CHALLENGES IN ASSET MANAGEMENT – A CASE STUDY

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ABSTRACT

Asset managers are faced with many challenges in the management of public infrastructure. This paper discusses three of the most common challenges in the design, construction, and operation and maintenance of public infrastructure. These are: building design quality, funding, and the use of asset management tools. The Construction Engineering and Management Group at the University of New Brunswick has conducted a research project on the impact of these challenges. The study examined buildings on selected military bases in Eastern Canada. In total, 215 buildings, ranging from two to fifty years in age formed the database for the research. Five categories of facilities from eight bases were selected to form the basis of the study. These were residential buildings (barracks for single personnel); administration buildings; operations facilities, which comprised vehicle storage or maintenance garages; tank and aircraft hangars; and lecture/training (institutional) facilities.

The Department of National Defence is presented as a case study to illustrate how user and facility manager perspectives of quality in building design often differ from the early stages of a building's life cycle. Secondly, the challenge of securing maintenance and rehabilitation funding for asset management is quantified. Finally, the importance of collecting cost data to assist in asset management decision-making is discussed. Difficulties include the need for an improved computerised system to manage assets and the challenges in getting everyone to use the same system effectively in a large public organisation.

While well-managed organizations have been able to fund maintenance and rehabilitation at minimum levels in the past due to inherent quality in design and construction, the research showed that quality in design has declined. Thus, more time and funding need to be allocated to asset management if newer constructed buildings are to reach their design service lives without major rehabilitation expenditures. Many public and private sector organisations face similar challenges; hence, the research findings have a wider application than the Department of National Defence.

1. INTRODUCTION

Organisations are gradually beginning to realise the importance of asset management as a valuable tool for use in strategically managing infrastructure assets. McGeorge and Palmer (1997) noted that buildings are durable assets, which could face technical or functional obsolescence long before they are structurally inadequate. As sustainability becomes an issue, and the cost of land acquisition and new construction rises, rehabilitation of existing infrastructure can become more attractive. The viability of this option can only be considered if the organisation is able to consider the particular asset as it relates to the entire portfolio.

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According to Vanier (1999), the principles of asset management are based on the following questions:

- What do you own?
- What is it worth?
- What is the maintenance backlog?
- What is its condition?
- What is the remaining service life?
- What will you fix first?

The answers to these questions should form the basis of an infrastructure asset management programme. There are however, three challenges that asset managers are faced with in the management of public infrastructure. They are quality, funding and good asset management tools. An extensive research programme, in collaboration with the Department of National Defence (DND), was undertaken by the Construction Engineering and Management Group at the University of New Brunswick.

The Department of National Defence (DND) is the largest owner of federal infrastructure with approximately 10 million square metres of building inventory and ownership of nearly 44% of all federal government buildings. In the past 20 years, DND has had to cope with major reductions in construction, operation and maintenance (O&M) funding at a time when its infrastructure continues to get older. The study examined buildings on selected military bases in Eastern Canada. In total, 215 buildings, ranging from two to fifty years in age formed the database for the research. Five categories of facilities from eight bases were selected to form the basis of the study. These were residential buildings (barracks for single personnel); administration buildings; operations facilities, which comprised vehicle storage or maintenance garages; tank and aircraft hangars; and lecture/training (institutional) facilities.

This paper presents findings of the research as it relates to the aforementioned challenges in asset management.

2. BUILDING QUALITY

From an engineering perspective a “quality” building may be one that is designed to be durable, reliable and usually built in conformance to a specification, but one which may ignore “quality of life” issues that have a significant impact upon the working or living environment of the user. Thus, users may perceive a well-built, durable structure as being of poor quality simply because their needs are not met by the non-technical requirements of the facility.

Arditi and Nawakorawit (1999) identified 22 building design factors including ease of cleaning, functional layout, air circulation, indoor air quality, choice of building equipment and materials, lighting and construction methods in a survey they conducted to study the degree to which a building design considers maintenance. This contrasts with the consumer perception of quality which involves reputation, benefit and price (Zeithaml 1988). Torbica and Stroh (2001) found that customer satisfaction in home building depended on both the product (design of the house, quality of the materials and operation of the house) and the experience involved in buying the home.

To gain an understanding of what users of military facilities perceived as "quality", a user quality perception survey was developed. A Likert scale questionnaire, consisting of five questions, was developed to assess what factors were important to users (desired quality), how users perceived a particular facility met his or her needs (perceived quality) and the users' overall perception of the facility's quality. In total, 1351 surveys were randomly distributed to occupants. The overall response rate was 498 surveys or 37%.

