

HOW POST OCCUPANCY EVALUATION (POE) CAN BENEFIT OWNERS, DESIGNERS AND OCCUPANTS OF NEW AND EXISTING RESIDENTIAL BUILDINGS

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Summary

The Post Occupancy Evaluation (POE) is a performance assessment of buildings under operating conditions that can help property owners and managers better understand how well a building is working and how its performance relates to the original design intents, how it compares to similar buildings or established benchmarks, and how a building can be improved. A thorough understanding of the functioning of a building can directly link its actual performance to either innovations, or corrective measures applied to both new and existing buildings. While there is a lot of information about POE of commercial buildings, there is a lack of similar, consistent ideas in the residential market. The objective of this paper is not to delve into scientific discussion, but to show the basic benefits to all participants in the POE process while describing it in simple terms on the example of a POE methodology for MURBs being developed in Canada. The most important reasons, objectives and potential benefits are shown to facilitate understanding of the challenge without getting into too detailed analysis about the process itself.

Keywords: POE, residential building, MURB, post occupancy evaluation, assessment

1 Why to evaluate multi-unit residential buildings?

The Code of Hammurabi¹ (1800 BC) told us what a building was required to do and not how it was to be constructed meaning that **“a building should not kill or injure anybody, on pain of death”** (Ref. [2]). Fortunately for designers, our legislations are not there...



Fig. 1 Toronto MURBs . Credits: University of Toronto, CMHC

1.1 Background

To increase our understanding of the performance of multi-unit residential buildings (MURBs), the evidence is required, but very limited information is available contrary to

the case of commercial and educational buildings well researched for decades. When provided, such information could identify ways of improvements to the benefit of building owners and occupants, and to develop benchmark data on performance indicators to support the development of building codes, regulations and guidelines. As innovative systems, equipment and practices are applied to the design and construction of new MURBs, all stakeholders should look for evidence that these new features actually deliver benefits to occupants and owners and, if they do, to what extent.

One of the best methods of obtaining performance data on MURBs is the Post Occupancy Evaluation (POE) of buildings – **a performance assessment of real buildings under actual operating conditions** (*Ref. [7]*), typically including also occupants' satisfaction survey and building monitoring to assess the level of success of design strategies in meeting performance targets, reference baselines or benchmarks after all systems are up and running (well) and usually after a year of a required minimum occupancy as, in some cases, full occupancy may be difficult to achieve.

(A **baseline** is defined as “a usually initial set of critical observations or data used for *comparison or control*”; a **benchmark**, on the other hand, is “*something that serves as a standard by which others can be measured or judged*” (*Ref. [5]*)).

The POE can actually determine “whether buildings will work for the people that will use, occupy or otherwise be impacted by them” (*Ref. [5]*). The purpose of showing its benefits is to convince all stakeholders to POE, but mostly those who design – architects and engineers, in an effort to prevent them from repeating their mistakes or from not following best practices. Experience shows that both cases can have often quite negative consequences for everybody involved.



Fig. 2 Toronto MURBs . Credits: University of Toronto, CMHC

1.2 Need to ask and to measure

In order to improve building performance we must measure – what cannot be measured, cannot be improved. Energy or water use could be relatively easy, but other aspects such as longevity, ecological impact and satisfaction, are not (*Ref. [8]*). The performance can be assessed by following POE's questions **why, how, what and when**. In order to get benefits from the process there must be a good understanding of it by the all POE's stakeholders. They may vary, depending mainly on ownership structure and on the objectives of the entity requesting the POE but generally can be categorized as follows:

1. Finances related (current or future clients)
 - Building developer
 - Building owner (in the case of a rental building)
2. Design and construction related
 - Design team, including architects, engineers and other professionals
 - Builder

3. Operation/occupancy related

- Property manager
- Individual building owners (in the case of a condominium)
- Building occupants/tenants

It is also important to be aware of the stakeholders different goals:

- **Developers** want to build with the lowest cost (usually) and to sell it for profit.
- **Owners** want the highest rents while buying cheap (low capital cost) and they typically don't require high quality products – rarely one looks at durability and Life Cycle Cost.
- **Design teams** depend on available financing and often are in a conflict of ideas versus financial constraints although sometimes a verification of the performance proves to be useful for the future designs (and marketing).
- **Builders** build as asked, but sometimes want to know more about better quality or new technologies, so they can offer new services.
- **Property managers** want the well operating building and do as asked by owners, but may be in conflict with occupants' satisfaction (or lack of it).
- **Occupants** are end –users, theoretically the most important ones in a chain, but seldom having much to say about their satisfaction, except when being surveyed within the POE, or any other related process.

