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Architecture, physical activity and a capability evaluative framework: satisfaction is not enough

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Abstract: Despite recognition that building design can contribute to human health by facilitating increased incidental physical activity, knowledge of how building design can enable this is underdeveloped. Further, there is evidence that design features introduced to support routine physical activity and improve occupant satisfaction may not necessarily lead to increases in actual physical activity. Evaluative frameworks encompassing a range of individual, organisational and built environment factors that contribute to shaping occupant behaviour may provide insight into how buildings can support greater levels of routine physical activity. This paper argues that capability theory can inform our understandings of the dynamic interrelationship between building design and building use. In this paper we describe our approach to developing a framework for capabilities-based evaluation of buildings and building occupant physical activity. Based on a capability perspective we consider the intersection of building 'domains' and 'functionings' that influence occupant physical activity; and question how such evaluations could account for a range of occupants. The research is of relevance to those engaged in the production of architectural environments and evaluation tools that support physical activity—inclusive of building designers, procurers, managers and occupants.

Keywords: Building evaluation; mobility; audits; capability approach.

1. Introduction

There is growing recognition that building design has the potential to contribute to human health through facilitating increases in incidental physical activity. The health risks of physical inactivity are well understood, and have even been described as a health hazard similar to that of smoking and obesity (Lee et al 2012). However, research on this issue from a built environment perspective lags behind that from medical, public health, sports and exercise sciences—especially for indoor environments (Marmot & Ucci 2015; Zimring et al 2005). We know 'behaviour settings' and their influence on physical activity and sedentary choices have been articulated (Sparling et al 2000) and that both the social and physical contexts of places have an influence over people's health behaviours (Baum et al 2009; King et al 2002). Yet only recently has the impact of individual, interpersonal, organizational and physical environment aspects on physical activity and sedentary behaviour begun to gain attention in architectural research

(Duncan et al 2015; McGann et al 2014). Architecture has the opportunity to provide better health and wellbeing outcomes for building occupants by increasing opportunities for routine physical activity within buildings. Indeed many architecture and health researchers are working in this space.

Effective evaluation of buildings for how they support physical activity is one area than can contribute knowledge about what constitutes healthy building environments. In the field of building performance evaluation research Leaman, Stevenson and Bordass (2009) argue for the need to move beyond evaluating buildings for only efficiency and productivity. In addition, they call for evaluation that captures a range of other qualities that may be difficult to fit into quantitative measures. In particular, we have a thin understanding of the interrelationship of individual, organisational and built environment factors that contribute to shaping building occupants' behaviour. Further, there is evidence that existing evaluative frameworks that measure occupant satisfaction with the perceived health of their environment may not necessarily be associated with increased actual physical activity (Creagh et al 2016). There is scope to consider one aspect of building occupant wellbeing as the capability to move around freely. In this context an evaluative framework that encompasses the range of individual, organisational and built environment factors that influence building occupants' physical activity or sedentary behaviour would provide a meaningful starting point for architectural designers and researchers. In this paper we present a critical literature review which identifies the need to better understand occupant capabilities to engage with physical activity within a building.

2. Mobility audits in urban planning and population health

Built environment audits are tools that systematically evaluate places and settings against their level of supportiveness for particular activities. Audits can provide a means to capture a measure of satisfaction with a place, or capture an inventory of built environment elements or behaviour. Built environment audits have increasingly been used in design-based disciplines, urban planning, transport planning and urban design, as well as by public health researchers, to evaluate places such as streets (Pikora et al. 2003), parks (Kaczynski et al. 2012), urban trails (Reynolds et al. 2007) and for communities (McGuirt et al. 2011).

Evaluations from audits have informed knowledge about built environment elements associated with physical activity with a view to inform an evidence base related to healthy built environments. Audits have also increasingly been used as advocacy tools, to measure places against recognised best practice and advocate for change. However, compared to the use of audits in urban planning research, the current state of the art in auditing buildings for physical activity is limited. This is despite recognition of negative health implications for the sedentary nature of workplaces and increasing interest in the role of buildings in providing opportunity for regular physical activity.

