Sciences
Sao Paulo, Brazil

The green wave of sustainability is getting bigger everyday and as consumers' awareness is increasing so are their demands for socio-environmental responsibility. That is the scenario the Brazilian building sector, one of the world´s biggest polluters, must face in order to continue developing. The expected investment for the next 4 years in this sector is more than US$ 165 billion in order to deal with the over $6 million housing units deficit and the growing demand due to the 2014 World Cup and 2016 Olympic games. This paper aims to present the Brazilian building sector situation towards the sustainability context and the challenges it must face to succeed. Workforce qualification, partnerships among actors, search for continuous innovation and competition, a performance-based legal and regulation framework and constant investments are the main challenges – and tools – to overcome the obstacles towards the sustainability goal.

Keywords: Brazil, housing, sustainability.

Introduction and Methodology

The impact the adoption of performance-based procurement in public housing policy has on innovation and sustainability in the construction sector in Brazil is analyzed. This article's objective is to present the Brazilian building sector situation regarding the sustainability context. The methodology was mainly based on a prospective study (PCC 2003). This prospective study was made in 2003 based on a ten-year period and interviewed 70 specialists representing all actors participating in the construction sector and present in 4 out of 5 Brazilian regions, although most concentrated in São Paulo. Other articles, news and studies produced in Brazil and abroad were used to support the analysis of all critical success factors (CSF) and its expectations in the future. Also notable are Sao Paulo's Industry Federation's (FIESP) study for the next 12 year-period of the Brazilian Building sector and the Agenda 21 for Sustainable Construction in Developing Countries.

Sustainability and sustainable development are treated as the same in this paper and according to the definition of "*Our Common Future"* (UN Documents): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Table 1 presents a brief timeline of the sustainability evolution internationally and nationally. Brazil was always late in implementing actions towards sustainability, but since the last decade of the 20th century it is possible to note the efforts of all

Brazilian groups – universities, private sector, government, civil society – in order to make Brazil a leading country on the path to real sustainable development.

Table 1

Timeline (Seiffert 2007, Sousa n.d.)

Time	International	Brazil
The 1960´s	Questioning the current production model (Club of Rome 1968).	
The 1970´s	Scientific publications that present the actual situation and the future consequences of modern industrial society pollution (report Limits of Growth of Club of Rome published in 1972); Several international meetings (organized by UN, NGOs as WWF and governments); UN creates its Environment Program (UNEP) in 1972.	Participate the Stockholm conference in 1972, but with the position that "nothing could harm economic growth"; Create Special Environment Secretariat in 1973; First social movements for environmental causes.
The 1980´s	Obligation of Environmental Impact Reports (first in the USA in 1970´s and during 1980´s in several countries); Environment Management Models (first was Responsible Action Program of Canadian Chemical Industries Association in 1984): UN Conference on the Environment in 1983, also called Brundtland Commission, presents the first definition of sustainable development (Our Common Future in 1987).	Law 6938/81 creates the National Environmental System and National Environmental Council (1981);1988 Brazilian Constitution has a specific chapter on Environment; Create Brazilian Institute for the Environment and Natural Resources (1989) unifying all former institutes and secretariats; Participate in UN Environment Conference in 1987 (UN Documents).
The 1990´s	Montreal Protocol of 1987 (Ozone cover protection); Basileia Convention in 1992 (transportation of hazardous materials); Berlin Mandate 1995 (about green house gases emission) and Kyoto Protocol in 1997; Unced-92/Rio-92/ECO-92 where Agenda 21 and ISSO 14000 and 14001 were presented;	Decree 99274/90 to effectively implement the 1981 Environmental Law; Unced-92/Rio-92 stimulates series of actions in order to improve environmental protection; Unced-92 propose creation of Agenda 21; Create the Environmental Crimes Law in 1998; After several name and status changes, in 1999, it is determined the name Ministry of Environment to the Special Environment Secretariat.
21st century	UN Conference on Environment and Development (Rio+10) in 2002; IPCC report in 2007 with alarming information on Climate Change; COP-16 with post-Kyoto discussion and a Green Fund creation.	Society, private sector, government and universities' efforts to effectively incorporate sustainability aspects in their practices; Strengthen of environmental associations, councils and organizations; Sectional mobilization towards sustainability.

The first section presents the competitive situation of the Brazilian building sector. Using a study (PCC 2003) the construction value chain´s critical success factors (CSF) are defined. Furthermore, through documented research in technical books, papers and the news the situation of each critical success factor as well as the expectations identified in the prospective study are analyzed.

At the end of this section it will be possible to identify the main challenges the Brazilian construction value chain must face, such as:

- Qualify the workforce in order to improve productivity;
- Develop managerial skills that enable companies to fully understand customers' needs and find alternatives to satisfy them;
- Define strategies that stimulate the private and public sectors to truly commit to improving quality, efficiency and productivity in order to achieve sustainability;
- Promote competition and innovation in the sector, through new contracting methods, performance-based normalization and elimination of bureaucracy.

The second section presents the impact the building sector has on the three components of sustainability: economy, society and environment. Through this presentation it will be possible to assure the strategic importance of this sector to Brazil, due to: the labor positions generated each year, the wealth generated and distributed or even the level of the usage and disposal of natural resources. At the end of this section it will be clear the strategic position of this sector to Brazil that represents 5% of national GDP and 20% of industry´s value creation, consumes from 40% to 75% of all natural resources, despite water and energy, is one of the biggest employers in the country and has the expectation of billions of dollars already planned to be invested and more than 2 trillion dollars and 10 million people needed to effectively reduce the housing deficit and solve the inadequate housing problem until 2022.

The third and last section aims to unify what was built on the two previous sections and will present the main challenges this sector will face in a globalized context, competitive and pressured by society to be social-environmentally responsible. Through the main actions defined in the Agenda 21 for Developing Countries by CIB, besides the expectations identified in the prospective study and the planned investments suggested by FIESP´s study, each actor´s responsibility will be identified in this value chain towards this transition to a low carbon, less environmental impacts and social development economy.

An Analysis of the Sector's Competitive Situation

Before the role the building sector has on Brazilian society and what trends are expected for the coming years is discussed, an assessment of the internal environment of this value chain is presented. This assessment was part of a prospective study (PCC 2003) that identified the critical success factors of the sector and each factor situation on that moment and the expectation of its future situation on three different scenarios – the continuity scenario, the optimistic scenario and the pessimist scenario. After assessing 88 indicators of the construction value chain, 19 critical success factors were chosen "according to its importance related to the indicators, possibility of comparable analysis between the factors, consistency and complexity to quantify, assess and compare the indicators" (PCC 2003). The critical success factors (CSF) are divided in three groups (access to housing, quality of housing product and technology and management) and are related to five performance indicators category of the construction value chain: competition, efficiency, quality, equity and sustainability.

Background to Critical Success Factors

Some of the CSF presented in this group relate to macroeconomic variables (that transcend the building sector) and are already a target of public policies (created after 2003, the year the studied was published) such as financial offer that had several governmental programs.

One of these programs that will be referred to in this article is the Programa Minha Casa Minha Vida (PMCMV) whose first version – from 2007 to 2010 – had the target of building one million housing units, the vast majority concentrated in families with an income of minimum wage (95% of the housing deficit is concentrated in this group), and its second version – from 2011 to 2014 – aims the construction of two million units. Brazilian minimum wage is actually 309 dollars, with an exchange rate of US$ 1 = R$ 1,65. This exchange rate was used in all values in this paper.

Another important regulation mark is the law 11.888 from June 24th 2009 that determines technical assistance to poor families to build their houses must be free. The objective with this law is to give more support to self-construction in order to guarantee a minimum quality level of these kinds of projects as well as aiming to minimize the great problem of inadequate housing that affects more than 15 million units (IPEA 2007).

On institutional matters, because of political instability and economic crisis during the beginning of the "re-democratization" process (from 1985 to 1992), state intervention on popular housing production was interrupted and restarted during Fernando Henrique Cardoso´s terms (FHC, from 1995-1998 and 1999-2002) when economics and politics became more stable. FHC government had two main contributions to the housing policy: the creation of programs that finance the houses to the end-user not the building companies (changing a policy that was practiced since 1960´s with the Banco Nacional da Habitação – BNH) and the consolidation of a housing deficit definition that was made with the work of Fundação João Pinheiro that developed a methodology and quantified for the first time this deficit.

Finally, Luiz Inácio Lula da Silva´s term (Lula, from 2003 to 2006 and from 2007 to 2010) also had two important institutional contributions: the continuity of the programs created by FHC, converting the Special Secretariat of Urban Development of the Presidency of Republic (Sedu/PR) into the Ministry of Cities (MCidades), increasing the resources destined to the housing programs and resuming stopped works. The other contribution was the openness of the process of developing public housing policies to all stakeholders through the Conference of the Cities and the creation of the Council of the Cities, making this process more transparent and democratic (Triana Filho 2006). The matter of land availability and adequate infrastructure also had a sensible investment rise during Lula´s term through the Programa de Aceleração de Crescimento (PAC) that centralized all existing initiatives and created new ones to support an economic and social growth, providing universal access to electricity, sanitation service, clean water, and others. Besides that, there are city level actions responsible for the urban land legislation, in order to balance the matter of land availability to popular housing, such as the application of progressive taxes in houses considered empty

Access to Housing

Regarding access to housing, it can observed that the major improvements were achieved during FHC and Lula terms, with the former more notably responsible for the political and economic stability and the latter notably recognized by continuing and expanding the previous projects, besides democratizing these programs and benefitting more people. However, there is still an obstacle to overcome, mainly the issue of land availability that needs more attention and action of the State, in all its levels, in order to guarantee that the land use accomplish the house social role and not just an asset capitalization option (Santana 2009).

Table 2

Critical Success Factors – Access to Housing (PCC 2003)

Critical Success Factor	**Definition**	**Performance Indicator category***				
Access to Housing		Eq	Q	Ef	C	S
Accessibility	Incapacity of the productive chain to provide access to quality houses to all people that need it, notably because of the distance between the price of the houses and the consumer´s income, specially the low income population.	X				
Financing Offer	Lack of resources for public and private financing, associated to the high cost of the actual financing options – mainly due to the high interest rates – what makes the access to this financing more difficult and leads to a high default rate.	X				
Land Availability	Lack of lands and adequate urban infrastructure to housing production, leading to a disproportional land price in determined urban areas better served by infrastructure and services.	X				
Informal Production	High incidence of informal production, due to the low accessibility to the formal market and the public housing programs. Informal production leads to high cost to dwellers and results in bad house quality, besides contributing to the degradation of social and environmental conditions.	X	X			X
Self-construction Support	State and private sector´s low capacity of supporting self-construction, what would be an adequate alternative.	X	X			X
Regulation and Coordination Capacity	Low political and institutional regulation and coordination capacity, especially because of the inexistence of a housing policy with targets and long-term strategies, effective investments and institutional articulation to avoid function´s superposition and to improve housing management efficiency.	X		X		
Housing Deficit	Necessity of solving the Brazilian housing deficit, estimated in 6.6 million units, and related to the factors presented above.	X				

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

Quality of Housing

As well as in the previous group, the Quality of Housing already has actions developed to work on the problems identified in the research and to modify some of its expectations. According to the research analysis, the actual housing quality is, “satisfactory in the high pattern, medium in the medium pattern and unsatisfactory in the low pattern. The trend to the future is of improvement; the quality will go respectively to fully satisfactory/ satisfactory in the high and

medium patterns and regular in the popular pattern. The best-assessed requirement is structural safety and the worst is environmental efficiency. On the other hand, this last one is the one that seems to have higher improvement in the future" (PCC 2003).

As it happens in the other two groups, the critical factors for quality don´t work independently, that is, there is a strong interdependency among these factors. Therefore, a weakness in one factor is enough to compromise the excellence of the offered product. It is possible to identify in the institutional context a commitment on the search for quality, on the regulations made by the Associação Brasileira de Normas Técnicas (ABNT) or on the efforts of the governmental operators, like Caixa Econômica Federal (CAIXA), in supporting and demanding approval of all innovative building solutions in the Programa Brasileiro de Produtividade e Qualidade do Habitat (PBQP-H).

The PBPQ-H was created in 1998, as part of the Brazilian commitment in the Conference Habitat II of 1996, with the general goal to "elevate the level of quality and productivity in the building sector, through the creation and implementation of mechanisms of technological and managerial modernization, contributing to the expansion of house offer, especially the low-income population," according to the information of its website (PBPQ 2009). Through a wide network, made by public and private agents, and constant dialogue among all stakeholders, this program aims to use purchasing power as a tool to promote continuous quality improvement of housing products offered to market. Although it has already had improvements with its more than 2,300 active participants, there is still a lot to do in order to make the assessment and approval process of innovative solutions faster and to incorporate in the programs' directions ways to enhance the ability of participants to search, understand and fulfill the end-user´s needs (Caravalho n.d.).

The partnership between PBPQ-H and CAIXA, the main operator of federal public policies, demands all building companies to be certified in the PBQP-H strengthens this strategy of using the State´s purchasing power as a stimulus to the commitment of private actors in the search for quality and continuous improvement. Besides the certification demand, CAIXA also uses the SINAT´s approval of new technologies, considered innovative, to approve the financing of housing projects by the bank.

As for ABNT´s actions and its normalization of the building sector, the expectation identified in the prospective study is "of improvement, even the continuity scenario and in the pessimist scenario it doesn't get worse. There is a perception that formal normalization will improve, due to the sector´s modernization and to legal demands. The main obstacle is the effective application of these norms" (PCC 2003).

A great step towards this normalization improvement was the edition of NBR 15757 (edited in 2008 and planned to be effective in November 2010), the first Brazilian norm that determines a minimum performance of buildings not specification of its components, although it makes reference to several previous norms that determines specifications. This norm raised discussions about its applicability all over the building sector, its impact on the market and the difficulty building companies are facing to accomplish this norm – that will be mandatory, including in the PMCMV operated by CAIXA – reflecting another fundamental point of improvement towards

product quality: the workforce qualifications from the project design until the end of construction and delivery to the end-users. This norm, made for buildings of 5 floors or less, clearly focused on the end-users' expectations, is an important milestone in the difference between prescriptive norms – base of all Brazilian norms – and performance norms. Even after ten years of discussion, including debates before and after its publications in 2008, there is an expectation that its liability will be postponed because the sector is still not sure about its capability to comply with the norm.

These discussions around NBR 15575 show the opportunity to strengthen all existing actions towards quality improvement and the search for building material compliance to quality standards that is the case of PBPQ-H. It also shows the importance of the project phase of buildings, including the project of building useful lifetime, the performance needed to fulfill end-user´s expectations and, therefore, the procurement method used to select the builder of a building.

Focus on the end-user is essential to achieve quality and its lack is notable in the popular building projects, reflecting the production model established after the Military Coup of 1964, that Bonduki (2000) defines as central-developing, characterized for: "1. authoritarism; 2. management centralization; 3. lack of users and society participation in any level; 4. disrespect to the environment and to cultural heritage with modernity myth predominance in a logic of urban transformation without commitment to the environment and cultural values; 5. disarticulation of sectional policies; 6. prioritization of individual transportation; 7. preference for great buildings, sometimes unnecessary, directing public investments to building companies to the detriment of social investments and; 8. prioritization, in the housing financing, of high income classes".

According to Bonduki, (2000) the central-developing model lasted until 1993, when "dozens of bad quality and bad location houses were financed and built by suspect companies and people who could afford them didn't want to live there and those who would accept living there couldn't afford it. In the end, lots of these units were left unfinished or empty."

Corroborating Bonduki´s definition, Leite at al. (2006) studying building of the Programa de Arrendamento Residencial (PAR) operated by CAIXA stated that:

> "Following the development of the studied building, it is possible to say that the client that most influences the requirements of the building project is CAIXA. These requirements, on the PAR´s buildings so far, don´t come from a systematic process starting in the end-user, but from guidelines of the program developed by the Ministry of Cities and by technical specifications made by CAIXA´s technicians. Identify the requirements of the end-user is essential to minimize conflicts and enhance the product value to this end-clients, once they might become the future owners of the building. According to Whelton and Ballard (2002), to generate more value to end-user and investor it is necessary that the responsible for conception and projecting the building learn about the building requirements in a critic and collective manner. This way, in order to create more value to (actual and prospective) end-users of PAR must participate in the design of the building. One first step on this end-users´ requirement management is to collect their opinion during the PDP [Product Development Plan]."

Medvedovski et al. (2006) also studying PAR, found results that show there are problems in maintenance of the buildings, in building management – especially in the relation between the building managing company and the dwellers – and in the houses´ characteristics that are changed by its own users because they don´t satisfy all their needs. This need of intervention not only might harm the building structure, safety and integrity but also shows a clear deficiency in fulfilling the user´s needs and expectations (Table 3).

Table 3

Critical Success Factors – Quality of Housing (PCC 2003)

Critical Success Factor	**Definition**	**Performance Indicator category***				
Quality of Housing		Eq	Q	Ef	C	S
Quality of Housing Project	The intermediate and final housing products still have serious quality problems, represented by the low performance in certain requirements and by the high rate of pathologies observed in the houses.		X			
Technical Normalization	Need to expand, adequate and refresh all the ABNT technical norms applied to the construction sector. It is also needed that the normalization be focused on performance and not on prescription, as it is still common, in order to stimulate technical improvement.		X			
Organizational and Institutional Support to Quality	Need to expand the actual actions dedicated to improve the quality of the value chain and its products, such as: use of State and private sector purchase power to fight non-compliance, certification schemes, expansion of laboratorial and technological support net, disseminate quality programs, as Brazilian Program of Productivity and Quality in the Habitat (PBQP-H).		X			
Knowing Customers´ Needs	Need to define what a quality house is and need to know deeper, through market research, the real needs of end-users, such as type of products, prices, financing options...		X		X	
Material and Components Compliance	Need to adequate materials and components to the existing technical norms.		X			

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

After explaining the central-developing model, Bonduki (2000) presents a proposal – still developing in practice – of a model he calls environmental-participative and whose characteristics are: “1. decentralized and democratic management, emphasizing the role of local power and in the sectional articulation; 2. creation of institutional channels for popular participation, as urban management councils, housing forums and the citizens participation on the definition of governmental priorities, with participative budget and following of budget execution; 3. inversion of priorities in order to guarantee access to housing and the city; 4. partnership between governments and NGOs to develop programs and projects, through the support of self-management or co-management in habitat production and wealth and job creation; 5. search of ways to lower the cost of housing production, through new ways of management, production and funding direct to the end-user and the recognition of the real city, through land regularization and urbanization of spontaneously occupied areas; 6. find a balance between environmental protection and urban projects implementation, housing production and recover of preserving areas already occupied; 7. reuse of urban disposals, by recycling, aiming

environmental preservation and it´s reuse in public programs and; 8. prioritize collective transportation and traffic safety".

