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THE EFFECT OF THE UNIQUE CHARACTERISTICS OF THE CONSTRUCTION INDUSTRY ON INFORMATION MANAGEMENT IN CONSTRUCTION FIRMS

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ABSTRACT
This paper reports findings of a study, which was carried out to investigate the effect of the unique features of the construction industry (CI), on information management (IM). It begins with a background of the IM process and a literature review of how the unique features of the CI influence IM. It then reports findings of a study carried out on some 160 construction firms (CFs) in Botswana. The study concludes that the construction environment is unique and makes the IM process a challenging task and its inefficiency or ineffectiveness on many occasions hampers the performance of CFs.

KEYWORDS
Information Management, Construction Industry, Construction Firms

1. INTRODUCTION

Information is a major resource in any business activity, particularly in competitive markets. It is a powerful and valuable asset that must be sought, guarded and conserved by businesses. The power and advantage it possesses is achieved only if, it is well managed and utilised by organisations at both strategic and operational levels (Cashmore and Lyall, 1991). The ease with which information is managed depends on how a firm employs its information resources in terms of quality and quantity. The attitude of management is also important as it determines whether to invest or not in information systems. Equally important to information management (IM), is the nature and structure of the industry, for the two determine how information is captured, processed, stored, disseminated, and utilised in a business. Comparing, for example, the banking, retailing and manufacturing industries with the construction industry (CI), one may not fail to see the effect of the nature of the industry on IM. While the retail, banking and manufacturing sectors have revolutionised the way services are delivered, the nature and organisation of the CI may have acted as its own barrier. Comparatively, the manner in which business is operated in CI has not changed for over several decades, particularly in the way information is managed. Though, the CI has increasingly become more dynamic, being influenced by many factors, it has been dubbed as a non-innovative industry in many aspects (Porter, 1979, Langford *et al*, 1995 and Martin, 1999). Moreover, the reputation of the industry has also been brought in question, particularly, regarding the way projects are delivered and the frequent financial failures of construction firms (CFs). The industry is famous for delivering projects late, at a higher cost than budgeted and below the specified quality. There is a lot of literature relating to business failures, for example, Adrian (1986) estimated that 13% of the CFs fail annually in the USA. Another estimate puts CFs in Botswana top of the list of all business failures, yet they constitute only 6% of the registered businesses (Ssegawa, 2001). Other reports (Latham, 1994; Gyles *et al*, 1992) have made similar comments on the industry and have emphasised the need to eliminate customer dissatisfaction, misunderstandings and conflict between parties, illegal and unethical behaviour. The reports insist on increasing competitiveness, increasing the pace of decision-making and identifying suitable performance measures. Yet the contribution of the CI to socio-economic development of any nation cannot be over emphasised, for example, it accounts for an average of 6% of GDP and an average of 11% of the total employment in Botswana (Ssegawa, 1999). Other scholars have indicated other areas of contribution as being the provision of

infrastructure, property investment, import substitution, employment, housing and business office space (Yahya, 1997; Ruddock *et al*, 1996; Wells, 1985; Turin, 1973 and Lopes, 1998). Most often, its buoyancy is used as an indicator of economic growth of a nation and makes the industry the focus of attention for policy makers, economist, politicians and scholars (Seddon *et al*, 1982)..

While the construction industry may be castigated for frequent bankruptcy and poor delivery of services, the author wishes to look at what could be the cause of poor performance. The author believes, like others (Harris and MacCaffer, 1989; Smith, 1988; Ashworth, 1988, Hillebrandt, 1989; Adrian 1986; Lucas, 1984), that the construction industry has unique features that distinguish it from other sectors of the economy. However, he further believes that the unique environment complicates many operational issues of the business, particularly IM. Identifying and analysing the unique features of the CI and their impact on IM might pave way in creating a deeper understanding of the operational complexities of CFs. This view is supported by Smith (1998) who asserts that the 'features' of the construction industry combine and interact in a manner that makes the management functions of planning, forecasting, and controlling difficult in the industry.