The main problem is that a building can be artfully designed, but be hated by its occupants. Often design is based for example on either designer's ego in expensive high-end condominium; or on financial constraints in low-rent apartment buildings or simply (!) on lack of the real-life knowledge about good overall building performance. Usually, however, it is the combination of all three factors taking toll on building performance, thus on occupants. We cannot forget that **the main goal is to occupy the building** and

- Occupancy lasts tens of years while all other phases up to several months
- Any feedback on what works and what needs improvement is welcome.

One of the aspects is that perceptions about occupants space (where life “does happen”) are usually very subjective, qualitative and not easily measurable. The factor of occupant's behavior is often neglected leading to problems based on cultural diversities when, for example, in one Toronto's apartment building live 15 nationalities from regions like Europe, Africa, Middle East, Asia and Latin America; all with different habits and traditions. In such cases the use of technologies related, for example, to airtightness (such as not operable windows combined with compartmentalized ventilation) can often lead to bad indoor air quality or much bigger energy consumption if calculations are based on standard behavior (a horoscope). Architects use traditional designs not based on users' feedback, but rather on wishful thinking about the occupants' behavior. They should be dealing with the issues in a design stage in order to predict and accommodate human factors while acquiring feedback after occupancy and learning from evaluated buildings to avoid future problems or just failures.

Occupants' impact, as the first hand verification, is very important, because what exist instead are engineer's calculations, standards, regulation, by-laws and wishes about the predicted performance. Occupants need to be asked about the space design, indoor comfort, problems and then, if required, the performance could be measured and solutions provided. Such measures may come too late for users in bad buildings, but they can be beneficial for designers and occupants of future ones. Often, however, owners prefer not to survey the occupants or risk losing the status of “green/sustainable, etc.” by adverse findings.

Figure 3 below shows the example where all of south facing full floor windows (east and west as well) are shaded all the time by either curtains or blinds due to the excessive glare and/or overheating. This causes a significant increase of energy consumption due to the blockage of much of the daylight and passive solar heat gains (smaller glazing does not require extensive shading). Irony is that the apartments were sold for the “beautiful view”, so it indicates that the value of it is of less importance than the discomforts. Had the occupants of the first tower built been surveyed about their satisfaction, the developer would know the potential problem. Apparently he didn’t as seen below.



Fig. 3 Buildings in Burnaby, British Columbia, Canada Credits: W. Kujawski.

Some of useful comments by POE’s gurus Bill Bordass and Adrian Leaman (2003):

- Designers seldom get feedback and only notice problems when asked to investigate a failure – *A.Blyth, CRISP Commission 02*
- **POE is not a very good name for the activity** – “*It’s what happens when we are gone*” – *Facilities Manager*
- **Being wise after the event: remote, late, academic, threatening** – “*We look silly and our PI insurers don’t like it*” – *Designer*
- **Some see it as expensive, indigestible, and of questionable value** – *Newcomers can ignore established techniques and try to do too much*
- **Who owns feedback? Everybody benefits, but nobody wants to pay** – “*Designers should pay, they and their next clients benefit*” – *Client*

2 Development of a comprehensive approach to POE for MURBs

2.1 Reasons behind

POE’s are not new and this paper is not claiming otherwise, especially when many MURBs projects in Canada have had some sort of POEs by assessing a set of basic performance criteria (e.g.; energy and water consumptions, indoor environment). However, the “POE” frameworks were usually developed on an ad hoc basis derived from the information available at the time and their results are difficult, if not impossible, to compare. Additionally, this situation has been made worse by the fact that POEs have not been a routine, or even a familiar, activity for most industry stakeholders, residing rather in building research than in real life. While energy use is routinely monitored, other indicators such as detailed indoor environmental quality (IEQ) etc., have not been assessed and often a research was required to develop them. Considering the growing need for

performance assessment of MURBs due to new performance levels required by the building code and aging building stock in need of retrofits, the Canada's national housing agency commissioned a group of experts to provide stakeholders a "good practice guide and toolkit" based on the adaptation of improved practices.

2.2 Methodology

In the First Phase a comprehensive approach to POE was developed in a form of the methodology/framework based on principles of the standard POE methodology and their objectives:

- Data collection from stakeholders – **to compare** the performance of a building relative to baselines or benchmarks.
- Surveys and interviews – **to determine** the extent of needs and satisfaction of occupants and its managers
- Data collection from site (monitoring) – **to provide** feedback on the building design, construction and commissioning
- Information transfer – **to evaluate** the success of innovative measures, systems, and unique features.

The first step's scope depends on the POE objectives: meetings with the owner and the design team to get information about: commissioning, operation, energy and water metering, design and actual occupancies, design goals, strategies, innovative features, etc.