This model, more compatible with the idea of sustainable development than the previous one, is still not a reality all over the country and it´s not only an organization's responsibility to implement it. It is, as it can be observed in the model´s characteristics, a city plan and not just a housing plan, being the participation and integration of several fundamental actors. This current moment can be called a fundamental moment of transition from the first model, focused on prescriptions to be followed, by the second model, focused on value creation according of the performance of what was bought, that is, focused on the end-user satisfaction.

Technology and Management

Regarding the Technology and Management group, the majority of the factors refer to internal issues of the sector, that is, issues the companies have more power of action and where there are greater challenges. The expectations raised by the research show, in all scenarios, a wait for improvements, however, in some items such as productivity, as stressed in the research, "even in the optimistic scenario, the average Brazilian productivity still isn´t 50% of the American average productivity" (PCC 2003).

Table 4

Technology and management (PCC 2003)

Critical Success Factor	**Definition**	**Performance Indicator***				
Technology and Management		Eq	Q	Ef	C	S
Project	Need to improve the housing project, that means incorporate the following practice on the companies´ project-design routine: modular coordination and compatibility among all subsystems; standardization of dimensions and constructive details; use more pre-manufactured components and systems; integrate the product to the production project (project to produce), coordinate all steps of production focusing on the end-user needs; use computing technology that improves productivity and avoid waste and error.		X	X	X	
Management	Need to improve the whole management of building production, disseminating across companies to proactively coordinate, plan, do and check in order to optimize the use of resources and assure quality in processes and products.		X	X	X	

Barriers to Technological Development	Need to implement actions to combat the barriers to technological development and productivity improvement, such as: expand access to equipment, diversify suppliers of materials (actually very concentrated); lower taxes on pre-manufactured products; contracting models that stimulate productivity; review the labor legislation aiming to reduce informality and improve its qualifications; modernize the local building codes that are old and prescriptive instead of performance-based, in order to stimulate innovation.			X	X	
Productivity	Need to enhance productivity related to project management and technological development discussed above.			X	X	
Waste and losses	Need to reduce waste and losses that are mainly related to management and technological development.			X		X
Cost of construction	Need to reduce cost of construction that depends on the supply market behavior, as discussed above, and to the workforce costs that depend on the evolution of real wages and productivity.			X	X	
Research	Need to expand technological research as fundamental support to technological improvement and to enhance productivity that needs more public and private resources to research, besides a stronger integration among private sector, universities and research centers.		X	X		X

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

The improvement of management process, from project to production and delivery of buildings, must take in consideration the needs of end-users, their participation must be sought in order to avoid delay in delivery due to changes in projects and higher costs due to these changes or even because the buildings, once they do not satisfy users´ needs, must be frequently modified (Guerra et al. 2009).

Again, we´ll make reference to the norm NBR 15575 – that didn't exist by the time of the prospective study base of this article because it also impacts on this group of factors. Once focusing on minimum performance and no longer on specifications to be followed, it will demand a managerial focus change and the way companies deal with the project phase, and all involved with it, inside the whole construction process. The huge public investments in popular housing heated the construction market and along with the NBR 15575 made for building of 5 floors or less (that is practically all popular building projects) and CAIXA´s demands for companies to participate the PBPQ-H, among others, will be a strong stimulus for improvement in the quality of management and projects in this sector.

Productivity improvement is related to workforce qualification, what has already been identified as a strong obstacle to the development of the productive chain, with the focus on performance and not on prescriptions, the demand for architects, engineers and specialists in all items of NBR 15575, such as lighting and acoustic comfort (one polemic item of the norm) will increase.

Partnerships between universities and companies, that according to the prospective study depend more on political will than economic issues, is an important point to be sought for both universities and companies, once this is a good win-win relation during this managerial focus transition period.

Sustainability, although not explicitly pointed out in the study´s answers, appears as an important issue for the future expected by the respondents on project improvements due to the integration of systems and subsystems to avoid waste, on the improvement of workforce qualification to enhance productivity, or on the trend of growth in "components made to save water and energy, systems of remote consume measurement, systems of intelligent components, systems of solar energy generation, materials aimed to sustainable constructions and material DYI (do it yourself)" (PCC 2003).

The prospective study of the building sector and the combat of barriers to technological development aims to stimulate innovation, that is, the continuous development of new process, projects and solutions that satisfy user´s needs in a more economic and better way than the actual options. Innovation development, through a procurement system that supports competition in the sector (fighting the existing oligopolies), through contracting alternatives that stimulate productivity and performance – as stressed in the research – and through the combat of workforce made by stronger control or by economic tools to stimulate workforce formalization. This will all enhance competition in the Brazilian construction sector. From the analysis of this prospective study data, actions must be proposed, discussed and implemented in order to enable the whole construction productive chain to compete in a new context that quickly appears, globalized and pressured by socio-environmental responsibility.

The Building Sector's Eco-Socio-Environmental Role in Brazil

The building sector is one of the world´s biggest employers and at the same time one that causes greatest impacts on the environment. This situation puts this sector in a strategic position anywhere in the planet, because to provide society the infrastructure to its development it is necessary to build roads and ports to plants and housing buildings. Throughout this large value chain of production, millions of people are employed and billions of reais (or dollars) are invested. An example is the Programa Minha Casa Minha Vida (PMCMV) that has more than 18 billion dollars of investments to build one million houses. The challenge of the sector continues, because for the 2011-2014 period, the second Programa de Aceleração do Crescimento investments in the building sector exceed 168 billion dollars, besides the investments in other construction areas – such as the transport and energy infrastructure. Only the second version of PMCMV, with the goal of building two million houses, is valued at more than 43 billion dollars.

It is evident that the construction sector has for at least four years guaranteed investments that will keep the sector employed, producing and, consequently, polluting. The Brazilian Council for Sustainable Construction estimates that from 40% to 75% of all natural resources extracted in the planet, despite water and energy consumption, are used in the building sector (CBCS 2009). Besides all this environmental weight, another prominent role this sector has is socially. In terms of employment generation, the building sector is one of Brazilian biggest employers with more than two million formal employments registered until November 2010 (MTE 2010) and with a

growing trend in job posts generations (Table 5). It is worth of note the great jump in job generation of this sector, both in relative or absolute terms, after PAC was launched (including PMCMV), heating the sector and reinforcing the weight of public housing programs. Despite the great growth of formal jobs in this sector, informality is still a serious problem, achieving in certain areas 50% of all sector´s workforce. Its impact transcends the matter of product/service quality or cost reduction, for instance, getting in areas such as social justice and development, because in the absence of a correct labor regulation there will be no stimulus to respect basic rights and workers´ safety, increasing accident rates and labor diseases, for instance (Reporter Brazil 2010).

Table 5

Amount of formal employment generated (Caged – MTE year)

Period	Construction Sector (CS)	All sectors	% CS
Jan a Dec/04	50.763	1.523.276	3%
Jan a Dec/05	85.053	1.253.981	7%
Jan a Dec/06	85.796	1.228.686	7%
Jan a Dec/07	176.755	1.617.392	11%
Jan a Dec/08	197.868	1.452.204	14%
Jan a Dec/09	177.185	995.110	18%
Jan a Apr/10	166.112	962.327	17%

Not only the amount of job generated has increased, wages and quality of life in the sector also have improved, as shown in a research by the Brazilian Council of Construction Industry (CBIC) (Tendenciasemercado 2010). This schooling rise took to an initial wage raise, from US$ 395,00 in 2003 to US$ 535,00 in 2010, a 35% real growth, higher than the respective period inflation. This wage raise generates a clear economic impact, raising workers' available income; one can consume more and promote the expected economic growth. Just as an example, in 2008 according to the Brazilian Institute of Geography and Statistics (IBGE) data, more than 23 billion dollars were spent with payroll in the building sector, with more than 15 billion dollars (65%) destined to the wages of workers.

Table 6

Workers' schooling evolution (CBIC, 2010)

Schooling	2002	2010
1 year study or less	8%	5%
8 years of study or less	37%	20%
11 years of study or less	36%	48%
More than 11 years	19%	27%

The economic importance of the building sector is not limited to the number of jobs generated or the wealth distributed, the investments and production of this sector represents approximately

5% of Brazil´s GDP and according to the Industry Federation of São Paulo (FIESP) projections, the investments and production needed until 2022 represent almost 6% of Brazilian GDP.

This investment estimation of over 2 trillion dollars until 2022 is higher than the effective investment. In 2009 the investment was 79 billion dollars, but still below the needed investment according to FIESP in order to solve the problem of inadequate housing and to lower the housing deficit to 1.5% - but there are already discussions in order to plan and coordinate the expansion of investments in this sector.

All these points reinforce the strategic role of the Brazilian construction chain in all its aspects: environmental, social and economical, being fundamental. Having in mind the increasing investments in the sector, an organized mobilization towards the triple victory of economic viability, environmental prudence and social justice, as proposed by Sachs (2002), in all policies involving this value chain.

Table 7

Need for new houses 2010-2022 (FIESP 2010)

Year	To meet the needs of the new families	To eliminate the deficit	To reduce cohabitation	Total
2010	1.281.560	120.000	120.000	1.521.560
2011	1.307.920	220.000	170.000	1.697.920
2012	1.334.822	220.000	170.000	1.724.822
2013	1.362.277	220.000	170.000	1.752.277
2014	1.390.298	220.000	170.000	1.780.298
2015	1.290.754	280.000	200.000	1.770.754
2016	1.314.905	280.000	200.000	1.794.905
2017	1.339.509	280.000	200.000	1.819.509
2018	1.364.572	280.000	200.000	1.844.572
2019	1.275.726	376.821	260.000	1.912.547
2020	1.297.632	376.821	260.000	1.934.453
2021	1.319.914	376.821	260.000	1.956.735
2022	1.342.579	376.821	260.000	1.979.400
Total	17.222.469	3.627.284	2.640.000	23.489.753

Table 8

Housing Investment, US$ billion, 2010 to 2022 (FIESP 2010)

Year	Investment on new homes	Investment on rebuilding	Total housing investment	Housing investment (% of GDP)
2010	91,27	23,31	114,58	5,70%
2011	96,91	24,68	121,59	5,80%
2012	102,90	26,13	129,03	5,90%
2013	109,26	27,67	136,93	5,90%
2014	116,02	29,32	145,33	6,00%
2015	114,47	31,05	145,52	5,70%
2016	121,33	32,77	154,10	5,80%
2017	128,61	34,59	163,20	5,80%
2018	136,32	36,52	172,84	5,90%
2019	135,21	38,56	173,78	5,60%
2020	143,12	40,59	183,70	5,60%
2021	151,47	42,74	194,21	5,70%
2022	160,32	45,01	205,33	5,70%
Média	123,63	33,30	156,93	5,80%

Future Challenges for the Building Sector in the Sustainability Context

The effects of human action over nature and its balance are being felt worldwide. Therefore, it is essential that a sustainable development model that can balance the social demands with environmental prudence and economic viability, is developed in which must not prefer one requirement to the detriment of others. The building sector has a large impact on the development of any nation, from maintenance of buildings, roads, power-plants, to building new buildings that enable an improvement in quality of life such as schools, hospitals and houses. This same sector is one of the world´s biggest polluters, consuming a huge amount of resources and disposing an equally huge amount of leftovers from construction and demolition, impacting the environmental quality in air, land and water pollution, for instance.

The pressure for sustainable behavior is gaining momentum, perhaps due to more clarified citizens/consumers demands or due to the more frequent natural catastrophes that shock – and affect – all mankind (Jacobi 1999, Manzini & Vezzoli 2002). In this scenario, one of the planet´s biggest polluter is not immune to this pressure, therefore, it is fundamental that all actors in the construction chain search and/or develop knowledge that enables them to deliver solutions that fulfill the identified consumer´s needs while respecting the environment.

Since the first meetings about environmental issues in the 1980´s, several tools have been developed to guide states, companies and civil society in the path towards sustainable development. One of these tools is Agenda 21 that can be defined as “a planning tool to build sustainable societies, in different geographic basis, that conciliates environmental protection,

social justice and economic efficiency" and can be split up from the global agenda into smaller agendas for regional, city levels or even for economic sectors (MMA 2010).

On this work of constructing sustainable sector, John et al. (2001) present the history of Agenda 21 for Sustainable Construction, dedicated to the developed countries and made by the International Council for Research and Innovation in Building and Construction (CIB). The need for creating an Agenda 21 for the sustainable construction in developing countries is also discussed due to the great context differences between these two groups of nations. The discussions were presented in 2002 by CIB and deal, as discussed by John et al. (2001), with the specificities of the developing world, such as the search for sustainable houses made accessible to millions of people who don´t have the purchasing power to buy their houses on their own, and the challenge to promote sustainable construction in areas where the basic infrastructure is bad – from the components/materials production according to some specification to bad roads and problems with energy and water supply (CIB 2002). The Agenda proposed by CIB outlines, with actions organized in 6 groups, the main challenges the building sector´s agents in developing countries will face in the context of sustainability (Table 9).

Table 9

A strategy for action (CIB 2002)

	Actions for the research and education sector	**Actions for the private sector and utility companies as service providers**	**Actions for clients**	**Actions for government and regulatory stakeholders**
Capacity Building	•Build internal capacity. •Expand learning offerings.	•Enable continued organizational learning. •Support the development of external capacity.	•Develop own understanding of sustainability and the benefits of more sustainable choices.	•Create an advisory stakeholder council. •Raise awareness of sustainable construction among government officials and politicians. •Introduce continued professional education.
Access to funding	•Identify and access appropriate funding streams. •Be creative in using existing funding streams. •Actively lobby for funding for sustainable construction.	•Provide funding for R&D for own benefit. •Through corporate social responsibility (CSR) budget contribute to funding for research for the common good.	•Use the savings, reduced risks and added value resulting from sustainable construction to leverage the additional capital costs required for its implementation.	•Reconsider scope of own funding programs. •Negotiate better terms and access to funding with overseas development agencies (ODAs). •Provide funding to support emerging businesses and innovative technologies. •Provide funding for training and education.

Partnerships and cooperation	•Establish cross-sectorial exchange programs. •Establish an effective South-South network of researchers & educators. •Clarify issues of knowledge sharing. •Pursue research and educational partnerships with other sectors.	•Cooperate on the implementation of the R&D agenda. •Partner with research organizations. •Form industry coalitions to fund pre-competitive research and development of enabling mechanisms.	•Form partnerships for learning with research and education institutions. •Form consumer lobbying groups to demand more sustainable services and products.	•Include the informal sector. •Bring traditional governance systems on board. •Partnerships between local government and research and education institutions.
Internal housekeeping	•Revise existing curricula. •Practice what is being preached.	•Assess risk of non-compliance and benefits of compliance. •Devise strategic plans for different industry sectors. •Change organizational values. •Improve resource efficiency and reduce impact.	•Rethink own internal procurement systems.	•Lead by example. •Adopt a regulatory framework for sustainable construction. •Comply with international agreements & frameworks. •Change professional fee systems.
Encouraging and supporting implementation	•Technology transfer. •Raising awareness. •Advocacy.	•Assist with the incubation and mentoring of emerging market niches. •Use new technologies and processes. •Create a demand.	•Use government influence to drive the market.	•Change standards and regulations to support sustainable construction. •Provide effective incentives and disincentives, e.g. tax breaks. •Enforce regulations.
Monitoring and Evaluation	•Provide independent monitoring to private sector and government. •Introduce mechanisms for own monitoring and evaluation.	•Adopt corporate social responsibility (CSR) reporting systems. •Participate in certification schemes. •Capture information for monitoring and assessment.	•Participate in monitoring and evaluation schemes. •Monitor cost benefits achieved.	•Set up legal structures for monitoring and evaluation. •Participate in monitoring and evaluation schemes.

Several actions proposed in the Agenda 21 are similar to the actions presented as challenges in the prospective study for the future of Brazilian building sector, corroborating the analysis made in this paper. On the global context of sustainability, the Brazilian building sector must make the ongoing transition from a quantitative model of reproducing standardized home buildings to a qualitative performance-based model that delivers the needed amount of housing respecting the environment, society and being economically feasible. All participating actors must assume their responsibility on this transition. The research and education sector must, through the construction of a wide network among developing nations, seal partnerships with public agents, private agents and the civil society in order to disseminate knowledge, finance research of new knowledge, and provide independent service of monitoring and evaluation that guide the other agents towards sustainable construction.

The private sector and utility companies must rethink their values and goals and search for solutions that enable the achievement of these goals inside the new context of sustainability. Through the cooperation with all the other agents of the sector (competitors, governments, research and education institutions and clients), they must develop, adopt, assess and continually improve products and processes, and use this cooperation to promote innovation, an important tool for sustainable construction.

The clients must, as important link for the market existence, use their power – alone or together with other clients – to stimulate the other agents, especially governments and the private sector, to commit to the development and offering of sustainable housing solutions. It is fundamental, therefore, that consumers look for knowledge and information on the sustainability matter, regarding concepts and applicability in construction and their lifestyle.

