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Providing Solid Evidence with Archival Data of Improved Organizational Productivity through Improved Environments

Discussion Document

Prepared for:

Greg Walker
Research Director
Continental Automated Buildings Association (CABA)
1173 Cyrville Road, Suite 210
Ottawa, Ontario, Canada
K1J 7S6

Prepared by:

Jennifer A. Veitch, Ph.D.
Principal Research Officer
National Research Council Canada (the NRC)
Construction Portfolio
1200 Montreal Road, Building M24
Ottawa, Ontario, Canada
K1A 0R6

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Regarding

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NOTICE

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Introduction

The National Research Council Canada (the NRC) is pleased to submit the proceeding Discussion Document (DD) document to CABA. The following document shall be considered the NRC's formal proposal pertaining to "Providing Solid Evidence with Archival Data of Improved Organizational Productivity through Improved Environments", and is based on all available information provided by CABA to the NRC as of 2018-05-28. Should the scope of the current project change, or should additional information be provided to the NRC that alters the NRC's proposed work plan and/or proposed budget, the NRC reserves the right to modify the proceeding DD document prior to acceptance by both parties.

Background

CABA is an industry association dedicated to the advancement of intelligent home and building technologies. It has an international membership of nearly 400 companies involved in the design, manufacture, installation and retailing of products relating to home and building automation. Public organizations, including utilities and governments, are also members. CABA's mandate includes providing its members with networking and market research opportunities. CABA also encourages the development of industry standards and protocols, and leads cross-industry initiatives.

Several conversations with CABA, its members, and other participants in the commercial buildings value chain, have indicated that quantifying and valuing benefits beyond energy – associated with better buildings generally, and advanced, intelligent building systems specifically – would support industry growth and better building environments for all. There is a renewed industry focus on how buildings can improve organizational productivity as a mechanism for increasing the ROI on building systems

improvements. Tenants in competitive real-estate environments are increasingly looking for buildings with green, sustainable, comfortable, and healthy credentials.

The NRC engaged with CABA's Intelligent & Integrated Buildings Council (IIBC) to develop a white paper entitled "Improving Organizational Productivity with Building Automated Systems", delivered in 2014. This white paper established a framework for quantifying and valuing the benefits of an enhanced BAS on organizational productivity, by identifying multiple metrics that contribute to organizational productivity, and mechanisms by which the BAS could affect these metrics. The NRC was also a co-author on a 2014 report from the World Green Buildings Council, entitled "Health, Wellbeing & Productivity in Offices", which laid out a compatible framework with a global consensus.

Following this, the NRC successfully completed a CABA Boutique Multi-Client Research Study entitled "Improving Organizational Productivity with Building Automated Systems: Phase 1". This work was supported by six CABA members in addition to the NRC: Philips, UTRC, Intel, Schneider, Distech (Acuity Brands), and Pella. The project was completed in April 2017, and a seminar summarizing the results was presented at the CABA Forum in Santa Clara in that month. This project involved the review and synthesis of a vast body of published work in the fields of engineering, psychology, business, public health, and others. The results demonstrated that better buildings strategies have positive effects on multiple organizational productivity metrics (absenteeism, employee turnover intent, self-assessed performance, job satisfaction, health and well-being). Further, these effects are similar in size to other corporate investments designed to improve these metrics (office type [private vs open-plan], workplace health programs, bonuses, and flexible work options).

In parallel, the NRC conducted an investigation of 2015 data from a large Canadian bank whose office staff are spread across green-certified and conventional buildings, combining building data from the company's facility management branch with regularly-collected employee survey data from the human resources department. The results showed that most of the green-certified buildings were occupied by more satisfied employees than matched conventional buildings, and employees in some of them also scored higher on manager-assessed performance. However, as in prior NRC research, there were some green buildings that lagged their conventional peers, suggesting that there is more to learn about how to deliver the best conditions for people and the environment.

The two parallel projects – the CABA Phase 1 project and the bank project – show the potential for better buildings to improve organizational productivity. However, the results are general rather than specific, providing little guidance on which technologies, design approaches, or operational practices lead to the largest benefits and the shortest payback.