The theoretical basis of auditing the built environment presented by Ferdinand Lewis provides some insight into how audits could be used to evaluate buildings for physical activity. Lewis (2012a; 2012b) drew on the work of moral philosophers such as Mills, Rawls and Sen, to develop a theoretical model of built environment audits based on how audits value 'resources' in the built environment, and how they position individuals' capacity to access these resources to improve their wellbeing.

Three audit types are identified by Lewis based on differing relationship between individuals and built environment resources. The first audit type is the utilitarian audit. This audit is informed by auditors' responses to the built environment and contains measures that prioritise psychological end-states such as 'the sense of safety', 'pleasurability' or 'comfort'. Evaluation is based on the averaging of a group of individuals' 'satisfaction' with the built environment. This audit of satisfaction assigns an

absolute proportion of the built environment resource to individuals, assuming that all individuals hold an equal proportion of the resource being audited. What is not taken into account in the audit's evaluation, is the varying capacities of building users to convert resources to improve their wellbeing. A further criticism is that an individual may not be aware of the possible extent of wellbeing and therefore adjust their perception of their own level of satisfaction to sub-optimal conditions, a concept termed adapted preferences (Qizilbash 2006).

The second audit type is the general resources audit. This audit evaluates the built environment resources available to individuals. Lewis refers to this type of audit as an audit of opportunity. This audit evaluates the means individuals have to convert built environment resources into wellbeing rather than end psychological states. General resources include the physical infrastructure and spatial characteristics of built environments that allow individuals to convert resources into wellbeing, such as increased physical activity. However, a weakness of the general resource audit is that it does not evaluate whether individuals do convert resources into wellbeing. Building accredited for sustainability and health standards, such as Green Star ratings, can provide the means supportive of higher rates of physical activity by usable and attractive staircases and well-designed building layout, but this may not necessarily translate into actual increases in physical activity when compared to standard buildings (Creagh et al 2016).

The third audit Lewis identifies in his general theory of audits is the capability audit. The concept of human capability first emerged in the field of development studies by Amartya Sen and later advanced by Martha Nussbaum (Philips 2006). The concept has however been applied widely in more design based disciplines, for example in transport planning (Beyazit 2011), disability studies (Riddle 2014) and product design (Ooseterlaken and Hoven 2012). Capability is a normative concept reflecting both what people can do and what or who people can be. These various 'doings' or 'beings' are referred to as a capability set and are effectively the range of positive freedoms available to individuals to carry out a range of 'functionings,' or day-to-day activities that support wellbeing. Evaluations based on a capability approach focus on conversion factors that create barriers or facilitate the expansion of capability sets.

In the context of the built environment, a capability audit would not only evaluate the presence of built environment resources, but also individuals' agency to convert resources into wellbeing. Capability audits according to Lewis audit both opportunity and agency encompassing both means and ends and addressing the weaknesses of the first two audits (Lewis 2012, 296). Lewis illustrates an example of a capability audit as the *Design for Health* audit. *Design for Health* evaluates as well as built environment factors, social capital and institutional factors which may constrain the agency of different population groups to convert built environment resources into health behaviour. Whilst the strength of Lewis' work is in presenting a theoretically robust model of audits, he falls short of providing any principles for audit developers seeking to take a capability approach to auditing. A key challenge is to understand how the concept of human capability for physical activity is translated into a building design context. To do so we first review the literature on barriers and facilitators to physical activity in buildings.