Lastly, the government and regulatory stakeholders must be responsible for the legal and institutional structure needed to effectively achieve sustainable construction. Through norms edition, professional regulation, laws and specific institutions and policies to incentive (or disincentive) expected behavior to promote this transformation, as well as transform itself, reviewing internal rules and procedures, giving more transparency and power to citizens control their acts.

Conclusion

With the high amount of investments planned in the sector, and with its ambitious goals – like PMCMV´s goal of two million houses – it is of great importance to discuss the capacity of this sector to grow without destroying, that is, to effectively build sustainable homes. The matter of use of resources during its production, use, and the durability of the building must incorporate the future expectations of the dwellers´ profile.

An Ernst &Young (2008) study showed that from 2007 to 2030 the economic situation of families will change substantially. It is expected that until 2017, 57% of all new families (needing new homes) will be on the base of the social pyramid while after 2017, 78% of all (19.9 million) families will be part of the middle class. This means they will have different expectations for their homes which should be taken into consideration in thinking about sustainability and flexible homes that could be rebuilt rather than completely replaced.

FIESP´s study (2010) summarizes the challenges discussed into five categories:

> "Workforce: The demand for workers in construction will grow at a rate of 3.1% per year between 2009 and 2022, which means increasing the number of persons employed in the sector of 6.9 million in 2009 to 10.2 million in 2022. Will be 3.3 million new jobs. Attract and qualify the number of young people is a huge challenge, since the growth of the economically active population projected for the period is only 1.8% per year and that during these years will see a gradual reduction in unemployment.

> Productivity: Even considering the success in attracting young professionals to build the 6.1% growth of GDP of the sector must be accompanied by an increase in productivity of the workforce 3% years. This increase in labor productivity will come from the qualification of the workforce, the formalization of the activities in the sector, the increased scale of housing projects and the adoption of new construction methods that allow a greater degree of industrialization in the chain.
>
> Capital: The need for credit for housing finance is expected to grow 9.4% annually, from US$ 42 billion in 2009 to US$ 136 billion in 2022. Traditional sources of financing the sector (FGTS and savings), despite having a promising growth path, will be insufficient to meet the required credit. Thus, as in the case of labor, the construction sector demand for funds will compete with demand from other sectors, all benefit from economic growth in the country, seeking new funding sources.
>
> Materials: The growth of housing investment in infrastructure and will bring a significant increase in demand for construction materials. This demand can be met largely by local industry or can be filled by imports. The proportion in which it occurs is a mystery today as some basic economic conditions, as the price of energy (electricity and natural gas) and the exchange rate are quite unfavorable for the domestic producer. It is worth mentioning that in a short time, from 2006 to 2010, the materials industry jumped from a surplus of US$ 1.8 billion to a deficit of US$ 1.2 billion. Give competitiveness to the domestic industry will be a need to prevent the growth of the sector might be found very high trade deficits and deindustrialization of the chain.
>
> Land: The housing needs of the country involving the construction of almost 24 million new homes between 2009 and 2022. Whereas homes with 60 m2 of private area on average, its volume of building entails the construction of 2.1 billion m2 and the occupation of more than 900 million m2 of land. Meeting these needs housing requires institutional improvements that prevent excessive pressure on the cost of land, which is a factor inhibiting investment."

Sustainability, as shown before, is also a great concern of this sector, but it can only be achieved with a common effort of all participating actors of this value chain, universities, government, private companies and civil society must get together in order to implement the urban policies in a way that balances all three dimensions of sustainability: economic efficiency, social justice and environmental prudence. Another great challenge that impacts not only the building sector but also the whole country is the inefficient bureaucracy, as stated in FIESP´s (2010) study:

> "The institutional improvement of a country is a key part of sustainable development. One of the chronic problems being solved in Brazil is that of bureaucratic inefficiency. FGV study this publication in 2009 of Construbusiness estimated the social cost of bureaucratic delays in Brazil was equivalent to R$ 135 billion in 2007. In housing, this enhancement factor is length - if not non-viability - project. Combating bureaucratic inefficiency must be given priority by governments. For the formation of a positive agenda for housing projects, the study outlined a number of points of improvement:

- Streamlining the review process at the municipal level, with intensive application of information technology in order to obtain quickness and transparency.
- Integration of the bureaucratic procedures of the three spheres of government in a single process to be consolidated in the district, which would eliminate duplication and facilitate procedures.
- Forming evaluation committees of bureaucratic procedures, with government and private enterprise.
- Creating of a single register of the property, which would reduce the number of operations to obtain the certificates.
- Equipping with adequate supervision, to enable a fast and transparent operation.
- Improving the legal environment as a whole, with the streamlining of procedures, intensive application of information technology to reduce costs for businesses and society as a whole.

We must move quickly on these things, because Brazil cannot waste opportunities for investment and more expensive goods of direct interest of its people."

Recommendations and Future Research

Workforce qualification, partnership among actors, search for continuous innovation and competition, a performance-based legal and regulation framework and constant investments are the main tools to overcome the obstacles to achieve the sustainability goal. These challenges towards sustainability are large and the work to be done is difficult. However, with the right planning and an effective coordination of policies and strategies of all actors, it will be possible to become the most important sector in the transition to a sustainable construction business model.

The contracting paradigm and the actual the delivery system of the Brazilian building sector is another important issue to discuss, although it wasn't object of this article, there is a great opportunity of performance based procurement implementation, according to the current construction industry structure (Chong et al. 2007, Kashiwagi et al. 2009, 2010) in order to solve several problems identified in this paper and promote a continuous development of quality, performance and innovation in this sector.

Although this study is focused on popular housing that is financed by governmental policies and is, nowadays, the most attractive niche in the building sector, the discussion about sustainability transcends this niche. Sustainability has been a market strategy to differentiation and that is, by definition, not sustainable. The responsible use of resources and universal access to the housing product are fundamental to build a truly sustainable society where everyone has a decent place to live and support to develop their capabilities to contribute to the improvement of society. By exposing the main challenges of the Brazilian building sector in the sustainability context, future research in this area was uncovered as: the level of development of each agent identified in the Agenda 21 – how committed to this strategies are they and the impact the transition to a performance-based approach has on the market competition and performance.

References

Bonduki, N. G. (2000). Habitar São Paulo: reflexões sobre a gestão urbana. São Paulo: Estação Liberdade.

CBCS (2009). Materiais, Componentes e a Construção Civil. URL http://www.cbcs.org.br/userfiles/comitestematicos/materiais/CT_materiais.pdf.

CIB, International Council for Research and Innovation in Building and Construction (2002). Agenda 21 for Sustainable Construction in Developing Countries: a discussion document. Pretoria: CIB & UNEP-IETC, URL http://cibworld.xs4all.nl/dl/publications/Agenda21Book.pdf.

Carvalho, M. S. de (n.d.). PBQP-H: Ferramenta de melhoria da qualidade das obras públicas? Pernambuco, URL http://www.ibraop.org.br/site/media/sinaop/11_sinaop/PBQP-H.pdf.

Chong, N., Sullivan, K., Sullivan, M., Kashiwagi, D. (2007). The Cultural Revolution. 4th Annual Acquisition Research Symposium, Monterey: California.

Ernst & Young (2008), Brasil Sustentável: potencialidades do mercado habitacional. S/l, disponível em URL http://www.ey.com/Publication/vwLUAssets/Brasil_Sustentavel_-_Mercado_Habitacional/$FILE/Brasil_Sustentavel_-_Mercado_Habitacional.pdf.

FIESP, Federação das Indústrias de São Paulo. ConstruBusiness 2010 – 9th Brazilian Construction Congress. São Paulo: FIESP, URLhttp://www.fiesp.com.br/construbusiness/pdf/apresentacoes/ConstBusiness2010English.pdf

Guerra, G. M., Kern, A. P., Gonzalez, M. A. S. (2009). Empreendimentos de Habitação de Interesse Social: o desafio na relação área/custo. Rio Grande: Dunas/Teoria e Prática na Engenharia Civil, 14, 51-58, URL http://www.editoradunas.com.br/revistatpec/Art6_N14.pdf.

IPEA (2007). Pesquisa Nacional por Amostra de Domicílios – PNAD. URL http://fisenge.org.br/wp-content/uploads/2010/02/jornal-julho-2.pdf

Jacobi, P. (1999). Poder Local, Políticas Sociais e Sustentabilidade. URL http://www.scielo.br/pdf/sausoc/v8n1/04.pdf.

John, V. M., Silva, V. G. da, Agopyan, V. (2001). Agenda 21: Uma proposta de discussão para o construbusiness brasileiro. Canela: ANTAC, URL http://pcc5100.pcc.usp.br/01_Construcao&Desenvolvimento_sustentavel/Agenda%2021%20CCivil%20-%20evento%20ANTAC.pdf.

Kashiwagi, D., Kashiwagi, J., Savicky, J. (2009). Industry Structure: Misunderstood by Industry and Researchers. PBSRG, Performance Based Studies Research Group, URL http://www.pbsrg.com/downloads/.

Kashiwagi, D., Kashiwagi, J., Sullivan, K. (2010). The Replacement of Client Decision Making with a Deductive Logic Structure. Proceedings of the 2010 Industrial Engineering Research Conference, Cebu, Filipinas.

Leite, F. L., Schramm, F. K., Formoso, C. T. (2006). "Gestão de empreendimentos habitacionais de interesse social: foco na gestão de requisitos do cliente e no projeto do sistema de produção". In: SATTLER, Miguel Aloysio, PEREIRA, Fernando Oscar Ruttkay (editores). Construção e Meio Ambiente. Porto Alegre: ANTAC, Coleção Habitare, 7, 208-239, URL http://www.habitare.org.br/ArquivosConteudo/ct_7_cap7.pdf.

Manzini, E., Vezzoli, C. (2002). O Desenvolvimento de Produtos Sustentáveis: os requisitos ambientais dos produtos industriais. São Paulo: Edusp (Trad. Astrid de Carvalho).

Medvedovski, N. S., Chiarelli, L. M. A., Tillmann, P., Quandt, M. M. (2005). Gestão habitacional para uma arquitetura sustentável. Porto Alegre: ANTAC, 5 (3), 49-61.

MMA (2010). Institutional Information. Available at http://www.mma.gov.br/responsabilidade-socioambiental/agenda-21.

MTE, Ministério do Trabalho e Emprego (2010). Estatísticas do Cadastro Geral de Empregados e Desempregados – Caged. Brasília, URL http://estatistica.caged.gov.br/consulta.aspx?mesCPT=11&anoCPT=2010.

PAC, Comitê Gestor do Programa de Aceleração do Crescimento (2010). 11º Balanço – 4 anos. Brasília, URL http://www.brasil.gov.br/pac/relatorios/nacionais.

PBPQ (2009). Institutional Information. URL http://www4.cidades.gov.br/pbqp-h/pbqp_objetivos.php.

PCC, Departamento de Engenharia da Construção Civil da Escola Politécnica da Universidade de São Paulo (2003). O Futuro da Construção Civil no Brasil: resultados de um estudo de prospecção tecnológica da cadeia produtiva da construção habitacional. São Paulo: Poli/USP, URL http://prospectiva.pcc.usp.br/arquivos/O%20futuro%20da%20constru%C3%A7%C3%A3o%20civil%20no%20brasil.pdf.

Reporter Brazil (2010). News, URL http://www.reporterbrasil.org.br/exibe.php?id=1794.

Sachs, I. (2002). Caminhos para o desenvolvimento sustentável. Rio de Janeiro: Garamond.

Santana, R. N. N. (2009). Forma Mercadoria assumida pela terra e submissão da propriedade à função social: uma contradição nas cidades do Brasil. Rio de Janeiro: ESS/UFRJ, URL http://www.ess.ufrj.br/ejornal/index.php/praiavermalha/article/download/43/28.

Seiffert, M. E. B.(2007). Gestão ambiental: instrumentos, esferas de ação e educação ambiental. São Paul: Atlas.

Sousa, A. C. A. (n.d.). A Evolução da Política Ambiental no Brasil do Século XX. s/l, URL http://www.achegas.net/numero/vinteeseis/ana_sousa_26.htm.

Tendenciasmercado (2010). News, URL http://www.tendenciasemercado.com.br/negocios/construcao-civil-setor-com-mais-emprego-e-melhores-salarios/

Triana Filho, A. (2006). Habitação Popular no Brasil: análise do modelo operacional de financiamento pelas agências oficiais. Brasília: UnB.

UN Documents URL http://www.un-documents.net/ocf-02.htm#I.

Enterprise Resource Planning Systems for Project-Based Firms: Benefits, Costs & Implementation Challenges

Yajun Zeng (University of Maryland), Yujie Lu (University of Maryland), and Miroslaw J. Skibniewski, (University of Maryland) (Ph.D)
Project Management Program
Department of Civil & Environmental Engineering
College Park, MD, USA

Enterprise Resource Planning (ERP) systems are configurable enterprise-wide information system packages that integrate information and information-based processes within and across functional areas in an organization. They have been widely adopted in many organizations and accepted as a de facto industry standard for the replacement of legacy systems. This paper analyzes and presents the costs and benefits of ERP systems for project-based industries, which have lagged behind other major industries in adopting ERP systems due to their project-centric nature and the high stakes involved in ERP implementation. The challenges during the process of ERP implementations are also identified as part of the effort to understand the implied costs of an ERP system. The evidence of the costs and benefits are drawn from previous studies and the analysis of the prevailing working practices in project-based firms. The classification of the costs and benefits constitutes a cost and benefit taxonomy which can be used to enable executives in project-based firms to make informed decisions on their ERP system investments.

Keywords: Enterprise Resource Planning (ERP) System, Cost-Benefit Analysis, Project-based Organizations, System Implementation.

Introduction

Since the 1990s, Enterprise Resource Planning (ERP) systems have become a de facto industry standard for replacing legacy systems and been perceived as the prevailing form of business computing for many large organizations in the private and public sectors (Gable 1998, Parr & Shanks 2000). ERP systems are designed and configured to achieve seamless integration of all of the information flowing through an organization, by integrating information-based processes within and across different functional departments, such as accounting, finance, human resources, manufacturing and distribution. They also connect the organization to its customers and suppliers and thus enable the integration beyond organizational boundaries. They are multifunctional in scope, integrated in nature, and modular in structure (Mabert et al. 2001). According to an AMR research, the total application revenue in the global ERP market was $28.8 billion in 2006; it was projected to increase to $47.7 billion in 2011 (Jacobson et al. 2007). Indeed, the ERP market is the largest segment of the applications budget (34%) in business organizations, with ERP penetration at 67% among large companies (Sirkisoon & Shepherd 2002). ERP is also increasingly deployed in small- and medium-sized companies, as ERP vendors turn their sights to smaller enterprises with tailored products for new business growth.

The adoption of ERP systems in project-centric industries appears to have lagged behind other major industry sectors, such as manufacturing and financial services. Project-based organizing is

found in a wide variety of industries, including architectural & engineering design, construction, aerospace & defense, professional services, entertainment, technology, and so on. In project-based firms, the project, which is defined as "a temporary endeavor undertaken to create a unique product, service, or result" (PMI 2008), is the primary unit for production organization, innovation, and competition. Hence project-based firms are distinguished from those organizations that are primarily based on and profitable from continual business operations, in which ERP system implementations have been more often documented. A study on ERP adoption by European midsize companies indicates that the project industry had the lowest ERP penetration rate at the time the survey was conducted (Van Everdingen et al. 2000). Another study states that very few organizations in the construction industry, which is ubiquitously composed of project-based firms, have implemented ERP systems, despite the wide awareness about such systems (Ahmed et al. 2003). There is also room for growth in the ERP market in aerospace and defense companies, many of which are project-oriented (Botta-Genoulaz & Millet 2006).

ERP systems, if successfully implemented, can bring substantial benefits to organizations. By providing real-time, organization-wide information access, ERP systems have the potential to improve organizational effectiveness and productivity, enable the management to make informed decisions, and enhance the competitiveness of the organization in the marketplace. However, their implementations are often characterized with large capital outlay, long implementation period, high complexity, and proneness to failure. It has been reported that the average implementation time of an ERP project was between 6 months and 2 years and that the average cost was about US$ 1 million (PMP Research 2001). This might keep many project-based companies from adopting ERP systems due to their limited financial, technical and human resources, and aversion to risks. Without essential awareness of the benefits ERP systems can bring and the stakes involved, project-based firms either rush to implement an unsuitable ERP system that might fail in the forms of overrun budget, prolonged schedule, abandonment of implementation, or unrealized returns; or simply refuse to take advantage of ERP systems and risk losing business competitiveness and growth opportunity in the market. Therefore, it is very important to fully understand and thoroughly evaluate the costs and the benefits of ERP systems before making the decision on whether to adopt an ERP system in the organization or which ERP packages and modules to be selected and implemented.

Research Design

The main objective of this study is to identify and analyze a full spectrum of costs and benefits of ERP systems in the context of project-based firms. Enumeration of costs and benefits is the prerequisite of sound cost-benefit analysis and many other kinds of economic or financial techniques in capital project decision making, such as Net Present Value (NPV) and Internal Rate of Return (IRR) methods. The identified costs and benefits of ERP systems constitute a comprehensive taxonomy. In addition, the challenges to ERP implementation in project-based firms are discussed, considering the specific conditions of such firms.

The costs and benefits of ERP systems are identified and analyzed from the point of view of senior management and/or owners of project-based firms, who make the decisions on ERP investment. The evidence of ERP costs and benefits are primarily drawn from extant literature.

There have been a large number of journal articles and conference papers related to ERP systems and their evaluation, selection, implementation, and use in recent years. However, most of them are placed in generic organizational environments and few address ERP systems in project-based firms specifically. In this study, the costs and benefits of generic ERP systems are considered to apply to project-based firms. Further, those costs, benefits, and issues more likely to be associated with project-based firms are elaborated in conjunction with the analysis on the prevailing practices and characteristics of project-based firms. There are also numerous publications generated by ERP vendors and consulting firms, in the forms of white papers, case studies, presentations, etc. These publications, although suffering from the lack of independence and objectivity, have been cited by researchers now and again and could provide useful references as well.