Other steps can be optional and include:

- Occupant satisfaction, building management surveys and data collection from the site. The framework provides the advice about each performance area, the instrumentation, measurements, interactions, anticipated time and effort, estimated cost of equipment, and other investigations.

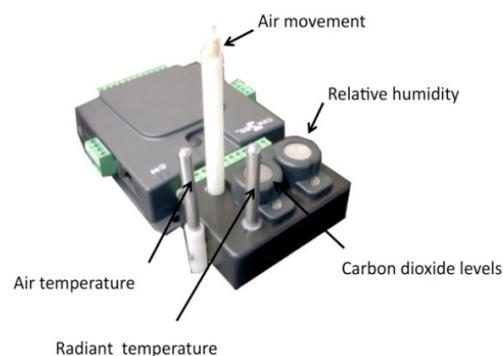


Fig. 4 Device to measure indoor air quality (IEQ). Credit: Laval University, Quebec

- Information transfer/a meeting with the stakeholders to present the results and to discuss the actual versus predicted building performance or design targets.

The Second Phase of the POE methodology being currently developed will be based on carefully researched modularity so it could be customized to meet the objectives of any party commissioning the POE, while still maintaining the standards of the "regular" POE.

2.3 Performance areas and indicators

The methodology includes the assessment of seven different performance areas:

- energy efficiency,
- water use efficiency,
- indoor air quality,
- lighting and the visual environment,
- acoustics,
- thermal comfort,
- building envelope performance.

As the objective of this paper is in benefits, not in details about the POE, only one example of indicators is shown here in relation to the energy efficiency that could result in reductions in energy consumption and costs, in the use of resources and ultimately, in decreased environmental damage and these are:

- Annual energy consumption per square meter of conditioned space (gas, electricity, propane, diesel, fuel oil, etc.).
- Energy use reported on an energy type basis and as aggregated total of different energy types.
- Energy consumption per square meter of conditioned space, corrected for weather conditions (“normalized”).
- Normalized energy use reported on an energy type basis and as aggregated total of different energy types.
- Disaggregated energy use by system or end use.

PERFORMANCE ANALYSIS

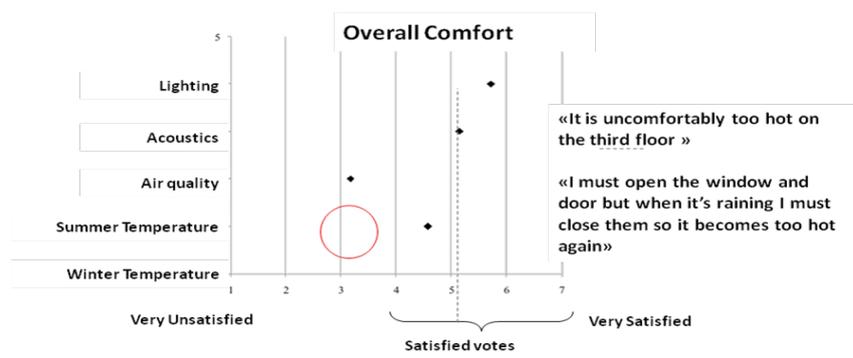
ENERGY ^a		Building ID	Saving Potential	
		9710 ^b	(%)	(\$) ^c
ELECTRICITY (kWh/m ²)	Annual Base Consumption	82.2 (53.2)	35.3%	\$67,525
	Annual Heating-related Consumption	9.9 (0.8)	91.9%	\$21,189
	Annual Cooling-related Consumption	3.4 (0.9)	73.5%	\$5,821
	Annual Electricity Consumption	95.5 (63.7)	33.3%	\$94,535
GAS (kWh/m ²)	Annual Base Consumption	73.1 (21.9)	70.0%	\$5,436
	Annual Heating-related Consumption	235 (85.0)	63.9%	\$15,957
	Annual Gas Consumption	308 (141)	54.2%	\$21,393
Annual Energy Consumption (kWh/m ²)		404	40.0%	\$115,928

WATER		Building ID	Saving Potential	
		9710	(%)	(\$) ^c
Annual Water Consumption (m ³ /m ²)		3.63	55.6%	\$104,419

WASTE ^d		Building ID	Saving Potential	
		9710	(%)	(\$)
Annual Waste Generated (yd ³ /unit)		4.67	59.6%	N/A

Fig. 5 Example: Energy consumption data with potential savings shown. Credit: NRCan.

Comfort, actual occupant's perspective



The ventilation system was under commissioning in summer 2011. The system showed anomalies which have been set at the end of the summer 2012, but the occupants did not receive benefits during the cooling period.



Fig. 6 Occupants' satisfaction survey. Credit: Laval University, Quebec.