A modified version of the user perception survey was also sent to facility managers and designers at four DND bases and to directors of physical plant at three Eastern Canadian universities. This survey was not originally part of the initial research programme but was added to the project when it became apparent from the literature review and from comments during base visits that the building occupants had differing perceptions of desired building quality compared to the base construction engineering staff.

2.1 Results of Questionnaires

The initial survey questions were designed to examine what factors users felt were important in building design. These were referred to as the desired quality (DQ) scores and rankings. Overall, 70% of the 25 factors (refer to Appendix for factors) were considered by users to be important or very important in the desired building quality. Occupants of buildings in the residential category considered that 77% of all factors were important or very important. Occupants of aircraft hangars considered 72% of all factors to be important or very important whilst occupants of operations buildings rated 71% of all factors important or very important. Occupants of administration buildings only considered 67% of all factors to be important or very important, followed by occupants of institutions who rated 63% of all factors at his level. Finally, only 60% of the factors were considered to be important or very important by occupants of tank hangars.

As discussed, a modified questionnaire was sent to facility managers and designers at five universities and bases to obtain information on how this group rated desired quality. In total 14 surveys were returned. The response rate was estimated at 60% of the potential maximum number of respondents based on a average of five facility managers/designers within each organisation. Tank and aircraft hangars were not included in the survey as they are not found on a university campus and there were not sufficient responses from the military facility managers alone, to rank the importance of the factors for these facilities. As expected, "building construction" was very important to facility managers and designers. These factors are consistent with those found in previous work by Arditi and Nawakorawit (1999 a & b).

2.2 Discussion of Questionnaire Findings

The difference between the factors users considered important in desired quality and those which facility managers/designers considered important was of particular interest. Zeithaml (1988) cited a study done for the General Electric Corporation on what was important to the consumer in appliance design. Consumers identified appearance, ease of cleaning and durability as the top three factors. The designer/manufacturer identified workmanship, performance and form as most important. It was of interest therefore, to see if a similar dichotomy was to be found in this research. The top five factors for the user group and the facility manager/designer group are compared in Table 1.

It can been seen from the table that there is general concordance between the two groups on what was important in administration buildings but interestingly not in the other three categories of buildings. Two of the exceptions are predictable. The first is the high importance facility managers/designers assigned to building construction but not by users. The second is the importance residential building occupants assign to privacy and personal space but facility managers/designers do not place this factor in the top five. These exceptions can be explained by considering how each group interacts with the building. Facility managers/designers are concerned with the day-to day operation and maintenance of the facility thus, quality in building construction is very important. In contrast, users are not concerned with this aspect of the building unless the construction is so poor that it has a personal impact, such as a roof leaking into a bedroom.

TABLE 1.
Comparison of Users' and Facility Manager/Designers' Top Five Building Quality Factors by Building Category

Building category	Rank	Users' factors	Facility manager/designers' factors
Administration	1	Telecommunications	Adequate computer outlets
	2	Adequate computer outlets	Telecommunications
	3	Adequate lighting	Adequate lighting
	4	Security	Security
	5	Building layout	Heating
Institutions	1	Computer outlets	Building layout
	2	Timely repairs	Mechanical ventilation
	3	Telecommunications	Heating
	4	Security	Building construction
	5	Building layout	Computer outlets
Operations	1	Lighting	Floor drainage
	2	Mechanical ventilation	Lighting
	3	Washrooms	Mechanical ventilation
	4	Natural ventilation	Building layout
	5	Heating	Building construction
Residential	1	Shower facilities	Shower facilities
	2	Washrooms	Heating
	3	Privacy	Washrooms
	4	Personal space	Building construction
	5	Cleanliness	Security

The concordance between the two groups was tested using Spearman's coefficient of rank correlation. There was a significant correlation between the user DQ rankings and the facility manger/designer DQ rankings for all categories of buildings. Thus, the research findings indicated that there was generally agreement between what users want and what facility managers/designers provide in DND.

3. FUNDING CHALLENGES

Knowing what users desire in a quality building and having the capacity to provide for those needs is frequently the source of conflict. There is always a trade-off in new construction between what is affordable and what is desired. In addition, designers and facility managers know that quality in design can result in reduced operating, maintenance and rehabilitation costs later on.

One significant difference between public and private sector maintenance and rehabilitation (M&R) budgeting is that there is no incentive in the public sector to systematically plan and budget for M&R. (Although, this can be true in the private sector if a facility changes ownership frequently and the facility is simply regarded as a financial asset.) This is because the public sector does not accrue unspent funds from one fiscal year to the next. Secondly, as discussed by Hudson et al (1997), cutbacks to public works budgets do not directly impact upon the financial viability or profit of the public sector as they would in a private corporation. A review of annual investment levels in the U.S. showed that public organisations, such as federal government departments and universities, only spend 1.4% of their respective current plant value (CPV) on maintenance. In comparison, major private corporations spent 3.5% (Barco, 1994). Finally, unlike funding for capital projects, there is no political gain to be had from increased maintenance spending thus, the political will is lacking to increase maintenance expenditures. This is due partly to the manner in which maintenance is perceived.