Benefits of ERP Systems

The benefits of ERP systems have been constantly advocated and reported by ERP vendors and consultants. These benefits are generally supported by the post-implementation performance of ERP systems and improvement of productivity and profitability of the hosting organizations. Davenport et al. (2002) propose a pyramid illustrating how the value from enterprise solutions, among which ERP system is the backbone, is achieved (Figure 1).

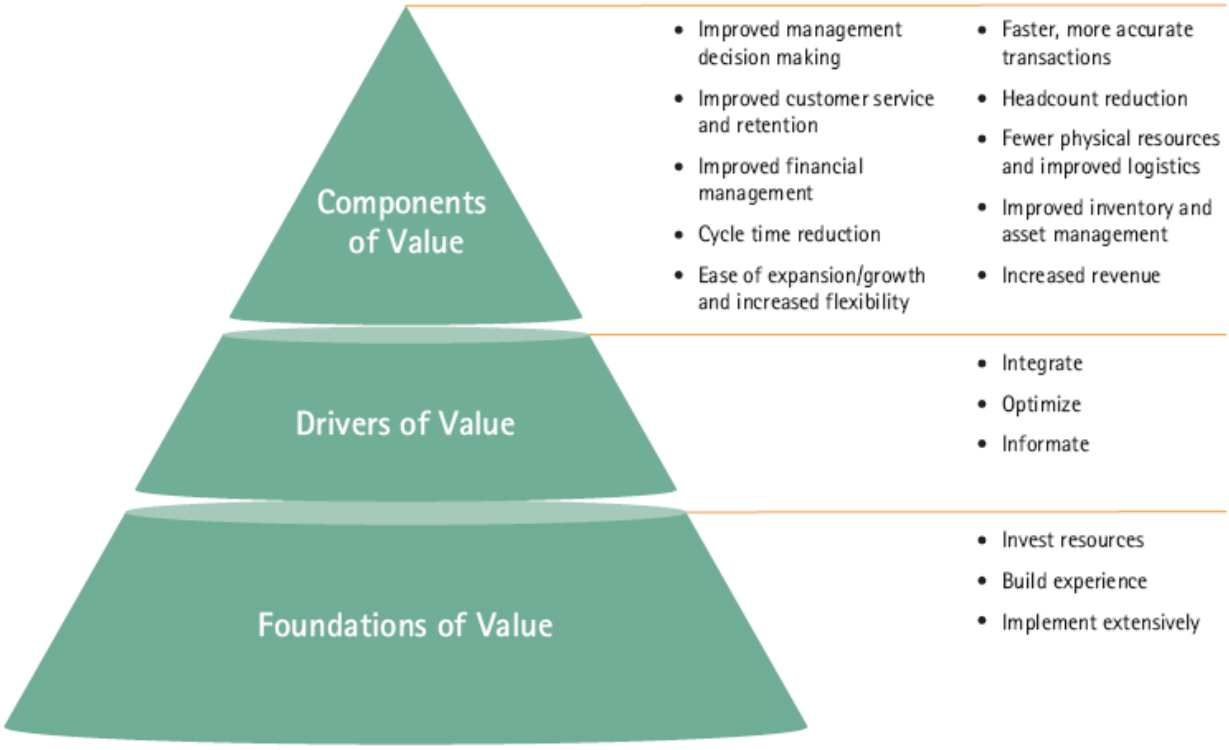

Figure 1: Value of enterprise solutions, adapted from Davenport, et al. (2002)

The benefits of ERP systems are realized, in other words, the value is achieved, by the following three means: integration of information system, data, and processes among different

organizational units and with existing organizational environment or external stakeholders; optimization of business processes using best practices or fitting the business needs; and transforming data into context-rich information and knowledge that support business analysis and decision making (termed "informate") (Davenport et al. 2002). There have also been attempts to systematically identify the benefits of ERP systems. Fig 1 lists 10 types of benefits as components of value. Shang & Seddon (2000) presents a comprehensive framework for classifying ERP benefits; according to the framework, 5 dimensions of benefits are proposed, which could be further classified into 25 sub-dimensions. This framework provides a basis for analyzing ERP benefits in project-based organizations.

Cost and cycle time reduction are the basic operational benefits of ERP systems. There are numerous studies stating that investment in information systems to automate transactions can speed up processes, substitute labor, and increase operation volume (Brynjolfsson & Hitt 1996, Shang & Seddon 2000). Unlike retailing companies that sell a wide variety of identical products to a large base of customers, project-based firms operate by providing specific services, products or other results, which are highly customized and seldom duplicable; and their customer base is usually much smaller. Thus it is very important for them to ensure the quality of every product or service and retain customers or clients. The capabilities of ERP systems to reduce duplicates and errors and enhance responsiveness to customer needs can help project-based firms to improve productivity and quality and retain customers. Besides, risk reduction is regarded as an additional benefit of ERP (SAP 2010). By providing real-time information as well as analysis and reporting tools, ERP systems can serve to reduce the business risks that might otherwise be difficult to forecast beforehand and resolve in time.

Since project-based firms are composed of dispersedly located teams undertaking different projects that have loose coupling with each other, these project teams normally enjoy considerable autonomy (Bresnen et al. 2004). This makes lots of firms essentially decentralized. Indeed, conflict and abrasion frequently occurs among different projects in a firm (Kodama 2007). By storing and managing all the data in a centralized database and providing built-in data analysis capabilities, ERP systems can enable both project managers and senior executives to better manage the resources (asset, inventory, workforce, etc.) within a project team and also among different teams, measure and control individual and team performance, and make better informed decisions. In addition, project cost management applications that are widely in use today may be confined to a single project or a number of them; they cannot provide a holistic view of corporate financial status or effectively manage all the financial assets and liabilities of the firm. In contrast, ERP systems have been proven able to effectively and efficiently manage the finance of a whole organization (Davenport et al. 2002). Therefore improved financial management is considered as a separate benefit.

Rackoff et al. (1985) proposed five strategic thrust areas where a company could make a major offensive or defensive move: differentiation, cost leadership, innovation, growth, and alliance. As stated by Shang & Seddon (2000), ERP could assist in achieving these strategic benefits, although the benefit of product differentiation is questionable as the products of project-based firms are always differentiated. Powered by the up-to-date information of ERP systems and the increased processing capacity, it is possible for project-based firms to respond quickly and competitively to new opportunities leading to business growth, such as bidding on new projects.

Such growth can lead to worldwide expansion, as ERP systems are capable of supporting global operations. The need to achieve project objectives that fully address key stakeholder expectations throughout the project lifecycle has been stressed in previous studies (Bourne & Walker 2005, Cleland & Ireland 2006). Thus the benefit of ERP to build external linkage is of significance to project-based firms. Also, ERP systems can help align business strategies with daily operations of an organization (SAP 2010). Another benefit is that, as Internet becomes indispensable and ubiquitous today, web-enabled ERP systems can integrate or support e-Business.

ERP systems, with integrated and standardized application architecture, provide an infrastructure that could support 1) business flexibility for current or future changes, 2) reduced IT costs and marginal cost of business units' IT because with the high integration cost eliminated and the need to purchase third-party software diminished, and 3) increased capability for quick and economic implementation of new applications (Shang & Seddon 2000). With organizational structure adjusted and business process reengineered according to the best practices embodied in the system, ERP implementation can support organizational changes and enhance corporate governance. Other organizational benefits include facilitating learning, empowering employees, building a culture with common visions, and improve employee morale and retention (SAP 2010, Shang & Seddon 2000).

Based on the above analysis and adapted from the framework developed by Shang & Seddon (2000), Table 1 lists 28 types of ERP benefits categorized into 5 dimensions. While the majority of these benefits are put forward from generic organizational environment, they could be evaluated in the context of project-based firms. Davenport et al. (2002) argue that increased revenue is a component of ERP value. Integrated business processes can enable an organization to provide new offerings of products or services or exploit new channels, thus generate extra revenue. Nonetheless, this is covered by other benefit sub-dimensions such as business growth and productivity improvement. There are also studies that support positive connections between ERP and improved liquidity (Matolcsy et al. 2005), and ERP and increased profitability (Hendricks et al. 2007, Matolcsy, et al. 2005). Similarly, they are considered as the results of benefit realization rather than benefit themselves in this study.

Table 1

Taxonomy of ERP Benefits, adapted from Shang & Seddon (2000)

Dimensions	Sub dimensions
1. Operational	1.1 Cost reduction • Labor cost (headcount) reduction • Inventory cost reduction • Administrative cost reduction (e.g. printing, office supplies, travel) 1.2 Cycle time reduction: faster project delivery • Cycle time reduction in customer support activities • Cycle time reduction in employee support activities • Cycle time reduction in supplier support activities • Cycle time reduction in support activities with other external partners or stakeholders 1.3 Productivity improvement 1.4 Quality improvement • Error reduction • Duplicates reduction • Accuracy or reliability rate improvement 1.5 Improve customer services and retention • Ease of customer data access and inquiries • Improved ability to retain customers 1.6 Reduce business risks • Better risk forecasting • Improved response and responsiveness to risk occurrence
2. Managerial	2.1 Better resource management • Better asset management • Better inventory management • Better production management for optimized supply chain and production schedules • Better workforce management • Few physical resources/better logistics 2.2 Improved planning and decision making • Improved strategic planning and decisions • Improved operational decisions • Improved customer decisions 2.3 Better performance measurement and control 2.4 Improved financial management • Improved financial budgeting and analysis • Better management of financial assets and liabilities • Centralized and real-time financial reporting and performance evaluation
3. Strategic	3.1 Improve alignment of strategies and operations 3.2 Support business growth 3.3 Support business alliance • Consolidate newly acquired companies into standard business practice • Collaborate with external parties for joint projects 3.4 Build business innovations • Enable new market strategy • Build new process chain • Create new business 3.5 Build cost leadership • Achieve economies of scale

	3.6 Generate or enhance product differentiation 3.7 Build external linkage (with customers, suppliers, contractors, collaborators, etc.) 3.8 Enable worldwide expansion and operations 3.9 Enable e-Business
4. IT Infrastructure	4.1 Increased business flexibility 4.2 Reduce or optimize IT spending 4.3 Increase IT infrastructure capability and adaptability for implementation of new applications
5. Organizational	5.1 Support organizational changes and corporate governance 5.2 Facilitate business learning and broaden employees' skills 5.3 Empowerment 5.4 Changed culture with common visions 5.5 Changed employee behavior with shifted focus 5.6 Better employee morale and satisfaction with improved retention of top performers

Costs of ERP Systems

Compared with typical software licensing and installation, ERP systems are much more expensive to acquire and deploy. The total cost of ERP project varies in a wide range, from hundreds of thousands of US dollars for a single ERP module implementation in small firms, to the magnitude of over one billion dollars for complicated global ERP roll-outs in multinational corporations. ERP cost depends on many variables, such as the ambition of the project, the number of the organization units the system will serve, the number of modules installed, the amount of integration required with legacy systems, the readiness and extent of organizational changes in terms of structure and business processes, the scope of software modification and customization, etc. This makes it hard to precisely estimate or predict the expenses.

In general, the cost of ERP system implementation can be classified into two categories: direct costs and indirect costs. Direct costs, or tangible costs, are those costs explicitly related to ERP implementation that the hosting organization has to pay and thus can be reflected on the corporate income statements. Normally, direct costs include expenses incurred due to software purchase or licensing, hardware acquisition and installment, procurement of external professional services, addition of headcount, staff training, and so forth. According to a survey on ERP implementations in Swedish manufacturing companies, the average shares of the proposed six components of ERP direct costs are: software, 24.2%; hardware, 18.5%; consulting, 30.1%; training, 13.8%; implementation team, 12.0%; and others, 1.4%, respectively (Olhager & Selldin 2003). Software and hardware costs basically depend on the selection of ERP packages and hardware upgrades, existing IT infrastructure, and IT planning. The use of ERP consultants, usually external consultants from professional service firms, is common in ERP projects and regarded as a success factor (Somers & Nelson 2001). Because lots of project-based firms have fragmented processes and differentiated business needs, customization, system integration and data conversion are critical, thus using consultants' expertise could play a major role in diminishing ERP risks. As a result, choosing the right consultants with sufficient application knowledge and industry experience and making full use of consulting services have the potential to control or lower the direct cost of ERP implementation in project-based firms.

Indirect costs, or intangible costs, are elusive to define, identify and control. They are "off-the-books" expenses, damages, or losses generated mainly by human or organizational factors (Irani

& Love 2001). Organizations implementing an ERP system often have to be prepared to see the organization reengineered, its staff disrupted, and its productivity drop before the payoff is realized (Umble & Umble 2002). Indeed, ERP system implementation may turn out to be a distraction or disruption, at least temporarily, to the firm's ongoing projects and operations. This include shifted management focus, using employees' time for extensive training, lowered employee morale and work efficiency because of possible job role redesign or headcount reduction, conflicts and frictions between organizational units, and so on. Indirect costs in generic IT investment (Irani et al. 1998, Love & Irani 2001, Marsh & Flanagan 2000) are also likely to occur in the ERP projects.

Table 2 provides a taxonomy of ERP costs, categorized into the two dimensions. It is noteworthy that while ERP maintenance cost in the post-implementation stages must be taken into account, the cost of optional ERP system upgrades and introduction of additional functionalities are considered separate projects. Besides, although indirect costs are difficult to fully enumerate and quantify, total cost of ownership (TCO) has been advocated by some as an effective method to measure the cost of ERP systems and support ERP strategies and decisions (Aberdeen Group 2006, West & Daigle 2004), which may partially incorporate the estimation of indirect costs.

Table 2

Taxonomy of ERP Costs, adapted from Love & Irani (2001) and Iba (2006)

Dimensions	Sub dimensions
1. Direct costs	1.1 Software purchase or licensing • ERP solutions • Database management system • System software • Security software • Additional applications 1.2 Hardware acquisition or upgrade • Servers & database machines • PCs, workstations, printers, scanners, and other computer peripherals. • Network equipment • Installation and configuration of hardware • Other facilities 1.3 Professional services by external consultants • Customization • Data conversion • Installation and configuration • System integration • Testing and troubleshooting • Other technical support 1.4 Internal staffing • Additional permanent hiring • Additional temporary hiring • Staff turnover 1.5 Instruction and training 1.6 Maintenance and mandatory upgrades 1.7 Administrative and miscellaneous costs • Overheads

	• Travel • Contingency
2. Indirect Costs	2.1 Disruption to ongoing projects (strains on resources, additional change orders, delays, etc.) 2.2 Temporary loss in productivity 2.3 Temporary decline in quality of work 2.4 Business process reengineering 2.5 Organizational restructuring 2.6 Shift of management focus and dedication 2.7 Use of management and employee time 2.8 Job role redesign & reassignment 2.9 Decline in employee engagement and morale 2.10 Culture changes 2.11 Conflicts and frictions among organizational units 2.12 Transition from legacy system to the ERP system 2.13 Impact on relationship with key stakeholders

Implementation Challenges

ERP implementations are exposed to various risks. Previous studies have described a number of risk factors in generic ERP implementations, such as low top management support and involvement, inadequate business process reengineering, inadequate legacy system management, and ineffective project management (Aloini et al. 2007, Umble et al. 2003). In project-based firms, the mission-oriented nature and resource- and time- constrained ways of working, combined with the loose coupling between different projects, usually create highly distributed and fragmented working practices (Bresnen et al. 2004, Lindkvist 2004). As such, implementing ERP systems in such organizations must overcome certain additional challenges.

Project success is critically dependent on the collaboration and support of its stakeholders. Examples of such key stakeholders include major clients of the company, as well as suppliers, regulators, and collaborating partners. Regarding ERP projects, stakeholders not only include those participants in the implementation processes, but also need to involve the stakeholders in the projects carried out by the organization during and after the implementation. It is these projects that bring profits to the firm and make the ERP adoption worthwhile. Ineffective stakeholder relationship management leads to frictions, scope creep, inappropriate measurement, specification changes, delays, and other issues (Hartman & Ashrafi 2002). Therefore, it is very important to maintain good relationships with stakeholders and involve key stakeholders, including but not limited to internal users, into the implementation process.

As a result of the physical dispersion of project teams, ERP systems in project-based firms have to be implemented in a multi-site manner, which brings special concerns (Umble et al. 2003). The conflicts between centralized control and individual site autonomy, and between corporate standardization and localized optimization, increase the complexity of ERP implementation and entail difficult trade-offs. Local legal, regulatory, and environmental issues are also need to be seriously addressed and reflected in the reengineered business processes. Moreover, since project teams are of high mobility, moving from one site to another with reshuffled staff as a project is completed, the temporariness of project team composition and site location makes it difficult to carry out ERP implementation and manage the IT asset effectively. In addition, project-based firms often need third-party specialized applications with functionalities that

current ERP systems are not able to provide. For example, engineering design and construction firms heavily rely upon Computer-Aided Design (CAD) or Building Information Modeling (BIM) solutions to undertake their projects. As a result, achieving integration and interoperability to some extent between ERP system and non-ERP applications is a big challenge during the implementation process.

Conclusion

This study aims to systematically identify and analyze the benefits and costs of ERP systems in the context of project-bases firms. A number of challenges to ERP implementations are also discussed that specifically pertain to such kind of organizational environment. The listed costs and benefits constitute a comprehensive taxonomy addressing the impacts of ERP systems on project-based firms, which can be used to conduct cost-benefit analysis and support decision making on ERP system evaluation and investment. While almost all direct costs can be quantified in financial terms, most of the benefits and indirect costs are difficult to measure using a quantitative method, which makes the comparative evaluation of costs and benefits inconclusive for decision making. The effort of developing effective techniques to approximate these intangible costs and benefits quantitatively and building sound cost benefit analysis method for ERP system evaluation will be undertaken in future studies.