It is against this background that a study was conducted to investigate the unique nature of the CI, how information is managed and the challenges encountered in managing operations of CFs. In particular, the study investigated the (a) effectiveness of co-ordination of effort and information within the CFs' employees and among the project stakeholders (designers, contractors; and sub-contractors); (b) planning capabilities of the CFs in realtionship with the uncertaininty found in the CI; (c) the effect of varying project locations on IM; and (d) attitude of managers and those involved in generating information on seriousness of IM. This paper, therefore, reports the outcome of the study by highlighting the process of IM and how the unique features of the CI influence IM. It then reports the findings of the study and ends with some recommendations.

2. BACKGROUND

2.1 IM

IM is a process of planning, organising, directing and controlling organisational information resources so as to support the achievement organisational objectives (Senn, 1990). As a result, IM has to produce quality information which is timely, relevant to the work situation, reliable, accurate and in the right format. The challenge therefore, is to devise an efficient and effective information infrastructure consisting of humanware, software, and hardware deployed within an organisation and its interface. The infrastructure should ensure that captured data is processed, stored and disseminated for utilisation in achieving organisational objectives. Cashmore and Lyall (1991) emphasises the purpose of IM as providing (a) strategic information, (b) operational information (c) shop floor information for controlling activities on a day-to-day basis and (e) collecting, processing and storing information, which can be used at a later stage, for example, during budgeting and tendering.

2.2 The CI and its Uniqueness

The scope of the CI may not easily be defined because of the permeable nature of its boundaries, particularly when vertical and horizontal integration are considered (Lavender, 1996). However, the CI can be described as an industry consisting of fragmented and independent legal entities and its product (building, road, dam, etc), in its life cycle, will most probably pass through different professions, who may include consultants and contractors, before it is delivered to the client.

Being part of the CI, CFs are engaged in activities, which include the construction of new structures, altering, extending, refurbishing, maintaining, repairing, and demolishing of structures (Smith, 1998). According to Barrie *et al* (1978), structures imply residential buildings (family homes, apartments, condominium, etc), commercial or social buildings (offices, churches, health, recreational and educational facilities, etc), heavy civil works (dams, tunnels, bridges, communication infrastructure, etc) and industrial complexes (oil ridges, refineries, mine developments, etc). CFs work in a unique environment, as perceived from a comparative point of view – a view based on the normal of way of doing business as compared to other sectors of the economy, for example, the manufacturing sector. The comparison begins with the planning, design, acquisition of inputs and production until delivery of output. Ssegawa (2001) compiled a list of characteristics unique to the CI based on the traditional procurement system (TPS), the most used system in many developing countries (Lavender, 1996). He identified the CI an industry (a) which is fragmented consisting of independent service providers; (b) where there are few clients

at any one time and who are most often ignorant of the construction process; (c) where work load fluctuates violently in booms and busts; (d) where it is difficult to forecast a firm's revenue; (e) which depends too much on borrowed funds; (f) where payment method is weird consisting of progress payments and paid in arrears; (g) where the risk is high and hence the need for sureties causing a further strain on cashflow; (h) where the method of getting work and price determination are very tricky; (i) where the method of recovering overheads (or mark-up) is unscientific; (j) where production is severely affected by the weather; (k) where each project is custom designed and made; and (l) where the production is always away from the head office. The next section examines the impact of some of the unique characteristics on IM.

3. THE CI, ITS UNIQUENESS THE EFFECT ON IM

3.1 Structure of the Industry

As already observed, the CI organised on a TPS is a fragmented industry made up of consultants, contractors and other allied trades. Fragmentation creates a myriad of complex relationships that frequently bring a lot of problems between the parties. First being, lack of co-ordination of effort and information flow among the stakeholders of the project, leading to disputes during and after construction.

Clients often engage consultants on project design who have neither site experience nor any link with sites to give them feedback information to improve their designs (Ogulana and Butt, 2000). As a result, contractors have difficulties during construction when designs do not relate to site conditions. When this happens, designs are normally changed during construction to suit site conditions or requirements, culminating in variations that cause delays and cost overruns. In some worst cases, projects commence without complete drawings or when there are errors in the drawings.