3. Research Approach

The literature includes a number of frameworks that seek to provide ways to categorise the influence of the built environment on people's physical activity. At the broadest scale social-ecological models understand an individual's environment as nested fields of influence: individual, social, organizational, community, policy (see for example Plotnikoff et al 2003). Although this model provides one of the foundations of this paper it does not offer sufficient focus on building design. Taking an explicitly built

environment focus Zimring et al (2005, 187) considers physical environment factors at "four nested levels of spatial scale: (1) urban design, (2) site selection and design, (3) building design, and (4) building element design." Zimring et al highlight the usefulness of this model in its correspondence to the "general temporal flow of a design project". We sought a capability approach to a framework that focused on the occupant/user experience of a building, rather than the designer. Hollands et al (2013) identify Ambience, Functional Design, Labelling, Presentation, Sizing, Availability, Proximity, Priming, and Prompting as factors in an environment of choice. A key difference in the approach taken in this paper, compared to Hollands et al is to separate domains and functionings and to develop a framework which illustrates their intersection.

An initial search of the literature produced a list of original research papers published within the last 15 years that had investigated the relationship between an aspect of the interior building environment and different direct and indirect indicators physical activity levels. Indicators included workplace stair use, sitting time at office, overall physical activity levels, and total energy expenditure. The literature base was expanded further through a snowball method, where further relevant papers were identified from the reference list of key papers.

The literature was initially summarized and categorized based on several key fields: methodology (e.g. cross-sectional, pre-post, longitudinal), method of investigation (e.g. direct observation, remote monitoring, questionnaire survey), indicator of physical activity (e.g. stair use, sitting time) variable under investigation (e.g. stairwell design/location, building layout, elevator availability), and building functioning. Variables under investigation were then clustered into building domains informed by the authors' experience in architectural design (Table 1). Building functionings were derived from the five physical environmental factors likely to influence stair use identified by Nicholls (2007): Appeal, Comfort, Convenience, Legibility and Safety. The application of these functionings was broadened to include 'Social/Organisational Program' within the category of convenience (e.g. workplace exercise programs and equipment), as well as 'Health Prompts' within the category of legibility (e.g. point of decision motivational signs). Papers were classified under multiple categories as appropriate. The building domains and functioning categories are described further in the following section.

Table 1: Description of the literature review

Methodology	Cross-sectional 5	Pre-post tests 6	Longitudinal 3		
Methods	Direct Observation 8	Activity Monitoring 7	Questionnaire/ Survey 8	Automatic Counting 3	
Indicator of PA	Stair Use 13	Sitting Time at Office 3	Total Physical Activity 5	Energy Expenditure 1	
Building Functionings	Appeal (Quality) 6	Convenience (inc programs) 8(+2)	Comfort 6	Legibility (inc prompts) 5 (+9)	Safety 2
Building Domains	Building Culture 9	Vertical Circulation 12	Horizontal Circulation 4	Interior Places 4	Outside 2

The strength of evidence was based on number and type of studies. Substantial evidence included at least one systematic review or two pre-post test studies; emerging evidence included at least one pre-post test study or two cross-sectional studies; and weak evidence had little or no published research (Table 2). Weakness or 'gaps' in the literature were notable in regard to building culture, horizontal circulation and, more surprisingly, in the consideration of the interface between building interior and outside (Table 2).

Table 2: Strength of Evidence. This table describes the strength of the available literature on possible conversion factors for people's active movement within buildings. S=substantial, E=emerging, W=weak.

		Building Functionings				
Building Domains		**Visible Active Movement**	**Convenient Active Movement**	**Quality Space for Active Movement**	**Safe Active Movement**	**Comfortable Active Movement**
	Culture	W	E	W	W	W
	Vertical Circulation	S	S	S	E	E
	Horizontal Circulation	E	S	W	W	W
	Interior Places	E	E	E	W	W
	Outside	E	E	W	W	W

4. An evaluative framework for buildings and occupants

As outlined in the previous section, two organising schema emerged in the analysis process. The first, on the left hand vertical axis (figure 1) are areas or 'building domains.' The second, on the top horizontal axis (figure 1) are 'building functionings'—qualities identified across the literature that represent the ideal states of people's physical activity within buildings. Together the two organising schema combine in a modular format through which to understand conversion factors for people's capability for movement in buildings. In the following paragraphs we will describe each of the building domains and building functionings that make up the framework.