All performance areas have sets of indicators, description of monitoring process, tools, timing and costs.

3 Overview of POE benefits to all stakeholders

The purpose of this section is to present benefits to stakeholders so they could think about the POE as being an inseparable part of the building process. Very often stakeholders don't even realize the power which the POE can play during different stages of a life cycle of the building.. Performance evaluation of new or retrofitted MURBs can serve to show whether promised benefits are actually delivered, potentially speeding their adoption by industry and driving regulatory changes so much needed in the domain of MURBs.

It's important to underline that there are certain conditions that should be met such as, for example, required timing of the evaluation:

- **for new MURBs:** after commissioning, and a minimum of one year following nominal full occupancy (80 % to 90 % suite occupancy and after all adjustments/ corrections to initial problems were made, if any were necessary) – It is critical to permit the normal operation of the building with occupants through all seasons.
- **for major MURBs renovations and rehabilitation of building systems:** before and after the work in order to assess its impact and in coordination with the replacement time for equipment, major market upgrades, etc.
- **The second POE:** after an appropriate period of time to permit normal operation and fully assess building performance; depends on the type of renovation or retrofit.

The benefits below are explained by time categorization; some of them are “timeless”.

Short term benefits of POE can help in:

- Identification of and finding solutions to problems in buildings;
- Responding to user needs;
- Improvements to space utilization based on occupants' surveys;

Medium term benefits of POE can show:

- Built-in capacity for potential building adaptation to occupants' changes and growth;
- Different uses for MURBs components through flexible design;
- Accountability for building performance by their designers (short term too early, long term less possible). Example: LEED plaque with all design team names.

Longer term benefits of POE can help in:

- Long-term improvements in building performance;
- Improvement in design quality;
- Strategic review

Overall benefits of POE can confirm:

- How well a building is working,
- How its performance relates to the original design intents,
- How it compares to similar buildings or established benchmarks, and
- How a building can be improved.

The most important benefits of POE:

- When the information is made available to as wide an audience as possible (beyond the institution whose building is evaluated and to the whole High Education sector and construction industry).
- Getting insights into problem resolution.
- Provision of useful benchmark data with which other projects can be compared.
- Opportunity for improving the effectiveness of building procurement (access to knowledge gained from many more building projects than any institution would ever complete).



Fig. 7 Toronto MURBs. Credits: University of Toronto, CMHC.

Conclusions about direct benefits of using the POE process in MURB's assessment:

- Survey of occupants satisfaction can increase their awareness about a building's operations;
- Monitoring of equipment and systems can prepare for further analysis and actions;
- Opportunity, through meetings with occupants, to train and engage them to help achieving optimal performance in terms of comfort and energy or water efficiency;
- Opportunity for understanding, through a POE, of the functioning of a building that can directly link its actual performance to either innovations, or corrective measures.

POEs addresses a number of questions which can play a major role in determining performance level of a MURB, but they are avoided by owners or designers because the answers may not be exactly what they would like to see or hear, even if answers usefulness in a long term is proven. Often there is also no interest in such questions at all, because working with some of the issues may take a too great deal of time.

Why bother with the effort if the occupants will pay anyway while not necessarily knowing that something is not working as planned or not working at all?

These questions may be as follows:

- Does the building perform as intended?
- Have the occupant's needs changed?
- What problems need to be tackled quickly?
- What can be learned for future projects?

The owners can always enjoy their benefits, which become incentives while using POE in their other buildings leading directly to:

- Less maintenance
- Enhanced occupant satisfaction
- Lower turnover rate
- Fewer occupant call-backs

At the end there should be one final note that reflects well what was presented above and is addressed to all participants in a building process:

“If we don't understand outcomes better and meet expectations more reliably, we might not have much of a business in a few years time”, *Bordass and Leahman*.

References

- [1] CMHC/Morisson Hershfield Ltd., *Draft Report of Post-Occupancy Evaluation Performance Assessment Framework for Multi-Unit Residential Buildings*, Ottawa, 2012.
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- [5] Merriam-Webster, 2012.
- [6] Hugh Byrd, *Post-occupancy evaluation of green buildings: the measured impact of over-glazing*, Auckland, New Zealand, 2012.
- [7] “*Guide to Post Occupancy Evaluation*”, University of Westminster, UK.
- [8] Nils Larsson, *Assessment tools*, 2008.

Endnotes

- [1] The sixth Babylonian king, Hammurabi, enacted the code, which consists of 282 laws, with scaled punishments, adjusting "an eye for an eye, a tooth for a tooth" (Wikipedia) WWW <http://en.wikipedia.org/wiki/Code_of_Hammurabi>.