Sub-contracting is a normal feature in the CI because of the numerous trades needed on a construction project. A building project, for example, may need the services of masons, plumbers, carpenters, bricklayers and electricians and painters. Apart from increasing the level and cost of supervision for CF, more information is needed in form of standards and specification in order to control the work of these trades. Also, engaging sub-contractors requires extra effort in preparing programmes, which are practical and suitable to the overall project programme. Compilation and management of financial information is inherently increased by virtue of the multiplicity.

3.2 Inability to Forecast Demand and Workload

Strategic planning entails a business being able to forecast future demand of its services with some appreciable degree of accuracy. This helps in planning capacity in terms of funds, assets, labour and office space. Also, from a short-term point of view, a firm should be able to forecast achievable turnover for the following financial year. A good turnover forecast enables the firm to budget for its required cashflow and working capital. In the manufacturing sector firms have a fair knowledge of their market share and may estimate with some degree of certainty, the most probable turnover achievable for the following financial year The CI environment makes the compilation of information for both short and long-term planning quite elusive for a number of reasons.

The CI of developing countries have a limited number of clients consisting of mainly the government. Yet, most governments of developing nations finance their development budgets from revenue obtained from exports of primary commodities, whose prices are subject to the vagaries of the world markets. As a result, the level of development expenditure from which construction projects are procured depends on the revenues from exports. In addition, procurement decisions are also influenced by the macroeconomic environment, such as, the need to balance the budget, control inflation, increase level of employment or secure a healthy balance of payments. Therefore, forecasting demand based on the government's development need becomes difficult as two examples from Botswana illustrate. The period between 1987-1991 characterised an excessive development expenditure, which resulted in a construction boom. While the boom brought a period of increased demand and profit margins, it had side effects on CFs and the economy. It caused inflation and increased construction prices, inefficiency and overspending. CFs were overwhelmed with jobs, became over-stretched and the priority shifted to the need to expedite project deadlines. Construction operations became difficult to manage, information on scheduling and cost control became difficult to compile. However, the boom ended and the CI experienced a downturn around 1992. This was mainly a result of the government's reduced revenues from diamond sales due to a world recession. It suspended implementation of any new projects in the National Development Plan 8. The action caught many firms,

which had 'gained weight', unaware and saw a number of them, particularly citizen owned, run into financial trouble (Ssegawa, 1999). The bust implied reduced jobs and profit margins and by the end of the recession, financial obituaries had been written for many CFs!

3.3 Difficulty in Ascertaining Revenue Earned

Firms need to ascertain revenue generated from their operations in a financial year for a numbers of purposes. It affects the level of tax and dividends to be paid. However, the duration of most construction projects straddle across a firm's financial year. Despite several of methods that have been formulated to try match costs and revenues of the period, none gives a precise picture of the amount of revenue attributable at the time (Adrian, 1986). Although, one may argue this is an accounting problem, issues of capital maintenance seriously affect firms, particularly when entrepreneurs make arbitrary and erroneous decisions on dividends or even withdraws.

3.4 Weird Payment Method

Contractors are normally paid after they have produced some work, which has been valued and certified by an architect or engineer. This contrasts with other sectors of the economy where payment may be on delivery, in advance or arrears. For CFs, the period between completing the work and the money being credited to the contractor's bank account may vary between 1-8 months. Even though the payment period may be stipulated in the contract, what happens in practice is less desirable. Disputes over the value and quality of work, bureaucracy, particularly on government jobs, often causes payment delays. Delays result in uncertainty of cashflow, low profit margins, increased interest rates, damaged relationships with creditors, project time and cost overruns.

3.5 Difficulty in Pricing

The most common method of getting work in the CI is by tendering and this where the price of a project is set. Price determination is a key decision in profit making organisation because if an inappropriate price is set, whether too low or too high, it results in losses. The ease with at which an industry sets a price for its service, the better. As an example, in the fuel distribution sector, the government of Botswana sets the price for a litre of fuel and the distribution points work out and manage their costs per litre sold. The tendering process is a challenging environment, where once an inappropriate price is set and the tender is opened, there is no retraction of price, bargain and negotiation, the job is lost! Therefore, the difficulty lies in acquiring accurate information to set a competitive price by computing accurate costs, overheads and setting a competitive profit margin. Under absorption or over-absorption of overheads may lead to financial losses and loss of jobs, respectively. The complexity of setting an appropriate mark-up arises from what has already been mentioned, the inability to ascertain the value of workload (turnover) and match it with the overheads of the period.