References

Aberdeen Group. (2006). The total cost of ERP ownership. Boston, MA: Aberdeen Group.

Ahmed, S. M., Ahmad, I., Azhar, S., Mallikarjuna, S. (2003). Implementation of Enterprise Resource Planning (ERP) Systems in the construction industry. *Proceedings of the ASCE Construction Research Congress*.

Aloini, D., Dulmin, R., Mininno, V. (2007). Risk management in ERP project introduction: review of the literature. *Information & Management, 44*(6), 547-567.

Botta-Genoulaz, V., & Millet, P. (2006). An investigation into the use of ERP Systems in the service sector. *International Journal of Production Economics, 99*(1-2), 202-221.

Bourne, L., & Walker, D. H. T. (2005). Visualising and mapping stakeholder influence. *Management Decision*, 43(5), 649-660.

Bresnen, M., Goussevskaia, A., Swan, J. (2004). Embedding new management knowledge in project-based organizations. *Organization Studies, 25*(9), 1535-1555.

Brynjolfsson, E., & Hitt, L. M. (1996). Paradox lost? Firm-level evidence on the returns to information systems. *Management Science*, 42(4), 541-558.

Cleland, D., & Ireland, L. (2006). *Project management: Strategic design and implementation* (5th ed.). New York, NY: McGraw-Hill.

Davenport, T. H., Harris, J. G., Cantrell, S. (2002). The return of enterprise solutions. Accenture.

Gable, G. (1998). Large package software - A neglected technology? *Journal of Global Information Management,* 6, 3-4.

Hartman, F., & Ashrafi, R. (2002). Project management in the information systems and information technologies industries. *Project Management Journal,* 33(3), 5-15.

Hendricks, K. B., Singhal, V. R., Stratman, J. K. (2007). The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM System implementations. *Journal of Operations Management,* 25(1), 65-82.

Iba, B. (2006). *Towards a whole lifecycle cost model for ERP projects.* Cranfield University, Cranfield, England.

Irani, Z., Ezingeard, J.-N., Grieve, R. (1998). Costing the true costs of IT/IS investments in manufacturing: A focus during management decision making. *Logistics Information Management,* 11(1), 38-43.

Irani, Z., & Love, P. E. D. (2001). The propagation of technology management taxonomies for evaluating investments in information systems. *Journal of Management Information Systems,* 17(3), 161-177.

Jacobson, S., Shepherd, J., D'Aquila, M., Carter, K. (2007). The ERP market sizing report, 2006–2011: AMR Research.

Kodama, M. (2007). *Project-based organization in the knowledge-based society*. Hackensack, NJ: World Scientific Publishing.

Lindkvist, L. (2004). Governing project-based firms: Promoting market-like processes within hierarchies. *Journal of Management and Governance,* 8(1), 3-25.

Love, P., & Irani, Z. (2001). Evaluation of IT costs in construction. *Automation in Construction,* 10(6), 649-658.

Mabert, V. A., Soni, A., Venkataramanan, M. A. (2001). Enterprise Resource Planning: common myths versus evolving reality. *Business Horizons 44*(3), 69-76.

Marsh, L., & Flanagan, R. (2000). Measuring the costs and benefits of Information Technology in construction. *Engineering Construction and Architectural Management, 7*(4), 423-435.

Matolcsy, Z. P., Booth, P., Wieder, B. (2005). Economic benefits of Enterprise Resource Planning Systems: Some Empirical Evidence. *Accounting and Finance,* 45(3), 439-456.

Olhager, J., & Selldin, E. (2003). Enterprise Resource Planning survey of Swedish manufacturing firms. *European Journal of Operational Research, 146*(2), 365-373.

Parr, A., & Shanks, G. (2000). *A Taxonomy of ERP implementation approaches*. Paper presented at the 33rd Hawaii International Conference on System Sciences, Wailea Maui, Hawaii.

PMI. (2008). *A guide to the Project Management Body of Knowledge (PMBOK Guide)* (4th ed.). Newton Square, PA: Project Management Institute, Inc.

PMP Research. (2001). Industry reports: infrastructure management software.

Rackoff, N., Wiseman, C., Ullrich, W. (1985). Information systems for competitive advantage: Implementation of a planning process. *MIS Quarterly, 9*(4), 285-294.

SAP. (2010). SAP ERP Business Benefits. URL http://www.sap.com/solutions/business-suite/erp/businessbenefits/index.epx (visited 2010, March 2).

Shang, S., & Seddon, P. (2000). A comprehensive framework for classifying the benefits of ERP Systems. *Proceedings of the 6th Americas Conference on Information Systems,* 1005-1014.

Sirkisoon, F., & Shepherd, J. (2002). The steady stream of ERP investments: AMR Research.

Somers, T., & Nelson, K. (2001). *The impact of critical success factors across the stages of Enterprise Resource Planning implementations.* Paper presented at the Proceedings of the 34th Hawaii International Conference on System Sciences.

Umble, E., Haft, R., Umble, M. (2003). Enterprise Resource Planning: Implementation procedures and critical success factors. *European Journal of Operational Research, 146*(2), 241-257.

Umble, E., & Umble, M. (2002). Avoiding ERP implementation failure. *Industrial Management, 44*(1), 25-33.

van Everdingen, Y., van Hillegersberg, J., Waarts, E. (2000). ERP adoption by European midsize companies. *Communications of the ACM, 43*(4), 27-31.

West, R., & Daigle, S. (2004). Total cost of ownership: A strategic tool for ERP planning and implementation. *Research Bulletin, 2004*(1-14).

Informal Projects Management with Volunteers Participation

Marek Wirkus (Gdansk University of Techology), (PhD, Engineering)
Faculty of Management and Economics
Gdansk, Poland

The article briefly presents some experiences and results of research which has been conducted in order to identify key elements influencing the success of projects managed in informal way with volunteers' participation. These experiences were collected during the realization of several "soft" projects. The general aims of these projects were sports competitions' organisation, cultural events and charity projects for big groups of people. Within research of project management, the following issues were discussed: the project area of activity and function possible to make by volunteers, the rules of volunteers employment in project, factors describing key elements influencing the success of projects including: the trust as the base of informal projects management, wide-understand communication, cooperation and team work. Project risk, reporting and controls of project execution and the role and element of project culture as elements influenced on project success are also discussed.

Keywords: project management, volunteers, participation.

Introduction

Volunteers are commonly and globally engaged in "soft" projects which happens in the economic world. The main reason for engaging volunteers is that they are offering for free their time and skills. Projects with volunteers are generally managed using the same rules that are used for managing "normal" projects. Looking at these kinds of projects, we should realize that volunteers are working without salary, have no legal agreement with employers and are not available full-time. Therefore, attention should be paid to regarding specific character of management and execution of these projects. Management of these projects is often done in an informal way, and these kinds of projects are not managed using any worldwide known methodologies described in literature. Management on these projects is based on common sense, learning new experiences and intuition of people who execute projects. Research is carried out in order to identify key indicators having influence on success of soft projects with participation of volunteers.

Volunteers and Reasons for Hiring Them in Projects

The foundation of volunteering is free-will, unpaid, conscious, exceeding family relationships (and relationships between neighbors) work for others. Everyone can be a volunteer. You are a volunteer if you want to work for others without payment, just because of free-will.

People give different reasons for working as volunteer and different expectations about working in this kind of projects. Here are most common reasons:

- Will to improve skills and will to gain practical experience, what will increase value one employee market
- Will for new experiences,
- Attractive topic of project,
- Gaining non-material benefits connected with attending this project - for example chance to attend interesting concert,
- Will for self-testing,
- Will to make own life more attractive, having new adventure,
- Do someone's moral duty.

Project executives are hiring volunteers because they are working for free (we should realize that in some projects low budgets limits hiring full time employees). We need volunteers usually for short time, in different period of time and only for some tasks in a project. Looking at these aspects we can see that volunteers give flexibility in this area. Volunteers are usually attending projects executed by non-profit organizations, for example:

- Non-government organizations, foundations,
- Local associations of local government agencies,
- Churches
- Entities under public administration and supervised by municipality.

The number of this kind of project is really huge, but they are undervalued by project management methodology.

More detailed research was done on eight projects. Quality researches were done by interviewing people who manage following projects and by interviewing volunteers working in these projects. Researches were focused on following projects:

a) Organizing musical concert for about 110 000 people,
b) Preparing huge sport event with on-street marathon for about 550 sportsman,
c) Charity event - collecting food and preparing Holiday event with meals for 1 200 people with low social status,
d) Organizing Tall Ships' Race,
e) Wedding party for about 150 people

Owners of all this projects say that projects were finished with success. Some opinions were confirmed by media and newspapers. But not in all cases it is possible to give indicator which were used to asses success. Concert was delivered in planned time, charity event has happened and so one. Projects did not exceed planed budget, but no one assessed satisfaction of people attending these events.

Here is a short characteristic of these projects:

- "Soft" projects, in different areas, where results of project are not material, so it is hard to identify and measure effect of project,
- Time of these projects is diverse: from a few months (charity event) to a few years (Tall Ships' Race). We can observe that there is intensive work (connected with the final product of the project (concert, sport event and so one)) at the end of the project,
- Project are executed under time pressure (for example it is not possible to change concert data),
- All projects were very complicated,
- Public media were interested in these projects, and opinion given by this media could not be ignored (but in some cases media did not have all knowledge to form right opinions).

Volunteers were important part of all of these projects. All these projects were managed in informal ways, without using any project management methodology. Managers were using intuition to manage projects. In details, we can characterize management of these projects as follows:

- Poor administrative documentation about course and results of the project (low level of "paper work").
- Most communication was don as individual, informal, face to face meetings,
- Reasons for making some kinds of decisions were not specified,
- Budged was low, but not exactly specified.

Organizational structure of all these projects was simple. Here are most important components of this structure:

- Project manager - he or she played key role and was support by organizational office which consisted from a few people,
- Specialized subcontractors,
- Group of volunteers. In some projects (for example. wedding party, Tall Ships' Race) number of volunteers were significantly bigger then number of employees, but in other projects (concert) it was in the other way. In all projects number of people needed in different phases of project was changing dynamically.

All projects were managed by organizations with poor awareness of project management methodology. Project managers didn't posses any certificates proving their project management skills. Their knowledge in this area was fragmentary, and came from personal experience, but not from professional trainings. On the other hand, project managers had great knowledge about topic of the projects. This knowledge came out of the previous experience. Project Managers was nominated as PMs because of this knowledge about the topic of the project.

Basing on observations of these people and basing on assessment of skills of this people we can point same key characteristics of people who should be involved in managing huge project (or people who are managing big work packages in projects):

a) Project manager should be full time employee, chosen basing on skills not on functions,

b) Leadership skills, ability to work with people, open, with good interpersonal skills, people who can build trust relationship,
c) Enthusiastic, with ability to motivate other people, giving enthusiasm to other people (volunteers),
d) Well motivated, and goal-focused,
e) Having skills in human resources management.

You should pay attention on choosing people for project management, especial if you want to nominate volunteer as a project manager. If you are choosing a volunteer as a project manager, you should be 100% sure if this person will attend this project until the end. If this person will resign the project before ending the project you will notice "information whole" and this will have great impact on the future of the project.

Rules for Recruiting and Hiring Volunteers

There was no problem in finding people who will meet basic requirements about qualifications and understanding issues connected with general purpose of project. Volunteers were recruited by press and on-line advertisements. Some of advertisements were focused on special group of people. For example there were advertisements focused on students interested in sailing (Tall Ships' Race) and sport event (sport event). Advertisements contained slogans like "great satisfaction guaranteed". Many volunteers were recruited using personal contacts of people employed in this organization and contacts of already recruited volunteers. People were engaged basing on oral declarations of candidates. People were declaring:

- Will to attend the project,
- Free time for attending the project,
- Education and overall skills. In some cases people were asked to prove skills. For example all medical stuff had to show appropriate certificates.

In very attractive projects (like concerts, Tall Ships' Race) which attracted attentions of many people, there was a preference for people with some experience in similar projects. It is necessary to pay attention on interview, which was not always appreciated by managed (because of lack of time). Skills, experience and abilities were independent from age of volunteers. It is important to asses all skills, to choose appropriate people, who will bring value to project, but these should be two-way relation - people should be satisfied with taking part in this project.

Usually interview was the only tool to verify skills of all volunteers. What is more interesting - in most cases all this declarations were enough. In most cases declared skills were followed by real, high scored, work. Of course some lack of experiences could be fixed by training. But analyzing training delivered during the project we can say that most training was delivered as short overview, rather than detailed trainings. It is important to how the volunteers will enter the project. Volunteers should:

- Engaged at the right time, he or she should have enough time to understand tasks he had to do an to "feel the project",

- Be assigned to right person, who is managing project (or some aspects of project) and is contact persona, working as mentor for a volunteer.

There was no formal agreement between volunteer and organization preparing the event. Volunteers did not ask form agreements

Areas of acting, rules and right of volunteers in project

In projects which were analyzed, volunteers had the following kinds of tasks:

- Not complicated task in which there was no need for complicated skills,
- Routine, toilsome tasks,
- In some tasks it was necessary to have some special skills. For example: driving license, fluent speaking in some languages, ability to give first.

Some examples of work done by volunteers are:

- Giving information at information point, giving brochures.
- Technical assistance, assistance at the office,
- Animate events that were accompanying main event,
- Help in doing main task in event, for example gathering food in charity event,
- Taking care for spectators, artists, sportsman or VIP,
- Working as a first aid stuff,

Volunteers were obliged to do some things connected with their role in projects:

- Be punctual,
- Work in suites delivered by organization,
- Attending meetings with management.

To do their jobs in right way, volunteers were obliged to find right information about what is happening in project (where and when) and what changes happened in project. They should know who is responsible for different are and should be able to contact this person.

Volunteers hired for projects had some rights. These rights came from oral agreements or local law. Because volunteers should not be charged for any their activities in project, managers were responsible for providing budget for covering expanses connected with volunteers' expanses. For example all volunteers should be insured against accidents, right to meals during working hours etc. It brought additional costs to projects.

Management should cover all other costs related to volunteers' work. For example (but not limited to) they should cover following costs:

- Business trips,
- Material and suites,

- Phone costs, internet costs etc.

In some cases volunteers were paying some small costs on their own (for example in charity event).Assigning tasks to people was based on oral orders, given during meetings with managers responsible for appropriate aspects of projects. Following aspects were specified during meeting:

- Setting scope of tasks,
- Giving instructions for doing tasks,
- Setting rules for contacts in the future.

After delegating tasks to volunteers, they were responsible for these tasks. In some cases formal responsibility were put on volunteers, but in most cases the manager who delegate task, took formal responsibility for this task. Most of decisions were oral decision, but in special situations decision were written down as a note from the meeting.

Project Planning Issues

Task planning was the weakest side of projects that were analyzed. It was because of the informal character of project - informal project management caused informal scheduling. No official methods like Work Breakdown Structure and Gantt Chart were used to plan tasks. Generally project managers were focused on milestones. They estimated data for milestones, as a reference data for other tasks.

Estimation of project duration was done using intuition and previous experience from similar projects. Sharing experience with specialist in different aspects of project was done only from time to time.

This informal scheduling effected in missing some tasks or wrong estimation of work needed to finish tasks (very often assumed work was smaller than real work). This under-estimation was brought to light in less inspected moments. Project managers, using intuition was predicting problems in project managements, and were starting initiatives were early (looking at the finish data - for example concert start data). But sometimes early start was causing lack of discipline, because everyone was thinking, that they have enough time.

One of big problems was volunteers availability - they were not full-time available. Their availability did not always match project managers' expectations. In some cases the declared availability which was not real availability, due the additional work or wrong estimation of time needed to normal, everyday duties.
Non-distinct planning caused that were peaks of work needed to do. These peaks were very high at the end of the project. Hiring additional volunteers and assigning new work to available volunteers helped to solve this problem but in some cases over locating caused that volunteers rejected new tasks, or were quitting the project. Lack of resources at the end of the projects, affected the quality of tasks and results of some task was not as good as it was expected.

Communication in Informal Projects

Good communication is key aspect of efficient volunteer oriented-projects execution. This conclusion was made by most of PMs after first failures. They said the main reason for these failures was poor communication. After this conclusion owners of subtasks were obligated to make sure that all volunteers have appropriate information about duties, tasks and project. It was necessary to get confirmation that volunteers understand all this information. There was a communication not only about tasks and duties but also about safe work, and safety at the project. During projects, communication happened differently in the following ways:

a) Informal, individual talks with volunteers - it was main form of communication (even in projects with large number of people). During these talks tasks were described in more details, detailed instructions and deadlines were given. These talks were great opportunity to share and discuss experience. It is important to say that this kind of communication has some pains: they are not documented and it takes a lot of time to communicate in this way. This is natural that volunteers wanted to say own opinion about project and informal meeting take longer time that it was expected. The volunteers were honest and were not afraid to say critical opinion (they were not afraid of losing a job).
b) Two-way sharing experience (during only few meetings) between people doing some parts of the project. The reason for this meeting was sharing experience, opinions and integration. Some people were glorified for good job, during these meetings.
c) Written, formal notes were done not so often. Written communication was very often done using real-time communicators. In some cases (Tall Ships' Race) there were prepared short leaflets with instructions about tasks to do.

Volunteers Motivating

The reason why volunteers are taking part in projects was given at the beginning of this article. All given reasons cause that volunteers are self-motivated. This means that they are motivated by emotions, and their will to attend in something special and by desire to gain expected results. Future satisfaction from attending interesting project is important too.