An analysis of theoretical and actual M&R funding was essential to understanding how DND funding compared with recommended levels of funding for M&R reviewed in the literature. The site visits and inspections gave an overall impression that DND infrastructure had been well maintained over the years. While many buildings remain in need of internal rehabilitation, it is not due to failure of building components but rather a need to modernise or "refresh" the interior décor to reflect the changes in approach to the quality of life for the soldier. This extends to the electrical and HVAC systems, which are not failing but are becoming obsolete as replacement parts are no longer available. Ottoman et al (1999) state that the percentage spent on building maintenance (including repair) should not be less than 1% of the CPV. A funding of 1.5% to 3% of CPV is recommended for renewal or rehabilitation depending upon the type of building. Given the relatively good condition of older DND buildings, it was surprising to find that M&R funding, as a percentage of CPV, was at the bare minimum level as shown in Tables 2 and 3.

TABLE 2.
Comparison of Historical and Theoretical Maintenance Funding Levels

Location	Mean CPV (1999$/m^2)	Actual Maintenance (1999$/m^2/yr)	Maintenance as % of CPV	CPV theoretical annual maintenance funding[2] (1999$/m^2/yr)		
				1%	1.5%	2%
1	1081	11	1.0	11	16	22
2	1043	11	1.0	10	16	21
3	1068	11	1.0	11	16	21
4	1248	11	0.9	12	19	25
5	1192	15	1.3	12	18	24
All buildings at above five locations	1109	11	1.0	11	17	22

TABLE 3.
Comparison of Historical and Theoretical Rehabilitation Funding Levels

Location	Mean CPV (1999$/m^2)	Actual Rehabilitation (1999$/m^2/yr)	Rehabilitation as % of CPV	CPV theoretical annual rehabilitation funding (1999$/m^2/yr)	
				1.5%	3.0%
1	1081	18	1.6	16	32
2	1043	7	0.6	16	31
3	1068	14	1.3	16	32
4	1248	14	1.1	19	37
5	1192	23	2.0	18	36
All buildings at above five locations	1109	16	1.5	17	33

These findings can be interpreted two ways. Firstly, the comprehensive asset management system used by DND in the past ensured that M&R funds were spent effectively. Secondly, additional research showed that building design and construction quality (Newton, 2003) was high in the older DND buildings. Thus, the combination sound asset management strategies and good quality contributed directly to the observed condition of the buildings.

Notwithstanding the above, the low M&R funding levels give rise to a series of concerns. Construction engineering sections at all bases reported that their funding was under "attack" as a result of the de-centralised control of funding for the operation, maintenance and rehabilitation of facilities at each base. Meanwhile, the mean age of DND infrastructure continues to increase and the backlog of service life extension rehabilitation projects is growing accordingly.

4. IMPORTANCE OF ASSET MANAGEMENT TOOLS

If asset managers are to substantiate the need for increased funding, building data collection is critical to asset management. Wooldridge et al. (2001) noted that infrastructure asset management comprises four separate disciplines: condition assessment, financial management and record keeping, capital programming and procurement. A good asset management programme integrates these components. DND has generally followed this system of infrastructure asset management and has made several attempts over the years to integrate the disciplines. The methods historically used by DND for infrastructure asset management have been driven by the financial management component however, and the four disciplines stated above have never been integrated into one asset management system. This is demonstrated by a case study of DND asset management.

4.1 Case study of DND asset management practices

DND asset management has its roots in the 1950's when a period of major construction began to replace temporary World War II infrastructure. Originally, all building costs were tracked manually at each base. Each building had a cost record card on which costs associated with major maintenance, construction and rehabilitation projects were recorded by the Property Records office. In the late 1970's, a computerized maintenance management system called the Construction Engineering Management Information System or CEMIS was introduced as a tool to assist with infrastructure management at each base. The system was primarily a cost tracking system and did not incorporate the functions of preventive maintenance (PM) nor property records management. Thus, the asset management system was fragmented. In addition, it did not capture any costs previously tracked under the manual system.

Preventive maintenance inspections continued to be scheduled manually and a written file on each building was kept in the PM section. PM inspection reports, recommendations for maintenance and repair work, and hand written cost records of individual building maintenance work were kept in each file. The Property Records office was responsible for manually maintaining historic information on the building property cost record cards and in building files until CEMIS could be adapted to incorporate this function. Each base kept its own cost data, which were then summarized and forwarded annually to the National Defence Headquarters (NDHQ).