3.6 Custom Designed and Built Product

In manufacturing concerns, products have a fair deal of homogeneity, allowing organisations to learn by using information from the first few units for rest of the production batches. Through repetition, firms gain experience, become more efficient in production and perfect their service delivery. Unfortunately, construction projects are custom designed and built with varying sizes, value, trades, materials and built at different locations and times. The variation of projects renders the information obtained from one project to another less useful and a lost opportunity to learn.

3.7 Production is Away from Head Office

Construction projects are normally carried out at locations away from the head offices of CFs. Problems arising from distant and constantly changing production locations have been well-documented (Canter, 1993 and Hillebrandt, 1989). Transporting material or labour for long distances may not be cost effective. The solution may lie in the use of local materials, labour and sub-contractors. The difficulty in this scenario, is the need to gather information on the availability and quality of local material and labour. Secondly, distant locations create problems in collecting, processing and effectively using relevant information, particularly material usage, labour productivity and associated cost. Firms find it difficult, if not unnecessary to invest in information systems in temporary locations. In addition, when ad-hoc systems are devised, it is production staff who normally capture the data. Adrian (1986) comments that in this set up, the interest of production staff and other employees of the firm, for example, accountants and quantity surveyors, may not be congruent. Ogulana and Butt (2000) add that problems associated

with site feedback are: (a) incompatible information formats between foremen and estimators; (b) variation of labour productivity from site to site due to several factors, such as, weather, level of supervision; (c) variation of material usage and plant cost from site to site. Ferry *et al* (1999) concludes that arising from the problems of feedback, many CFs hardly keep data obtained from distant locations because of its diminished value for future use. Moreover, lack of a permanent production place exposes construction to the vagaries of the weather, causing delays and sometimes the need for re-work, hence causing costs to escalate.

4. THE STUDY

4.1 Methodology

The most recent figures indicate that there are slightly over 997 registered CFs in Botswana, of varying sizes in terms of turnover or employment (CSO, 1999). Variation in sizes, makes the operational characteristics of CFs different. To have a fair comparison, firms, which were studied, were grouped using Botswana's Central Tender Board (CTB) classification (currently under review). CTB uses an assessment method based on plant, personnel and financial capability of CFs to classify firms as class O, A, B, C, D, and E. The class then determines the maximum value of a single project that a firm can handle, for example, the large classes, D and E, may tender for jobs above the value of. P8.0 (approximately US$ 1.2) million while class O (opportunity class) firms, handle projects below P0.3 million (Ngowi, 1998). Firms in class D, E and O were omitted in the survey. The former (D and E) are most probably international firms and tend to be operational and financially more organised because of their foreign backing (Ssegawa, 2000). The latter, were also omitted because of the difficulty in tracing their postal or physical addresses. Therefore, firms in classes A, B and C, executing projects between P0.3 - P8.0 million were selected.

The study involved sending questionnaires consisting of structured closed and open-ended questions to 230 CFs firms. The open-ended questions required a comment from respondents to clarify the closed-ended question. Some questions required ranking and an importance index (II), ranging from a minimum of 0 to a maximum of 4, was constructed using the formula: $II = \frac{(4A+3B+2C+1D+0E)}{(A+B+C+D+E)}$, where A = excellent/always, B = often/good, C = regularly/average, D = seldom/poor and E = never/poor are the frequencies (%)of responses. A high II value, of above 2.0, indicates that respondents view the factor or issue significantly, even if it may not be highly ranked.

4.2 Results and Findings

A response rate of 69.6% (160 out of 230) was achieved. Table 1 indicates that the TPS, with an II of 2.95, is most common system of project delivery in Botswana. Table 2 confirms that government (central and local) is the biggest client of the CI, providing 72.5% (52.4+20.1%) of the construction jobs. The separation of design and construction and government being the biggest client have already been identified as unique characteristics of the CI.