Volunteers want and need to have impulse, which will stimulate them to be more engaged and to work more effectively. Well motivated people have more enthusiasm in doing their jobs and are more resistant for small failures. In projects that were analyzed project managers forgot to motivate volunteers. Volunteers, working for free cannot be motivated by financial aspects - so they should be motivated in the different way, to be well-engaged in projects. They can be motivated in following ways (but not all this methods were fully used in all projects):

- Showing appreciation for volunteers for well done job (for example by praise and thanks or other different kinds of oral appreciation),
- Internal prizes. Internal prizes were given not in money, but for example in tickets (for example tickets concerts or ability to attend a party).
- Making sense of community and team working with other volunteers by identifying with each other by: having these same suits, having meetings with meals for volunteers, making chances for networking and building relationships.

In these kinds of projects it is difficult to use punishment as a way for stimulation volunteers. It is almost impossible to use financial punishment or make legal consequences for volunteers, who are not doing their job well. In some cases negative motivation was done by some symbolic punishment like loss of prizes - for example, people who will not do their job well will not receive tickets for concerts or will be move to less prestige tasks. Motivating people by oral appreciation and small punishment seems to be the best solution for motivating volunteers.

Risk and Trust in Projects with Volunteers

Hiring volunteers raise some risks in the project (which should be summed with other risks in project) - to optimistic estimation of task start and finish data, lack of cost control and so one. In generally there was no deep researches done by PMs about risks and especially risk raised by hiring volunteers but PMs took same intuitional operations to identify risk and mitigate them.
It is possible to identify some typical risk which occurs in these kinds of projects. Here are some examples:

a) Smaller than expected efficiency. Reasons why this can happen are:
    a. Wrong people were chosen and task are assigned to people who are not available enough a do not have appropriate skills, knowledge and experiences,
b) Quitting volunteers from project (sometimes without notifying management about this) what can bring problems especially in peak work time. Volunteers were quitting because of discouragement, which is caused by:
    a. More intensive and more difficult work than it was expected,
    b. Lack of identification with project,

After identifying this risk they can be mitigated by hiring other volunteers with better sense of responsibility or hiring more volunteers then it is necessary. All problems with volunteers are connected with recruitment processes. Each volunteer have different personality, and declarations they gave at the interviews were not always right. Sometimes they were over-scoring their skill. Looking at the time restrictions it was not possible to make good recruitment process. Trust plays a key role in cooperating with volunteers. Managers delegating task to volunteer trusted them and hoped that they will do their jobs in appropriate way. Management depends on volunteers more than they depend on managers. Two different attitudes of management can be observed (all of them are basing on life experience of management):

a) Full trust - some managers were assuming that people will do their jobs well. Usually managers trusted well known people and people with references.
b) limited trust - in limited trust volunteers were regularly monitored. After good results of monitoring limited trust was slightly changed to full trust.

The best method for monitoring was *Monitoring by Walking Around*. This method put stress on observing and talking with people (personal contact). During these meetings it was possible to send feedback to volunteers, asses their work (it motivates people) give other instructions, inform about changes, and so on.

Summary

Soft projects like organizing concerts, sport events, charity event are not always appreciated. Sometimes they seem to be less complicated and not so valuable as for example bridge building or skyscrapers. Project managers of soft projects are not as appreciated as PMs of normal project, so in some cases it was difficult to hire right skilled managers. Informal methods of project management are used because PMs were not familiar with formal project management methodologies.

In soft projects volunteers were engaged to do some jobs. This brings benefits for both sides. Volunteers are usually enthusiastic people working for free in selected tasks. It could be hard (from manager perspective) to hire volunteers to project. Sometimes they are not well prepared; have poor skills (looking at the tasks which are assigned to them). In some cases costs and problems that are generated by volunteers are bigger benefits they bring.

Key aspects which have influence on projects with volunteers' participation are:

a) You should accept every volunteer who want to access the project. Skills of this people should be assessed in appropriate way.
b) Trust play key role in this projects,
c) Monitoring by Walking Around is good solution for monitoring volunteers,
d) Communications should be, accurate clear and well organized
e) Non-material motivating is important for people who are by default self-motivated,
f) Written communication should be done where necessary, especially in peak time,
g) Real availability should be periodically refreshed,
h) Project manager should be chosen basing on skills, have leadership skills, ability to work with people, open, with good interpersonal skills, people

Given above elements are guidelines for initiators and people executing project with volunteers' participation. Using these guidelines will make those chances for success in soft projects will be bigger. Also training about project management for people who will manage project will improve efficiency of this people.

References

Grudzewski M.W.; Hejduk I.K.; Sankowska A.; Wantuchowicz M. (2009) Zarządzanie zaufaniem w przedsiębiorstwie. Oficyna a Wolters Kluwer business.

Kerzner H. (2005), Advanced Project Managament. Helikon 2005.

Wirkus M. (2009) Realizacja programów – kluczowe czynniki sukcesu in: Project management w czasach kryzysu J. Kisielnicki (ed.). Gdańsk: Stowarzyszenie Project Managament Polska, 129-145.

Project Management Methodologies: A Comparative Analysis

C. M. M. Chin (Kuala Lumpur Infrastructure University College), (PhD),
Kajang, Selangor, Malaysia

A. C. Spowage, (University of Nottingham Malaysia Campus), (PhD) and E. H. Yap, (University of Nottingham Malaysia Campus), (PhD)
Semenyih, Selangor, Malaysia

Across all industrial sectors, project management has become an essential element in the successful delivery of projects. Regardless of the industrial sector or size of project, project management methodologies (PMM) can be applied to improve the probability of meeting the project goals. In an earlier published work, we had classified PMM in five distinct but interdependent levels. In this paper, our objective is to further extend the discussion on the characteristics of L3 methodologies by comparing the PMM currently being applied in three distinct sectors: (1) academic institutions; (2) industry organizations and (3) government linked organizations. Each of the PMM across the three sectors will be compared and discussed against a list of elements to elicit a common set of requirements.

Keywords: project management methodology, organization specific, comparative analysis.

Introduction

Project management methodologies (PMM) have been popularized for use in various industry sectors for over 30 years (Goff 2007, Johnston & Wierschem 2005). Numerous professional bodies have developed a wide range of methods and techniques to aid in the management of projects. Today, PMM boast tighter project controls, improved approaches and leverage on tremendous experiences, however many projects still fail (Delisle & Olson 2004).

In the previous study (Chin & Spowage, 2010), the Project & Engineering Management group at The University of Nottingham's Malaysian Campus classified PMM into two major categories with five distinct but interdependent levels (Charvat 2003, Pitagorsky 2003, Turbit 2005, Wideman 2006). The two categories were project management methodologies (that provide a high-level framework for the project) and application development methodologies (which provide details on project design and development). The most apparent difference being that application development methodologies have a stronger focus on system testing, which is not covered in PMM. The confusion within the published literature and by project practitioners as to what constitutes a methodology is understandable as opinions vary widely. As a consequence we have classified PMM into five different levels; L1-Best practices, standards and guidelines; L2-Sector specific methodology; L3-Organization specific customized methodology; L4-Project specific methodology and L5-Individualized methodology. Each methodology has a degree of specificity increasing from the root (L1) to the tips of the branches (L5) as illustrated in Figure 1.

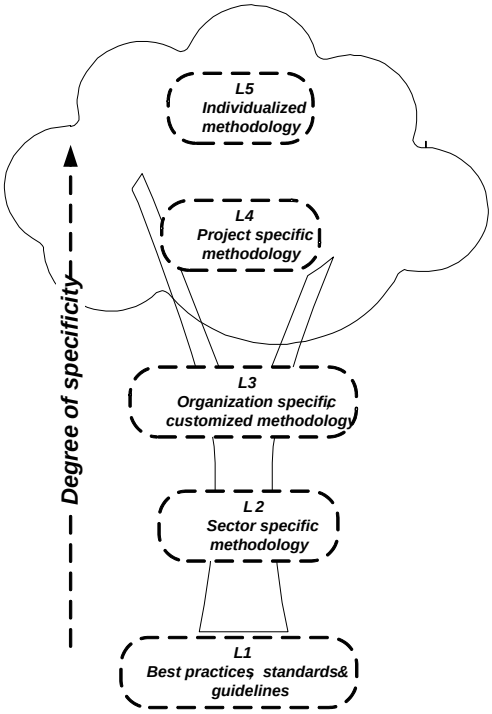

Figure 1: Classification of PMM

The objective in this paper is to further extend the discussion on the characteristics of L3 methodologies by comparing the PMM currently being applied in three distinct sectors: (1) academic institutions; (2) industry organizations and (3) government linked organizations. Each of the PMM will be compared and discussed against a list of common elements, components and requirements.

Understanding Project Management Methodology in Practice

Project management is a well-recognized discipline and the principal vehicle used by the majority of the world's leading organizations to deliver their work. Regardless of the industry sector or project sizes, utilizing an appropriate PMM is widely believed to enhance the probability of completing projects on time, within budget and to deliver the product to the satisfaction of all stakeholders (Charvat 2003, Josler & Burger 2005, Milosevic & Patanakul 2005, Munns & Bjermi 1996, Pitagorsky 2003). However, this condition only applies if the project manager understands the nature of the project and is able to 'reshape and scale' it to fit the project.

Effective PMM are those that can be tailored to the specific environment and that can be adapted to the dynamic nature of projects and stakeholder' demands. Thus, a methodology must be flexible; yet it should provide guidelines which leverage on both best practices and past experiences to ensure the project goals are achieved. It should help the project team to clearly understand the scope of their work, what to accomplish and how to accomplish it using the tools and techniques available within the methodology (Charvat 2003). It is impractical to develop a

new methodology for each new project within the organization. However, in the adoption and use of a methodology it should be easily customizable to any project within a given environment (Charvat 2003, Chemma & Shahid 2005, Cockburn 2000b).

Based on the literature discussed above and the research work (Chin & Spowage 2008a, 2010, Spowage & Chin 2009) done by the engineering management group at the University of Nottingham Malaysia Campus, we have defined a PMM as "a comprehensive set of best practices, tools and techniques that are dynamic, flexible, adaptive and customizable to suit different projects within a specific environment". The methodology should therefore consist of a set of processes, templates, techniques and tools to assist in planning and managing the project throughout its entire life cycle. The components of the methodology will cover (1) project management processes such as initiating, planning, executing and monitoring project progress with (2) a selection of tools and techniques to communicate the delivery to the satisfaction of all stakeholders; (3) consolidated and integrated set of appropriate best practices and values of project management and (4) a list of references and terminology to define a common language for the project environment.

Organization Specific Customized Methodologies

In the classification of PMM (Chin & Spowage 2010), L3 sector specific methodology are tailored to meet the strategy, structure, nature of projects and needs of an organization to effectively become a L2 methodology. An important step in implementing a L3 methodology within an organization is to integrate the project processes with the organization's business systems. Without this vital element the organization will encounter considerable difficulties in accessing information and will constantly have to duplicate administration. These two factors are also commonly cited as a cause of resistance to the adoption new methodologies.

There is a number of leading organization specific methodologies currently in the market. These include Microsoft's well-integrated methodology known as Microsoft Solution Framework (MSF) a successful design, deployment and operation methodology (MSF 2002). IBM similarly has its own effective PMM called the Rational Unified Process (RUP) (Kroll & Royce 2005). Another earlier user of PMM approach is a Swedish company, Ericsson, which introduced a common methodology for handling product development projects known as PROPS (Eskerod & Riis 2009, Mulder 1997).

L3 methodologies are also being adopted by academic institutions, for example, the University of Cornell's PMM (Cornell n.d.), which was adopted from Princeton University methodology and the University of Tasmania's methodology (University of Tasmania n.d.) which was adapted from the Tasmanian Government Project Management Guidelines (Tasmanian Government 2006). In other universities, PMM are mainly adopted for administrative, information and technology services (University Michigan 2005, University of South Carolina 2007, University of Sydney 2008). These will be discussed in the following sections.

Comparative Analysis of the Various Project Management Methodologies

In order to critically review and compare the various PMM available in the market, a total of 34 L3 organization specific customized methodologies have been identified, examined and categorized into (1) academic institutions methodologies; (2) industry methodologies and (3) governmental methodologies. Each of these methodologies was obtained from the organization's website and public folder which were accessible and downloadable. The majority of the PMM examined were created from the year 2000 to 2008 and all had access to a similar level of best practice. The analysis of each organization specific methodology will be discussed in the following sections. All the PMM identified were compared using the same list of elements to give a balanced discussion.

Academic Institution Project Management Methodologies

A total of 15 academic institutional methodologies were examined (Tables 1 & 2). The academic institutions were from several different countries and adopted different project management practices in the design of their methodologies. The majority of the PMM were aligned to Project Management Institute's Project Management Body Of Knowledge (PMBOK) guidelines (PMI 2008). However, UK academic institutions showed a stronger preference for alignment with the Association of Project Management Body Of Knowledge (APMBOK) (APM 2000) and Projects In Controlled Environments (PRINCE2) (PRINCE2 2005), mainly because PRINCE2 is the de factor standard in the UK (PRINCE2 2005).

A majority of academic institutions designed their PMM specifically for the management of information technology (IT) and information systems (IS) projects within their institutions. This is probably a reflection of the higher level of maturity of project management within the IT section compared to other sectors. Although many of these PMM were used primarily to manage IT projects they are also easily applicable to projects in other areas. The majority of PMM from academic institutions used a structured approach with unique project phases, processes, inputs or activities, deliverables, tools and techniques.

Though the PMM were adequate for facilitation, a handful of the methodologies are not complete, not having template samples, checklists nor hints and tips to guide project managers. Furthermore, a number of PMM do not include a common set of references on the terms and acronyms used by the methodology (Tables 1 & 2). These are important components to be included in a typical PMM since many academicians' and administrators lack project management knowledge and skill sets to effectively managing their research projects (Gist & Langley 2007). Further, we found there are a handful of PMM which were not updated in accordance to its adopted project management practices. Amongst the 15 PMM investigated in this category, it was found that only two academic institutions (U11 and U15) have near complete coverage of all the identified elements.

Table 1

Comparison between academic institutions' PMM

Comparison elements	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**U7**	**U8**	**U9**	**U10**	**U11**	**U12**	**U13**	**U14**	**U15**
Project phases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Project types	IT	IT		IT	IT	IT		IT		IT	IT		IS		IT
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables		✓	✓	✓	✓		✓	✓			✓				✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
Checklists	✓			✓						✓	✓	✓			✓
Hints and tips									✓					✓	
Terms & definition		✓	✓			✓	✓				✓	✓	✓	✓	
Frequent update	✓		✓	✓			✓								
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓

Table 2

Comparison elements (U – university)

Comparison elements	**Country**	**PM practices**
U1	Australia	PMBOK
U2	Australia	Thomsett Organization 3rd wave PM
U3	Australia	
U4	Australia	PMBOK
U5	US	
U6	UK	PRINCE2
U7	Australia	PMBOK
U8	US	PMBOK
U9	US	IPS
U10	US	
U11	US	PMBOK
U12	UK	APMBOK
U13	UK	PRINCE
U14	US	MSF
U15	US	Knapp & Moore

Industry Project Management Methodologies

The following organization specific customized methodologies reviewed in this category were all applied by well-established industry organizations (Tables 3 & 4). Analysis indicated that the majority of organizations developed the PMM for use in managing IT related projects as was the case for those methodologies applied in the academic institutions. Many of the PMM were designed internally by the organization's information service departments. The PMM were commonly considered to be mandatory guides that had to be followed when managing IT projects. These findings are apparently similar in academic institutions and government linked organizations perhaps due to the influences of project management in the IT sector (Betts & Lansley 1995, Crawford et al 2006, Themistocleous & Wearne 2000).

A review of these PMM found that some methodologies lacked the elements identified as essential to the management of projects. The most common missing elements included templates, checklists, hints and definitions. Furthermore, there are also questions raised of the PMM version, some had not been recently updated to integrate current best practice. Among all the PMMs, only one industry player (I10) adopted the PROPS approach that has been popularized for managing product development projects by Ericsson (Mulder 1997). Another industry player (I5) developed their PMM based upon the IBM RUP model which focused on agile methods. On the whole many industry players seem more comfortable with the adoption of PMI PMBOK, the industries de facto standard, when they designed their own PMM.

Table 3

Comparison between industrial PMM (I – industrial)

Comparison elements	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
Project phases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project types	All	All	All		IT	IT	IS	All	IS	All	All
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables		✓	✓	✓		✓	✓	✓	✓	✓	✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓	✓			✓	✓				✓	✓
Checklists	✓		✓					✓		✓	
Hints and tips									✓		
Terms & definition	✓	✓				✓		✓		✓	✓
Frequent update		✓						✓	✓		✓
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 4

Comparison elements (I – industrial)

Comparison elements	Country	PM practices
I1	US	PMBOK
I2	US	
I3	US	PMBOK
I4		
I5	US	IBM RUP
I6	US	PMBOK
I7	US	
I8	US	PMBOK
I9	US	PMBOK
I10	Sweden	PROPS
I11	US	PMBOK

Governmental Project Management Methodologies

In reviewing PMM designed for implementation within the government sector it was found that the majority were designed in alignment with PMI PMBOK (Tables 5 & 6). Almost all of the PMM established could be applied to all types of projects inclusive of IT projects. Similarly, most methodologies consisted of unique project phases and processes. Each of the reviewed PMM was largely complete with appropriate activities, deliverables, tools, suggestions and techniques for project manager's guidance. The majority of the PMM in this category were well structured, organized and presented in a comprehensive guidebook.

Although these PMM were comprehensive, the lack of templates and necessary hints and tips to assist the project manager limit the value of these methodologies. This was also a concern identified from reviewing the academic and industry PMM. Another matter of concern was whether the PMM adopted were updated on a regular basis, it was common that the version of the PMI PMBOK guide (or similar) used to build the methodology was not cited. On the outlook, each PMM were uniquely established in different countries, standardized and regulated by an independent project management unit to guide, monitor, control and regulate the use of PMM in an organization.