The statement of work for the CABA Phase 1 project had outlined a three-phase, multi-year effort to deliver actionable information to the commercial buildings value chain. Since that time, further discussions with many partners, including CABA, have refined the NRC's plan. Instead of three sequential phases (one of which was the now-completed Phase 1 project), the NRC is pursuing work in three tracks

in parallel, which taken together will provide solid evidence that specific energy retrofits can result in improved organizational productivity as well as reduced operational costs for energy and maintenance:

- *Track 1: Field investigation of retrofit benefits:* Together with project partners, this project stream will combine customized investigations of target buildings assessed using both occupant surveys and on-site physical measurements before and after planned organizational investments in building retrofits and in comparison to their peers assessed at the same time.
- *Track 2. Demonstration of retrofit benefits with archival data* (the subject of this DD): In this track, provided suitable data from a project partner, we will focus on the specific renovations undertaken in a subset of buildings, and compare the responses of occupants in those buildings with their matched counterparts that had not then been renovated. These tests will identify the effects of the specific retrofits undertaken, and will build evidence to support similar investments to be made elsewhere.
- *Track 3. Laboratory prequalification of proposed retrofits:* Organizations face complex decisions about which technologies to implement, and whether or not there are compensatory mechanisms at play. For example, perhaps by adding individual control or comfort features to individual workstations, it might be possible to offset the potential downsides to reducing the footprint of individual workstations. The specific technologies to be tested in this project stream will depend on the interests of project partners, who may include technology providers as well as large landlords or tenant organizations. Tests of the effects of using specific technologies can narrow the range of choices for a specific project to those that will deliver on both the expected energy and organizational benefits, while also supporting the larger need for solid evidence of the value of building retrofits.

The NRC is uniquely-positioned to conduct this work, for the following reasons:

- World-leading expertise in both engineering and behavioural science;
- A global leader in R&D related to buildings;
- Co-authors of prior related CABA and WGBC reports;
- Extensive experience measuring and analyzing organizational productivity and indoor environment data;
- A long track record of delivering large-scale valuable projects for industry clients;.
- History of enabling acceleration of building technology to commercialisation and user acceptance;
- Multiple instances of positive influence on industry standards, codes and best practice documents.

Discussions with CABA led to the mechanism of a CABA Boutique Research project to facilitate Phase 1, and will be used again in Track 2. In a Boutique Research project a subset of CABA members are solicited to co-fund the project, which is typically conducted by the proposing organization. In this case, we anticipate other partners along with CABA. CABA will then be one of the project partners under a

contract with NRC. CABA members will have their own contracts with CABA. The Steering Committee for the project will constitute co-funders from the CABA members who join the CABA Boutique Research Project, along with representatives from any other funders with whom NRC contracts, the NRC and CABA representatives.

Objectives

This project (Track 2) will leverage archival data from partner organizations to evaluate the effect of various intelligent building technologies and operations on multiple organizational productivity metrics. Results will enable decision-makers[1] to value strategic investments in specific building technologies.

Work Plan

The work under Phase 2 will comprise two stages:

1. Acquisition of relevant RE and HR data from one or more partner organizations.
2. Analysis of these data to quantify how investments in building technologies affect organizational productivity metrics.

In Stage 1 the archival data will be gathered, qualified, and prepared for analysis. Analysis cannot commence until suitable data have been acquired. The specific variables of interest are described in the Materials and Equipment section below. Our experience on projects similar to this one is that most modern large organizations (and their service providers) will already be archiving the data we need for this project in RE, facility management (FM), and HR databases. The challenge will be to get access to these data from an organization (which might require the agreement of multiple internal stakeholders), putting data confidentiality provisions in place (particularly with HR data), knowing which staff were in which buildings (or which technologies they were exposed to) at the time the HR data were collected, and understanding extraneous factors that might have affected outcomes other than the technology in question. Our prior experience shows that these challenges can be overcome with a motivated partner, and the NRC has mechanisms in place to facilitate this process.

Analysis may follow either of two models: pre-post or cross-sectional, and one or both may be utilized in this project, depending on the nature of the data available.