Table 1: Type of Project Procurement Systems in which Firms have been Involved

Procurement system	Frequency (%) of response					II	Rank
	A	B	C	D	E		
TPS	44.2	25.1	15.2	12.4	3.1	2.95	1
Turnkey Contracts	13.2	17.1	19.2	22.1	28.4	1.65	2
Design and build	10.2	15.0	23.3	25.8	25.7	1.58	3
Management	8.9	11.8	21.6	27.8	29.9	1.42	4
Management for a fee	5.6	8.7	20.1	30.3	35.3	1.19	5

Table 2: Categories of Clients that Frequently Projects

Category of Client	Value of work (%) contracted in the last two year	Rank
Government (Central)	52.4	1
Government (local)	20.1	2
Parastatals (govt. owned	14.7	3
Private Organisations	9.6	4
Individuals	3.2	5

Table 3 shows that respondents viewed cost, with an II of 2.78, as the most affected area of project delivery resulting from the separation of design and construction. Smallwood (2000) focused on this factor and highlighted that the submission of incomplete designs before selecting a contractor and contractors not being involved in the design process exacerbates the situation. Table 4 indicates that respondents viewed quality, with an II of 2.98, as the most affected parameter when it comes to engaging sub-contractors on a project. Cost was the least affected and respondents commented that requiring sub-contractors to make a quotation normally controls costs. However, others added that costs might increase in form of increased supervision and re-works. However, Tables 3 and 4 rank all delivery parameters high, all above 2.00, pointing to the effect of fragmentation as a major factor in the delively of projects.

Table 3: Extent to which Separation of Design and Construction Affects Delivery of Projects

Delivery parameter	Frequency (%) of response					II	Rank
	A	B	C	D	E		
Cost	34.6	27.8	20.4	15.6	1.6	2.78	1
Time	30.1	29.9	15.4	22.5	2.1	2.63	2
Quality	25.6	31.7	11.1	30.1	1.5	2.50	3

Table 4: Extent to Which Involvement of Sub-contractors Affects the Delivery of Projects

Delivery parameter	Frequency (%) of response					II	Rank
	A	B	C	D	E		
Quality	40.1	32.1	14.7	12.2	0.9	2.98	1
Time	35.9	27.9	26.6	9.4	0.2	2.90	2
Cost	27.4	22.2	19.9	18.1	12.4	2.34	3

Table 5 shows the period its takes to pay contractors. By the end of two months, 87.8% of contractors are usually not paid despite a stipulated period of within 14 days after presentation of certificates. They blame government bureaucracy in the payment system as the main cause of delay and not lack of funds. Although in some countries, the latter may be the problem.

Table 5: Extent to Which Payments are Delayed

Payment delay (end of, months)	0-2	3-4	5-6	7-8	Above 9
Frequency (%) of response	12.2	40.2	32.1	14.7	0.8

Tables 6-7 deal with data collected on the question of planning in CFs. Most firms do not produce corporate budgets which would forecast anticipated corporate revenue, production costs and expenses for a proceeding financial year, as indicated in Table 6 by a 75.3% 'NO' response. Most firms (68.8%) indicated that they produce cashflow statements but on a project by project basis not on a corporate level. All firms (100%) indicated that they produce budgets and review projects during their entire duration. Respondents highlighted further that there was no use in producing corporate budgets with anticipated revenues, when they are not sure of the value work they would win in a proceeding financial year. All firms indicated that they carry out variance analysis as a means of controlling project costs. An almost equal number of firms (53.1%) claimed to have some sort of cost database.

Table 6: Extent of Planning Capability

Planning Tool	Existence of the exercise in the firm	
	NO (%)	YES (%)
Do you produce a corporate budget?	75.3	24.7
Do you produce a cashflow forecast?	31.2	68.8
Do you produce a production budget?	0	100
Do you carry out a variance analysis?	0	100
Do you have a cost database?	46.9	53.1

Table 7 shows the extent to which planning tools are used in CFs. Production budgets are the most frequently used tools as shown by an II of 3.46. Variance analysis came second with an II of 2.99, perhaps as expected because of their use in the control of projects. Cashflow came third, with an II 2.31, although respondents had reservations about its usefulness because of the high uncertainty of payments. Respondents mentioned that an in-house cost database is not often used because of the variation of costs from project to project and most firms employ outsiders for estimation of their tenders.