Table 5

Comparison between governments' PMM (G – government)

Comparison elements	G1	G2	G3	G4	G5	G6	G7	G8
Project phases	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓
Project types	All	All	ITS		IT	All	All	All
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables			✓	✓	✓	✓	✓	✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓	✓		✓		✓	✓	✓
Checklists	✓	✓	✓	✓	✓			
Hints and tips					✓	✓		
Terms & definition	✓	✓				✓	✓	✓
Frequent update			✓				✓	✓
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓

Table 6

Comparison elements (G – government)

Comparison elements	Country	PM practices
G1	US	PMBOK
G2	US	PMBOK
G3	US	
G4	Canada	PMBOK
G5	Australia	
G6	US	
G7	US	PMBOK
G8	Australia	PMBOK

Components of a Project Management Methodology

Globally there are over half a million published standards (Bredillet 2003, Garcia 2005), termed L1 methodologies in this work, which are recognized as guides to best practices and standards (Figure 1) (Chin & Spowage 2010). Analysis of the PMMs reviewed indicated that the most popular L1 best practice used to build the L3 organization specific customized methodologies was the PMI PMBOK followed by PRINCE2; while others L3 methodologies were based on APMBOK and PROPS.

It was evident that the use of project processes varies across organizations. Although the majority of processes integrated into a PMM are based upon the PMBOK guide, organizations recognize the importance of being unique in the market. Therefore it is common place to customize PMM process groups to suit their organization's practice. For example, Table 7 shows a list of the varied project management process group terms used across the three organizations

sector specific PMM. We found that the highest and most frequently used process groups in PMM were initiation, planning and closing processes.

Table 7

Process group occurrences across organization sectors

Process group	**Number of occurrences**
Initiation/definition	20
Planning	25
Executing/do it	16
Controlling/monitoring/track/manage	18
Closing/closeout/exit/finalise/completion/closedown/conclusion/finalise	25

Based on the review, only a few organizations integrate technology elements into their customized PMM. For example, U5 is outstanding in this regard as it embeds technical applications such as analysis tool, mathematical analysis, simulation, project management software, project management information system (PMIS), change control systems and a project tracking database into the methodology. In addition, with an increasing demand and accessibility of the information highway many organizations have set up a web based PMM for ease of use, especially when they are in a distributed project organizational environment. This popular technology tool was practiced by U11, U12, U15, G5 and I11.

Another component common to the majority of PMM examined was the various types of tools, techniques and templates embedded in the methodology. Table 8 shows the toolkits and templates utilized in the different process groups in all three organizational sectors reviewed. Across the PMM the project proposal was one of the most frequently used toolkits, and commonly placed in the initiation process. In the planning process, risk plans, communication plans and work breakdown structures were the three toolkits most frequently used in the majority of the PMM examined. In the execution and controlling process, change request plans seem to be a favorable toolkit. In the closing processes only a few organizations utilized the lesson learned reports and end project reports to finalize the end of the project.

Table 8

Usage of PMM toolkit and templates by organization sectors

Process group	PMM toolkit and templates	Number of occurrences
Initiation	Project proposal	5
	Project initiation document	3
	Kickoff meeting	3
Planning	Work breakdown structure	12
	Responsibility assignment matrix	3
	Scheduling	7
	Resource plan	7
	Budgetary plan	7
	Risk plan	19
	Risk log	8
	Stakeholder analysis	6
	Communication plan	18
	Quality plan	10
Execution & controlling	Change request plan	10
	Change request log	9
Closing	Lesson learned report	6
	End project report	7
	Acceptance signoff	5

Summary

The objective of this paper was to compare and discuss specific customized PMM across three sectors to elicit a common set of requirements. Although the organization specific PMMs reviewed differ; many have some commonality in terms of its processes, procedures, tools and deliverables. In concluding this study, these commonalities have been compiled and combined with the literature investigations and earlier studies (Chin & Spowage 2008a, 2008b) and the reviewed PMM discussed above:

1. It should facilitate the identification and management of risks and opportunities.
2. It should facilitate the clarification of goals and the scope of the project by incorporating the best practices of all project management group processes (Kroll & Royce 2005, MSF 2002), tools, techniques (Bolles 2002, Charvat 2003, Murch 2001) and templates to effectively plan and manage research projects.
3. It should create a project board to oversee, monitor and assess the research project progression.
4. It should be scalable and adaptable to project sizes; where it should be specific to the organization but customizable to individual projects (Charvat 2003, Chemma & Shahid 2005, Cockburn 2000a, MSF 2002).
5. It should leverage on the best practices of the specific environment/discipline to minimize obstacles and failure rate.
6. It must be in place to promote organizational learning (MSF 2002).
7. It should be based upon organization, governmental and sector specific standards and regulations (Charvat 2003, Josler & Burger 2005, Pitagorsky 2003, Turbit 2005, Wideman 2006).

8. It should model the work flow of typical project (Bolles 2002, Charvat 2003, Murch 2001, Turbit 2005).

References

APM. (2000). *APM Project management body of knowledge*: The Association of Project Management (APM).

Betts, M. & Lansley, P. (1995). International Journal of Project Management: a review of the first ten years. *International Journal of Project Management,, 13*(4), 207-217.

Bolles, D. (2002). *Building project management centers of excellence*. Saranac Lake, NY USA: AMACOM.

Bredillet, C. N. (2003). Genesis and role of standards: theoretical foundations and socio economical model for the construction and use of standards. *International Journal of Project Management, 21*, 463-470.

Charvat, J. (2003). *Project management methodologies: selecting, implementing and supporting methodologies and processes for projects*: John Wiley & Sons.

Chemma, A. & Shahid, A. A. (2005). *Customizing project management methodology.* Paper presented at the 9th International Multitopic Conference.

Chin, C. M. M., & Spowage, A. C. (2008a). *Project management methodology requirements for use in undergraduate engineering research projects.* Paper presented at the 4th IEEE International Conference on Management of Innovation & Technology, Bangkok, Thailand.

Chin, C. M. M. & Spowage, A. C. (2008b). *A Project Methodology for Managing University - Industry Innovative R&D Collaborative Project.* Paper presented at the ISPIM Innovation Symposium - Managing Innovation in a Connected World, Singapore.

Chin, C. M. M. & Spowage, A. C. (2010). Defining & classifying project management methodologies. *PM World Today, XII (V).*

Cockburn, A. (2000a). Just in time methodology construction, *Human & Technology Technical Report*.

Cornell, U. o. (n.d.). *Cornell Project Management Methodology*. URL http://projectmanagement.cornell.edu/ (visited 2008, March 24).

Crawford, L., Hobbs, B., Turner, J. R. (2006). Aligning capability with strategy: categorizing projects to do the right projects and to do them right. *Project Management Journal, 37*(2), 38-50.

Delisle, C. L. & Olson, D. (2004). Would the real project management language please stand up? *International Journal of Project Management, 22*, 327-337.

Eskerod, P. & Riis, E. (2009). Project management models as value creators. *Project Management Journal, 40*(1), 4 - 18.

Garcia, S. (2005). How standards enable adoption of project management practice. *IEEE Software* (September/October).

Gist, P. & Langley, D. (2007). Application of standard project management tools to research a case study from a multi-national clinical trial. *Journal of Research Administration*.

Goff, S. (2007). What is a PM methodology? A search for efficiency, consistency and performance. *asapm Online Magazine*.

Johnston, C. & Wierschem, D. (2005). The role of project management in university computing resource department. *International Journal of Project Management, 23*, 640-649.

Josler, C. & Burger, J. (2005). Project management methodology in HRM. *Cupa HR Journal, 56*(2), 25-30.

Kroll, P. & Royce, W. (2005). *Key principles for business driven development*. URL http://www-128.ibm.com/developerworks/rational/library/oct05/kroll/ (visited 2008, March 31).

Milosevic, D. & Patanakul, P. (2005). Standardized project management may increase development project success. *International Journal of Project Management, 23*, 181-192.

MSF. (2002). *MSF project management discipline*.

Mulder, L. (1997). The importance of a common project management method in the corporate environment. *R&D Management, 27*(3).

Munns, A. K. & Bjermi, B. F. (1996). The role of project management in achieving project success. *International Journal of Project Management, 14*(2), 81-87.

Murch, R. (2001). *Project management best practices for IT professionals.* Prentice Hall.

Pitagorsky, G. (2003). *The business value of embracing a unified pm methodology*, from Allpm.com

PMI. (2008). *A guide to the Project Management Body of Knowledge - 4th Edition*: Project Management Institute.

PRINCE2. (2005). *Managing successful projects with PRINCE2* (Fourth ed.). London: TSO.

Spowage, A. C. & Chin, C. M. M. (2009). Application of an appropriate project management methodology: the only way to manage your project effectively, *Effective Project Management Conference, The Asia Business Forum*. Kuala Lumpur: The Asia Business Forum.

Tasmanian Government. (2006). *Tasmanian government project management guidelines*.

Themistocleous, G. & Wearne, S. H. (2000). Project management topic coverage in journals. *Int. J. Project Management*, *8*, 7-11.

Turbit, N. (2005). Project management & software development methodology, *The PROJECT PERFECT White Paper Collection*.

University Michigan. (2005). *Project management methodology*. URL http://www.mais.umich.edu/projects/proj_management_meth.html (visited 2008, March 31).

University of South Carolina. (2007). *Project management methodology*. URL http://uts.sc.edu/csprojects/principles.shtml (visited 2008, January 10).

University of Sydney. (2008). *Project management methodology*. URL http://www.usyd.edu.au/ict/PMO/pmo/pmm.shtml (visited 2008, March 31).

University of Tasmania. (n.d.). *Project management guidelines* (Project Management Guidelines): Tasmania Government

Wideman, M. (2006). *Project management methodologies*. URL http://www.maxwideman.com/issacons/iac1013a/index.htm (visited 2008, January 24).

Construction Industry Indicators Affecting Contractors

Hendrik J. Marx (University of the Free State), (PhD)
Department of Quantity Surveying and Construction Management
Bloemfontein, Free State, South Africa

Annual monitoring of the condition of the South African construction industry is vital to enable government and other role players to evaluate the impact of current interventions to timeously and pro-actively implement revised legislation, strategies and development programs to form an updated roadmap for the future well-being and growth of the industry. This monitoring of the construction industry is done annually by the Construction Industry Development Board (cidb) by utilizing construction industry indicators. A database with contact particulars of employers, contractors and agents involved in 3441 projects completed in 2008 was compiled. Three separate survey forms were faxed or e-mailed to the contractors, employers and agents of these projects. Their responses were captured in a Microsoft Access database. The scope of this report is limited to the results received from the contractors. The main findings were that the projects of small up-coming contractors were just as profitable as those of the larger well-established contractors. Only 42% of all contractors were paid on time. The national departments were the worst performers with regard to timeous payment of contractors. This research contributes to the understanding of the construction industry and highlights existing problems to solve on the way forward. Government can make use of the results obtained to timeously and pro-actively implement revised legislation, strategies and development programs to ensure the well-being and growth of the industry.

Keywords: Construction industry indicators, cii, key performance, kpi.

Introduction

The Construction Industry Development Board (cidb) Act (Republic of South Africa 2000) was passed in 2000 to establish a statutory body aimed at driving an integrated construction industry development strategy. This body was necessary as the construction industry plays an indispensable role in the South African economy by providing the physical infrastructure which is fundamental to the country's development. The construction industry operates in a uniquely project-specific and complex environment, combining different investors, clients, contractual arrangements and consulting professions. It impacts directly on communities and the South African public at large, and its improved efficiency and effectiveness will enhance quality, productivity, health, safety, environmental outcomes and value for money. In terms of this act, the cidb 'may develop target and performance indicators related to best practice standards and guidelines and establish mechanisms to monitor their implementation and evaluate their impact'.

Construction Industry Indicators (CIIs) have been developed by the Department of Public Works and the cidb with the assistance of the CSIR (van Huyssteen et al., n.d.) to play a useful role in developing a sustainable industry and to be adopted as a tool for improving performance in the South African construction industry. The CIIs of the cidb rely heavily on international experience and particularly those indicators adopted in the United Kingdom. In the United Kingdom the first Key Performance Indicators (KPIs) were published in 1999 in response to the Rethinking Construction report by Egan (1998). These KPIs had three objectives, namely:

- To provide companies and projects with a simple method of establishing a performance measurement system;
- To provide organisations with a straightforward method of benchmarking their performance against others in the construction industry; and
- To track long term trends in performance, and specifically, to demonstrate whether the construction industry was achieving the targets set out in Rethinking Construction. (Rethinking Standards in Construction 2006)

Cost, time and quality are the three basic and most important performance indicators in construction projects followed by others such as safety, functionality and satisfaction (Chan and Ada 2004). Based on the Egan report the Movement for Innovation and Construction Best Practice Programme (CBPP) was formed and is now recognised as a leading organisation involved in the production of KPIs within the industry (Beatham et al., 2004). The KPIs launched by the CBPP are: client satisfaction, product and service, profitability, productivity, defects, safety, construction time and construction cost. These KPIs were benchmarked within the construction industry and have been very successful in introducing many companies to the subject of performance measurement (Beatham et al., 2004).

The cidb CIIs measure the performance of the South African construction industry by measuring employer satisfaction with the project milestone dates achieved, construction costs versus tender amount, contractors' performance, agents' (consultants') performance, and the quality of materials used. The contractors' satisfaction is measured by their profitability, the quality of the contract documentation, the efficiency, openness and transparency of the contract adjudication process, the management of variation orders and claims, payment delays and the performance of their materials suppliers. The procurement indicators measured are obtained from the agents involved and include contractor performance issues utilised in the adjudication of tenders, the type of procurement procedure used, and the contracting strategy adopted.

The cidb CIIs described above have been captured since 2003, and are currently being captured in partnership with the Department of Quantity Surveying and Construction Management of the University of the Free State. This report is part of a series of annual papers (Marx 2008, 2009) presenting the results of this continuous survey project. It is a report on the results of the 2009 survey for projects completed in 2008.

Methodology

A database, with contact particulars of employers, contractors and agents involved in 3441 projects completed in 2008, was compiled. Three separate survey forms were faxed or e-mailed to the contractors, employers and agents of these projects. Their responses were captured in a Microsoft Access database. The average perspectives of the respondents were determined for different project types, employer categories and provinces. All questionnaires made used of the scale to measure satisfaction levels as shown in Table 1.

Table 1

Definition of the % satisfaction levels

Dissatisfied			**Neither Satisfied nor Dissatisfied**				**Satisfied**		
10	20	30	40	50	60	70	80	90	100

Scope

The CIIs of the cidb need to evolve from the lessons learned from previous surveys, and are therefore subject to change and refinement. Furthermore, the CIIs used were only mainline indicators. Questions were not asked to pin-point the exact reasons for all problems experienced.

From the 3441 completed projects in the database, the contact particulars of 3428 contractors, 3252 employers and 2430 agents were available. Survey forms were received back from 1169 contractors, 332 employers and 602 agents reflecting response rates of 34%, 10% and 25% respectively. This report is limited to the results obtained from the contractor survey forms.

Discussion of the Survey Results

Project Type and Employer Category Distribution of Responses Received

Table 2 gives a distribution of the 1169 survey forms received from contractors for projects completed in 2008. The number and percentage of survey forms completed are indicated for different employer categories and project types.

Table 2

Contractor survey responses received for different project types and employer categories (2008)

Project Type	**% / No.**	36,0	17,7	5,7	16,5	8,9	10,4	2,5	2,3	**% of Total Survey Results**
Residential Building	75	46	6	8	9	3	2	1	-	6,4
Non-residential Building	261	130	29	19	49	8	15	11	-	22,3
Civil Works	400	105	65	21	79	53	70	5	2	34,2
Mechanical Works	82	26	8	10	20	10	6	2	-	7,0
Electrical Works	231	74	70	6	21	21	15	1	23	19,8
Special Works	118	40	29	3	15	9	13	9	-	10,1
Not specified	2	-	-	-	-	-	-	-	2	0,2
Total No. of projects	**1169**	421	207	67	193	104	121	29	27	
		Private sector	Public Corporation e.g. ESKOM, ACSA	National Department	Provincial Department	Metropolitan Council	Regional / District Council	Public Private Partnership	Not specified	
		Employer Category								

The majority of responses received came from civil works projects (34,2%), non-residential building projects (22,3%) and electrical works projects (19,8%). The results in this report are presented per project type and per client category to ensure that the results for other types of projects do not disappear in the average of all projects.

Projects of the private sector (36%), public corporations (17,7%) and provincial departments (16,5%) were best represented in the survey. The responses received were well distributed between the different project types as well as between the employer categories. The number of responses received in each category should always be considered when evaluating the results.

Contractor Financial Grade Distribution of Responses Received

The contractors are registered with the cidb in different financial grades, indicating their financial capability to complete projects of certain maximum values. The grading is as follows: Grade 1 to 9 correspond with project values of R0,2 million; R0,65 million; R2 million; R4 million; R6,5 million; R13 million; R40 million; R130 million and no limit respectively. Table 3

shows the distribution of the 1169 survey forms received from different financially graded contractors in terms of project types.
Table 3

Contractor survey responses received per project type and contractor financial grading (2008)

Project Type	**No.** / **%**	1,3%	12,7 %	7,8%	12,6 %	18,1 %	14,5 %	12,6 %	5,5%	6,4%	8,5%
Residential Building	75	3	6	5	13	8	10	10	2	5	13
Non-residential Building	261	3	26	18	38	59	33	25	8	19	32
Civil Works	400	3	42	37	31	32	87	70	42	34	22
Mechanical Works	82	2	11	6	7	24	8	19	-	1	4
Electrical Works	231	3	47	10	52	42	24	16	12	8	17
Special Works	118	1	17	15	6	47	6	7	-	8	11
Not Specified	**2**	-	-	-	-	-	1	-	-	-	1
Total No. of Projects	**1169**	15	149	91	147	212	169	147	64	75	100
		1	2	3	4	5	6	7	8	9	Not specified
		Contractor Financial Grade									

Grade 1 (up-coming, small) contractors were not targeted in this survey due to the fact that most of them do not possess a facsimile machine or have an e-mail address. Therefore, only 1,3% of the responses received came from Grade 1 contractors. A well distributed response was received, with the largest response from Grade 5 (18,1%) and Grade 6 (14,5%) contractors.