About 1994, CEMIS was replaced with a new management system called the Base Construction Engineering and Management System or BCEMS. While this system enabled managers to send cost record information to NDHQ electronically, it still did not address the original problem of the fragmentation and the duplication of asset management data. It also did not include the capture of historical building cost data. At the same time, a new property management system "ALADDIN" was introduced, which was not linked to the maintenance management system.

Despite these inherent problems, the highly structured, activity-based costing system ensured a wealth of information continued to be available to define and substantiate work requirements. Both the old system and its replacement had search engines that allowed data searches to be conducted using many parameters.

Three significant events occurred in the mid-1990's that fundamentally changed DND infrastructure asset management. These events led to major changes in how requirements were defined and how funding was allocated. Firstly, departmental restructuring led to downsizing and a delegation of authority for, and control of, minor construction and operations, maintenance and rehabilitation (O,M&R) spending from NDHQ to the bases. Funds for infrastructure O,M&R were no longer protected. Consequently, the base construction engineering staff were forced to justify why funds were required for building O,M&R. If engineering staff did not have well defined and programmed requirements, funding was given to other organisations within the base that could substantiate their needs. Downsizing led to the re-organisation of engineering sections and de-centralised control of preventive maintenance. Building maintenance, repair and rehabilitation suffered at some bases as a result of this.

Secondly, in the explosion of the desktop computing and computer aided drawing and design (CADD) as tools for asset management, the "new" BCEMS mainframe system that was undergoing a trial evaluation was redundant, unable to meet the infrastructure asset management needs of DND. There was also a renewed initiative to merge the functions of property management and maintenance management into one infrastructure asset management system. Finally, the Auditor General of Canada strongly recommended that the Department re-define what constituted "maintenance" and "construction" or capital funding to bring DND in line with acceptable accounting practices (CICA, 1997). Prior to this time, all work that did not replace existing infrastructure, or was a result of a change in use, was funded as "maintenance".

These occurrences led to an infrastructure asset management policy vacuum as new policies and procedures could not be written fast enough to keep up with the changes. Consequently, some bases continued using the separate maintenance and real property management systems, other bases adopted "off the shelf" maintenance management systems and ignored property management, aside from lease and utility agreements. Still others managed by crisis. This effectively broke the asset management cycle which, although imperfect, had been the backbone of a generally very good infrastructure management system. Valuable asset management information was lost during this period and preventive maintenance programming was either reduced or dropped altogether. Without coherent building historical cost data, it was difficult to substantiate funding requirements. The impact of this on DND infrastructure management has now been recognised and efforts are underway to bring all bases back to a common infrastructure asset management programme that incorporates, condition assessment, capital programming, financial and real property management. A new realty asset information system has been proposed to meet these needs and is expected to be implemented in 2004.

This case highlights the need to not only incorporate the four disciplines of asset management in an asset management system, but also the importance of incorporating historical building data in newer versions of asset databases. Additional research in this area (Newton, 2003) has further quantified (for DND asset managers) the impact of design quality on building life cycle costs and the challenges inadequate funding will present in future years.

5. CONCLUSIONS

Despite minor differences in the importance of desired quality factors such as building construction quality, the research findings indicated that there was generally agreement between what users desire in building quality and what facility managers/designers provide in DND. This is good as it shows that users' needs are understood by designers.

The findings showed that well managed organisations have been able to fund M&R at minimum levels in the past due to inherent quality in design and construction; however, the research showed that quality in design has declined. Thus, it will be more challenging to manage assets in the future if funding levels do not increase. This also demonstrates the importance of a good asset management system. A case study of DND asset management practices found however, that failure to adapt to rapid changes in information technology and funding allocation will affect the asset management practices of the best organisations.

Consequently, more time and funding will need to allocated to asset management if newer constructed buildings are to reach their design service lives without major rehabilitation expenditures. Many public and private sector organisations face similar challenges; thus, the research findings have a wider application than the Department of National Defence.

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APPENDIX

Quality Factors Used in Quality Perception Questionnaire:

A	Building layout
B	General interior appearance
C	Exterior appearance
D	Privacy
E	Washroom facilities
F	Shower/bathing facilities
G	Common rest areas/lounges
H	Laundry facilities
I	Adequate/appropriate lighting
J	Repairs carried out in timely manner
K	Ease of cleaning
L	Cleanliness
M	Adequate/appropriate electrical outlets
N	Adequate/appropriate telecommunications outlets
O	Adequate computer outlets
P	Natural ventilation
Q	Mechanical ventilation
R	Heating
S	Security
T	Interior finishes
U	Adequate personal space
V	Building construction
W	Adequate/appropriate floor drainage
X	Convenient service points
Y	Accessibility (ease of access to the building)