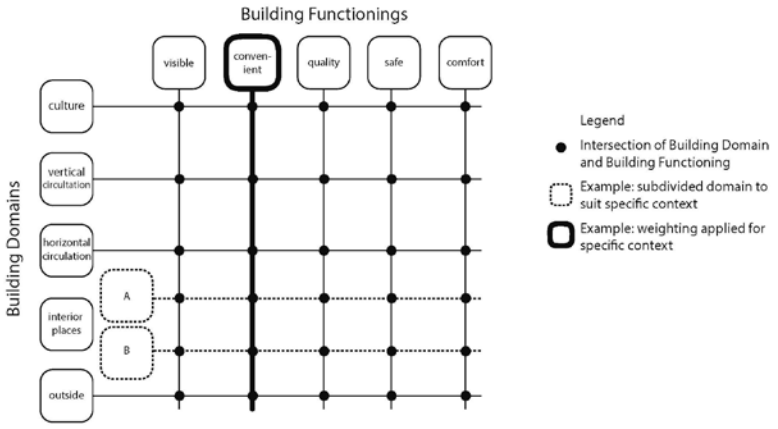

Figure 1: The Framework: Example showing potential to weight functionings, and divide or add domains. (Image: Authors' Own)

Building Culture: The 'Building Culture' domain recognises the importance of peoples' actions (and especially the people with power) within a place to shape it physically and socially (Jancey et al 2015). Many evaluations of physical activity in buildings, and urban environments more broadly, struggle to engage with culture as a key domain. Recognising the importance of the social aspect of an environment is part of a social-ecological understanding that moves beyond placing individuals as solely responsible for their own health behaviours. Recognising the significance of building culture and also challenges the dominant architectural mode of place analysis which focuses on the built form as the dominant driver of any behaviour.

Vertical and Horizontal Circulation: The most dominant cluster of literature regarding people's physical activity in buildings is around the use and design of 'Vertical Circulation.' There is in particular a focus on stair use prompts and various approaches to programing elevators (see for example Soler et al 2010; Nicoll & Zimring 2009). In comparison, there is less literature on the relationship between 'Horizontal Circulation' and occupants' physical activity. In architectural practice there is a deep interest in the typologies of buildings and how these different arrangements of areas and circulation influence people's experience of space.

Interior Places: Mapping studies of people's movement in buildings emphasises the importance of trips to in-office destinations in accumulating incidental physical activity and breaks in sedentary behaviour (Rassia 2008; Creagh et al in print). These destinations in an office context include printers, tea room/kitchen, meeting rooms, break-out spaces/landings and toilets. Quantity, access, variety, comfort, privacy, layout and kit (equipment) are likely factors influential on the utilisation of destinations within a building (Oseland et al 2011). We have used the term 'Interior Places' to emphasise both the quantitative and qualitative aspects of destinations within the building. For example, in an office context, some interior places such as toilets, and arguably print stations will be used by occupants irrespective of their placement and condition (Rassia 2008). Others, areas such as meeting rooms, break out-space, kitchenettes, will be used relative to their user-perceived appropriateness for the function (Oseland et al 2011).

Outside: West Australian studies have identified street/footpath as the places where the majority of people's physically active time is spent (Rosenberg et al 2010). As such, the environment outside the building (and our perception of that environment from inside the building) is an important driver of active movement. The framework focuses on the interface between the inside and outside of the building: that is, what can be seen from inside the building; the experience of moving between the inside and the outside; and the facilities and environment of the outside immediately surrounding the building.