Table 7: Extent of Use of the Planning Tool

Planning Tool	Frequency (%) of use of the planning tool					II	Rank
	A	B	C	D	E		
Production Budget	56.0	35.0	7.8	1.2	0.0	3.46	1
Variance analysis	36.4	34.6	20.5	8.5	0.0	2.99	2
Cashflow	4.7	38.7	39.9	15.8	0.9	2.31	3
Cost database	15.8	28.7	27.8	15.8	11.9	2.21	4
Corporate budget	5.6	8.7	20.1	30.3	35.3	1.19	5

Tables 8-10 depict the way pricing decisions are arrived at in CFs. Table 8 shows that in most firms, management takes responsibility of the mark-policy, while in second place are estimators (the two having an II of 3.11 and 3.04 respectively). In a number of firms, the decision is left to the production staff (II of 2.85), while accountants were rarely given the responsibility (II of 0.63). In some firms an estimation committee exists but this is not common as an II of 1.04 indicates. This finding may be explained in the manner in which CFs are organised. They tend to be a one-person's show, the owner of the business and therefore 'management' often means the owner of the CF.

Table 8: Who is Responsible for Your Mark-up Policy?

		Frequency (%)					II	Ran
		A	B	C	D	E		
a.	Management	44.1	34.0	12.0	5.3	3.6	3.11	1
b.	Estimator	36.0	37.0	23.0	3.4	0.6	3.04	2
c.	Production personnel	23.7	45.7	23.5	5.6	1.5	2.85	3
	Estimation committee (a, b, c and	2.3	12.5	17	23.5	44.7	1.04	4
d.	Accountant	0.0	0.0	12.8	37.1	50.1	0.63	5

When it came to what factors are considered when formulating a mark-up policy, the need for profit topped the list followed by the need to recover overheads at an II of 3.21 and 2.75, respectively, as given in Table 9. However, these two factors are progressive, a firm cannot make profit before it recovers overheads. Though the nature of project and client came last on the list, their II was close to the highest factors implying that the factors are also significant. It was difficult to judge from the responses exactly how the mark-up percentage or figure is arrived at on each project or as a corporate standard. Table 10 shows the most probable range of success of CFs when tendering is between 0-25% (one success in four tenders attempted). This is similar to the rate of one success in six (17%) tenders attempted that Canter (1993) found among British CFs.

Table 9: What Factors Most often Affect your Mark-up Policy?

Pricing factors	Frequency (%)					II	Ran
	A	B	C	D	E		
Need to make profit	47.5	34.5	10.1	7.0	0.9	3.21	1
Need to recover overheads	30.1	29.7	27.5	10.4	2.3	2.75	2
State of the market	28.4	26.7	23.6	18.0	3.3	2.59	3
Type and size of project	23.6	22.7	28.8	19.5	5.4	2.40	4
Type of client	2.5	16.7	23.1	26.5	31.2	1.33	5

Table 10: Rate of Success in Tendering in the Last Two Years (tenders won against tenders tendered for)

Success rate (%)	0-25	26-50	51-75	76-100
Frequency (%) of response	81.4	16.0	4.0	0.0

5. CONCLUSION

The study has shown that the government is the biggest client of the industry and that TPS is the most common system of procurement in Botswana. Due to the separation of the design and construction and involvement of many subcontarctors, project delively is often compromised in terms of cost, quality and time. Planning is also hampered by several factors, including, inability to ascertain workload, differences in project parameters and hence the little usability of information. This exacerbated by poor quality of, or a complete lack of information. While most of the factors that are incorporated in the formulation of project mark-ups have been identified, it was difficult to find out how they are exactly arrived at and set.

6. RECOMMENDATION

There are two areas that the author would wish further investigation in relation with CFs in Botswana. Firstly, to create an information system may be used by small and medium CFs in estimating, budgeting and control of projects. Secondly, to document the various methods used in determining the project overheads and the factors that are encompass the policy with a view to finding the most suitable and practical policy or system.

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