Contractor Survey Response Distribution per Province

It was also important to determine if the responses received were not dominated by those economic regions in the country with the highest construction activities. Table 4 shows the distribution of contractor survey responses received per province. The percentage of responses received for projects completed in each province are indicated. This was compared with the percentage of cement sales in each province. The cement sales can be considered to be one of the indicators of construction activity in a province. Figure 1 shows the correlation between cement sales and the survey responses received, and indicates that the survey results received were not dominated by any one province. Certain results of this survey are expressed per province to ensure that the situations in less economically active provinces are correctly reflected and do not disappear in the average response received.

Table 4

Construction survey responses received per project type and province (2008)

Project Type	**No.** \ **%**	0,4	4,8	22,5	21,4	6,9	7,8	4,7	2,7	18,1	10,7
Residential Building	75	-	7	6	17	3	8	4	1	21	8
Non-residential Building	261	-	11	47	103	2	7	3	4	37	47
Civil Works	400	2	20	97	53	31	28	19	13	87	50
Mechanical Works	82	-	2	16	11	3	19	6	8	12	5
Electrical Works	231	-	10	53	61	31	16	14	3	36	7
Special Works	118	1	6	44	5	11	13	9	3	18	8
Not specified	2	2	-	-	-	-	-	-	-	-	-
Total No. of projects	**1169**	5	56	263	250	81	91	55	32	211	125
		Not specified	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape	Eastern Cape
		Province									

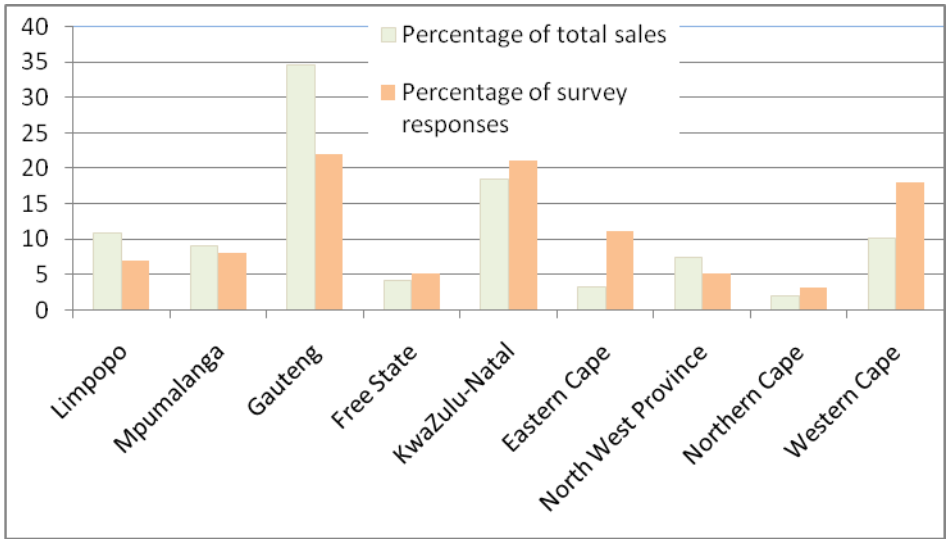

Figure 1: Correlation between contractor survey responses received and cement sales per province (Cement and Concrete Institute)

Contractor Profitability for Different Project Types

Table 5 indicates the distribution of contractor profitability for different project types and shows that for 4% of all the projects completed the contractors made a loss.

The project types, with the highest percentage of projects with profitability of more than 10%, were special work (52%) and mechanical work projects (51%).

If the percentage of projects completed with 6-10% and more than 10% profit are combined for each project type, the results show that the residential building and non-residential building projects were much less profitable than all other project types. This may be due to the complexity of building projects and the large number of parties involved.

Table 5 shows that only 31% of all contractors made a profit of more than 10%. This implies that the contract price adjustment provisions, used to compensate contractors for rising costs, were not sufficient, as fifteen percent of the value of the work completed was excluded from escalation. This 15% is considered to be profit and other costs that should not escalate.

Table 6 shows the profitability of contractors per financial grade. It is interesting to note that the group of Grade 2 contractors, who are up-coming, small, and less experienced, made a loss on only 6% of their projects which is the same percentage as the performance for Grade 7 contractors (6%) and better than the performance of Grade 8 contractors (9%). Furthermore, the up-coming Grade 2 contractors made a good profit of more than 10% on 40% of all their projects which is better than the performance of any higher financially graded group of contractors.

Table 5

Profitability of projects for different project types (2008)

Profitability	**% of Projects in each Project Type**						**% of all Projects**
Loss	4	5	4	3	5	-	4
0 – 5%	32	29	20	23	20	14	22
6 – 10%	44	51	45	23	40	34	43
> 10%	20	15	31	51	35	52	31
	Residential Building	Non-residential Building	Civil Work	Mechanical Work	Electrical Work	Special Work	

Table 6

Profitability of contractors per financial grade (2008)

Profitability	**% of Projects in each financial grade**							
Loss	6	1	3	2	3	6	9	4
0 - 5%	30	17	25	16	21	25	21	25
6 - 10%	24	59	38	47	48	42	38	35
> 10%	40	23	34	35	28	27	32	36
	2	3	4	5	6	7	8	9
	Contractor financial grade							

There is thus no relationship between profit and the financial grade of a contractor. There should be more emphasis on developing good small contractors, not only to achieve a larger financial grade, as small contractors can make just as good a profit as their larger and higher graded counterparts.

Performance of the Employer and the Employer's Agents

The contractors' satisfaction with the employer and agents (consultants) was tested with regard to overall performance, the quality of the tender documents and specifications, efficiency, openness and transparency of the contract procurement / adjudication processes followed, and the management of variation orders and claims. Table 7 shows the results obtained. The best overall employer categories were public corporations and public private partnerships with an average satisfaction level of 83% followed by provincial departments with 82%. The worst overall performance was achieved by the private sector and regional / district councils, with a satisfaction level of 79%. Bearing in mind that a score of 80% means satisfied, then the lowest score achieved is of no concern.

The average overall performance of the agents, in the eyes of the contractors, was slightly lower than the performance of the employers. The contractors were satisfied with the quality of the documentation and specifications, but the private sector and national departments received a slightly lower score of 78%, and regional / district councils the lowest score of 77%. The contractors were satisfied with the procurement / adjudication of the tenders.

The contractors' satisfaction levels were definitely lower for the management of variation orders (VO's) and claims. The national departments received the lowest scores of 73% for VO's and 71% for claims.

Table 7

Contractors' level of satisfaction with the employer's and agent's performance (2008)

	Satisfaction level %						
Employer Overall	79	83	80	82	80	79	83
Agent Overall	77	81	79	78	79	77	81
Documentation / Specifications	78	81	78	81	81	77	82
Procurement / Adjudication	82	82	83	83	83	81	83
Management of VO's	76	80	73	77	80	76	80
Management of claims	75	79	71	75	78	76	80
	Private Sector	Public Corporation	National Department	Provincial Department	Metropolitan Council	Regional / District Council	Public Private Partnership

To determine whether the contractors' financial grade played any role in the evaluation of the performance of the employer bodies and agents, Table 8 was created. It is interesting to note that

the higher grade contractors (7 to 9) were less satisfied than the Grade 2 to 6 contractors. The reason may be that the higher grade contractors are more sophisticated and expect more from their employers and their agents.

Table 8

Contractors' level of satisfaction with the employer's and agent's performance per financial grade (2008)

	Satisfaction level per contractor financial grade %							
Employer Overall	85	86	83	80	82	77	74	76
Agent Overall	83	83	82	80	82	75	68	67
Documentation / Specifications	86	86	81	80	84	77	71	70
Procurement / Adjudication	85	87	83	81	85	79	78	77
Management of VO's	89	80	80	77	82	73	66	68
Management of claims	80	80	78	78	80	70	68	68
	2	3	4	5	6	7	8	9
	Contractor financial grade							

Table 9 shows the contractors' levels of satisfaction with the employer bodies in different provinces. The number in brackets indicates the number of responses on which the average satisfaction level was based. The reliability of the data is lower for those employer bodies in provinces where only a few responses were received.

The contractors in the North West province were least satisfied with their metropolitan councils which received an average score of only 57%. This figure is based on responses received from three projects. Public corporations received the lowest scores in Limpopo (74%) and in the Northern Cape (73%). Gauteng Province was the national department with the least performance of 72%. The least performing provincial department was also Gauteng, with a score of 71%. The best performing national department was the Western Cape (90%), if the 100% score of the Northern Cape which is based on only one survey result, is ignored. The regional / district councils that received the lowest score of 73% were KwaZulu-Natal and the Northern Cape.

Table 9

Contractors' level of satisfaction with the employer's overall performance per province (2008)

Employer Category	**Satisfaction Level %**								
Private Sector	88 (13)	78 (101)	77 (115)	85 (18)	85 (16)	83 (19)	77 (13)	78 (81)	78 (41)
Public Corporation	81 (9)	83 (66)	87 (33)	74 (13)	85 (32)	83 (10)	73 (6)	82 (23)	86 (14)
National Department	87 (3)	72 (13)	86 (12)	76 (5)	75 (6)	75 (8)	100 (1)	90 (8)	82 (11)
Provincial Department	88 (17)	71 (24)	84 (36)	76 (25)	89 (20)	95 (4)	85 (2)	84 (38)	77(27)
Metropolitan Council	80 (4)	83 (4)	85 (15)	90 (6)	75 (2)	57 (3)	70 (2)	76 (23)	80 (9)
Regional / District Council	80 (10)	79 (15)	73 (10)	93 (8)	79 (11)	77 (11)	73 (8)	83 (29)	75 (19)
Public Private Partnership	-	85 (4)	76 (5)	83 (6)	85 (4)	-	-	85 (6)	80 (3)
The value in brackets is the number of projects involved	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape	Eastern Cape
	Province								

Payment Delays

The average number of days delay between certification and receipt of contractor payment of interim and final certificates is shown in Table 10.

With regard to early payment the national departments were the worst, with payments made within 30 days on only 37% of their projects. The best performing client categories with 62% and 54% of project payments made within a month were public private partnerships and metropolitan councils respectively. The different contract documents used for projects had different requirements regarding timeous payment of certificates, but payment within a month was considered to be reasonable. It is of great concern that only 42% of all contractors were paid on time (< 30 days). The worst performing employers were the national and provincial departments who paid 23% of their contractors only after three or more months.

Table 10

Days delay between certification and payment (2008)

Avg. Days Delay	**% of Projects in each Employer Category**							**% of all Projects**
≤ 14	9	3	10	8	5	7	24	8
14 to 30	29	38	27	31	49	40	38	34
30+ to 60	45	39	31	27	34	44	21	38
60+ to 90	12	14	9	11	5	4	7	10
90+ to 120	3	1	12	13	2	5	7	5
120+	2	5	11	10	5	-	3	5
	Private Sector	Public Corporation	National Department	Provincial Department	Metropolitan Council	Regional / District Council	Public Private Partnership	

Contractors refrain from standing up to their contractual right to be paid on time for fear of losing job opportunities in the future. This creates major cash flow problems for contractors and the cidb should communicate this with client bodies.

These payment results are also shown in Table 11 as timeous payment (< 30 days) by the employer bodies in different provinces. The results are disturbing as many employer bodies in various provinces pay only 0 to 20% of their contractors on time.

Table 11

Timeous payment (<30 days) of contractors per province and by employer categories (2008)

Employer Category	**% of Projects where contractor is paid within 30 days**								
Private Sector	31 (13)	29 (101)	33 (115)	44 (18)	50 (16)	32 (19)	31 (13)	58 (83)	37 (41)
Public Corporation	33 (9)	42 (65)	58 (33)	15 (13)	41 (32)	80 (10)	0 (6)	26 (23)	50 (14)
National Department	0 (3)	62 (13)	58 (12)	20 (5)	0 (6)	13 (8)	100 (1)	50 (8)	27 (11)
Provincial Department	18 (17)	17 (24)	17 (36)	57 (23)	0 (20)	50 (4)	0 (2)	58 (38)	35 (26)
Metropolitan Council	75(4)	63 (40)	53 (15)	100 (6)	50 (2)	0 (3)	0 (2)	39 (23)	44 (9)
Regional / District Council	40 (10)	60 (15)	10 (10)	63 (8)	45 (11)	9 (11)	0 (8)	59 (29)	70 (19)
Public Private Partnership	-	50 (4)	80 (5)	67 (6)	25 (4)	-	-	83 (6)	33 (3)

The value in brackets is the number of projects involved	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape	Eastern Cape
	Province								

Performance of Materials Suppliers

Contractors were requested to indicate their overall satisfaction level with their materials suppliers, the ability of the suppliers to keep to their quoted / agreed upon delivery schedules and whether the materials delivered on site complied with the specifications. The results are indicated in Table 12.

Only the materials suppliers of building projects received an overall performance score of slightly less than 80% (satisfied). The problem was their capability to stick to the agreed upon delivery schedules (77% to 78%) and not with the quality of the materials delivered, as the scores received for materials delivered as per specification were above 80%.

The materials suppliers' data was also evaluated in terms of the contractors' financial grade as indicated in Table 13. There is a tendency for the higher financially graded contractors (7 to 9) to be less satisfied with their materials suppliers' performance. Table 13 shows that the problem experienced was not with the quality (specification) of the materials, but with the delivery capability of the suppliers. Their projects were larger and it is likely that suppliers could not keep up with the larger orders placed. Table 14 shows the materials suppliers overall performance per province. The Western Cape is the province with the lowest score of 74%.

Table 12

Materials suppliers' performance (2008)

Contractors' Level of Satisfaction % with the Materials Suppliers for each Project Type						
Overall Performance	78	79	81	81	83	85
Keep to agreed upon Delivery Schedule	77	78	80	80	81	84
Material delivered as per Specification	81	82	85	85	86	88
	Residential Building	Non-residential Building	Civil work	Mechanical Work	Electrical Work	Special Work

Table 13

Materials suppliers' performance (2008)

Contractors' Level of Satisfaction % with the Materials Suppliers per contractor financial grade								
Overall Performance	87	85	81	82	82	77	76	76
Keep to agreed upon Delivery Schedule	87	86	79	81	81	75	73	71
Material delivered as per Specification	90	88	85	86	85	80	81	78
	2	3	4	5	6	7	8	9
	Contractor financial grade							

Table 14

Contractors' level of satisfaction with overall performance of materials suppliers per province (2008)

81	78	81	83	81	83	83	74	80
Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape	Eastern Cape
Province								

Conclusions

The main findings of the 2009 survey of contractors' opinions for projects completed in 2008 were as follows:

1) Contractors made a loss on 4% of all projects completed.
2) Mechanical work (51%) and special work projects (52%) showed the highest percentage of projects with contractor profit of > 10%.
3) There was no relationship between profit and the financial grade of contractors, as up-coming small contractors made just as good a profit as the higher graded contractors.
4) The overall performance of the majority of employer bodies was satisfactory (≥80%) but the agents received a slightly lower score.
5) The higher financially graded (7 - 9) contractors were less satisfied with the performance of their employers and agents.
6) Contractors were satisfied (≥80%) with the procurement / adjudication procedures followed, but the quality of the documentation / specifications received a slightly lower score.
7) The national departments received the lowest score for the management of variation orders (73%) and claims (71%).
8) Only 42% of all contractors were paid on time, within 30 days, with the national and provincial departments being the worst performers.
9) Contractors gave materials delivery for building projects the lowest score.
10) Higher financially graded contractors (7 - 9) were less satisfied with the delivery capabilities of their materials suppliers.

References

Beatham, S, Anumba, C. and Thorpe, T. (2004). KPIs: a critical appraisal of their use in construction. *Benchmarking: An International Journal*, 11(1), 93-117.

Chan, A.P.C. and Ada, P.L. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal*, 11(2), 203-221.

Egan, J. (1998). *Rethinking Construction: The Report of the Construction Task Force.* Her London: Majesty's Stationery Ofc.

Marx, H.J. (2008). Contractors' perspective of the condition of the construction industry as captured by the CIDB survey of construction industry indicators 2007. *In: Conference proceedings of QS + 20/20 Vision Beyond 2010. Quantity Surveying Conference, Midrand, South Africa 10 October, CD ROM version.*

Marx, H.J. (2009). Consultants' and clients' perspectives on the construction industry as captured by the CIDB survey of construction industry indicators 2007. *In: Conference proceedings of The Fourth Built Environment Conference. Association of Schools of Construction of Southern Africa, Livingstone, Zambia, 17-19 May 2009, CD ROM version.*

Republic of South Africa. (2000). *The Construction Industry Development Board act, 38 of 2000, R*evised standard for uniformity in construction procurement. South Africa: Government Printer.

Rethinking Standards in Construction: can standards support industry performance improvement? (2006). Report of a strategic workshop to initiate a new approach to UK standardisation, May, 1-16.

The Construction Industry Development Board (CIDB). (2007). The cidb Construction Industry Indicators Summary Results. South Africa, Pretoria. URL http://www.cidb.org.za/documents/KnowledgeCentre/cii%20brochure%20with%20inlay.pdf (visited 2008, July 25).

Van Huyssteen, S., van Heerden, L., Perkins, P. and Gyimah, O. (n.d.). The *identification and measurement of performance indicators for the* South African construction industry. URL http://buildnet.csir.co.za/cdcproc/docs/3rd/vanhuyssteen%20_vanheerden.pdf (visited 2008, July 25).