The pre-post model can be conducted with a single building, provided it has a large enough population with valid data to ensure statistical power in analysis. In its most straightforward application, key outcome variables related to organizational productivity are measured both before and after the application of a new building technology or process. Data from a comparable building that did not undergo a change during this time are also required. With appropriate statistical controls, the difference in the outcome variables is attributable to the applied technology. For example, an organization might see a reduction in average staff sick leave following the introduction of an advanced control system that optimizes

[1] E.g. building owners and operators, who might be project partners themselves, or clients of project partners.

ventilation delivery. Applying this same technique to multiple buildings (from one or more portfolios), each with their own technology implementation, can isolate the effects of a variety of technologies, as well as providing valuable replication of the effects of similar technologies across buildings. This approach is complicated if multiple technologies or other changes occur in the same building simultaneously, but statistical techniques can at least partially separate out effects with appropriate data.

The pre-post model is the preferred option for several reasons. It is statistically stronger than a cross-sectional approach because individuals act as their own controls - many factors other than building technology that might affect organizational productivity outcomes are thus held constant. Note also, that because this project can be conducted entirely with archival data, the intervention could be one that happened in the past, with pre- and post-data already recorded, There is no need to wait for new data following a future, scheduled technology implementation.

The cross-sectional approach is best carried out on a variety of buildings in the same portfolio (i.e., employees from one host organization). Rather than examining changes before and after the application of a technology, the cross-sectional approach (in its most straightforward application) samples data from all buildings at a single point in time, and relies on prevailing variations in building features and technologies across the portfolio. Some buildings will have a certain combination of features, other buildings will have another combination, and statistical techniques are used to tease out the effects of different technologies on outcome variables. Keeping the analysis within a portfolio means that contextual differences between organizations (and differences in available data – format, definitions etc.) that might obscure technology effects can be controlled to some extent, although there may still be cultural, climatic, local economic and other differences between buildings in the same portfolio. However, the robustness of conclusions can be enhanced by applying this technique across several portfolios.

The detailed work plan in each stage will be guided by the Steering Committee.

Materials and Equipment

The data necessary to undertake the analysis outlined in this proposal have particular characteristics. Partners indicating that they would like to provide data to the project should be aware of these characteristics in advance so they can assess data availability within their own organizations, or from their own clients or other relationships.

Working with international organizations, the NRC has developed a multi-metric framework for assessing the broad impact of building environments and technologies on organizational productivity. These metrics are derived from archival data already routinely collected by most office building stakeholders, and typically include the following categories/sources:

- Tenant/employer HR data from individual employees, for example:
    - Retention: e.g., number of people leaving their jobs voluntarily
    - Absenteeism: e.g., days per person of short-term, discretionary sick leave

    - Performance: e.g., manager assessed, or a defined/tracked task performance metric
    - Job satisfaction, well-being: e.g., regular employee survey
- Facility manager (or equivalent) RE data, for example:
    - Occupant comfort: e.g., regular tenant satisfaction survey
    - Tenant complaints: e.g., log of calls to FM support system
    - Building automation sensors: e.g., space temperatures, return air CO_2 levels
    - Relevant building and technology characteristics: e.g., location, size, age, systems, envelope, schedules
    - Retrofits (if any): their nature, when the change was made

In all cases, the dates on which the data were collected are required, as is the information that links the HR data to the RE data (i.e., locations of the individuals and work groups within the RE portfolio).

The final choice of characteristics and metrics will be determined via discussions between the NRC and project partners supplying data. It is understood that not all of these metrics might be available at each study building, and that this does not necessarily exclude a site from consideration; a subset of variables could contribute to overall conclusions derived from many buildings. Further additional metrics of value, or surrogate metrics, from a particular site might also be considered.

Deliverables

There will be three deliverables for this project, both due at the end of the project schedule. Project participants will have the opportunity to review drafts of these documents, and provide comments, prior to delivery of final versions.

1. A detailed report with major sections describing the characteristics of the data, the building technologies addressed, analysis methods, and results. This report will position results to provide participants with marketplace advantage, according to the following:
    - Evaluate the effects of specific building technologies and strategies on organisational productivity metrics.
    - Input to more informed decision-making and purchasing.
2. A PowerPoint slide deck describing the project and its major findings. This slide deck may be used by the NRC in describing the results to the partners themselves, or in other partner-approved technology transfer activities. The slide deck may also be used by partner organizations as source material for their own presentations for marketing or other purposes.
3. A version of the final report edited for submission to a scientific journal.

The Steering Committee will review drafts of these documents. Submission of the journal manuscript will occur only with agreement of all project partners.