Building Functionings: The 'building functionings' on the horizontal axis (table 2) are derived from the work of Nicoll (2007) on stair case design in academic buildings. Nicoll identifies five use factors: Convenience, Legibility, Appeal, Comfort, and Safety. We have shifted the language slightly to consider use and design. Legibility, a term that refers to the way building elements are 'read' by occupants, is here an idea within 'Visible Active Movement'. We have used 'Quality of Space for Active Movement' to emphasise that Nicoll's 'Appeal' is a result of design decisions that value the quality of the building environment. For the remaining three drivers the key words and emphasis remain: 'Convenient Active Movement', is how straight-forward it is to move around the building; 'Safe Active Movement' is how safe it feels to move around the physical and social environment and 'Comfortable Active Movement' is occupant comfort while moving around the building. Occupant comfort and building performance is a key area of research in architectural science which has historically placed emphasis on the building

services' ability (through lighting, heating, cooling, airflow) to achieve people's comfort while sitting and working.

5. Implications and considerations for adapting a capability audit for buildings and occupant physical activity

The Active Building Framework that we outline here is proposed with reference to a capability approach to built environment auditing as described by Lewis (2012). A capability approach has the potential to overcome weaknesses of existing audit approaches used to evaluate buildings and internal environments. In its current form, the framework is a guide for the development of a building physical activity audit tool (a copy of the current draft is available on request from the authors). An audit tool informed by the framework could work through each of the intersections of domains and functionings identifying areas of strength and weakness of the building's performance in terms of supporting capability for active movement (figure 2). An audit developed in this way could potentially measure the interactions between people's movement and the building environment and to propose and evaluate changes. Using such a tool in an overall evaluation may help to identify areas in need of particular attention and that the organisation/individual has the capacity to improve. In some cases it may be more convenient to consider each building domain at a time, an example of this would be when conducting a review of an existing building: for instance looking at vertical circulation, then at horizontal etc. In other cases it may be more useful to consider a building functioning in its entirety. This might be particularly useful in the design process. Looking at a sketch design of a building we might ask "How convenient would it be for occupants to move actively in this building?" in which case working through the 'Convenient Active Movement' section would present a series of provoking questions (or design problems) to engage with. In this way, the framework is user experience focused. It invites the designer to think through the building as an experience rather than a design—it invites reflection on the quality of the journey rather than the elegance/efficiency of the plan.

Figure 2: Sample page from Active Building Framework in development. (Image: Authors Own. Graphic Design: Mark Robertson)

The modular format of the audit framework also enables a capability evaluation. The adaptive structure of the framework emphasises the intersection of building domains and functionings. Weightings can be distributed across a range of distinct modules—each representing various capabilities embedded within specific building contexts. Through articulating a diverse range of capabilities relevant to physical activity in buildings the framework can potentially intersect with group and individual experiences of the world in different ways. The importance of understanding the varied context of buildings and how they shape the experience of a range of building users has been highlighted in literature from usability and adaptive performance perspectives (Lindahl, Hansen and Alexander 2013).

An adaptive framework approach rather than a prescriptive linear format is reflective of the indeterminate nature of capability as noted by some scholars (Philips 2006, 92). Although capability scholars like Nussbaum have provided a set of standard human capabilities, Sen on the other hand did not specify capabilities, instead suggesting that social evaluations should emerge from particular contexts (Philips 2006). The modular format of proposed framework accommodates the context specific nature of capabilities. For example someone using the framework to evaluate a residential apartment block may want to divide the 'interior places' category to consider apartments separately from shared places within the building (such as a laundry, entertaining room or gym) but apply the functionings with a shift in emphasis to each of these sub domains.

An adaptive framework for audit evaluations creates space for deliberation from audit designers and building users on content and process. Weighting of domains and capabilities allows different audit evaluations or intervention scenarios to be tested and compared. By offering multiple evaluation scenarios, the scope of audit knowledge is broadened and there is the possibility to accommodate a diverse range of building users. The modular design of the framework enables collective evaluation which can be responsive to the particular use and context of a building by incorporating further domains and adapting methodologies to particular domains. As Brown and Cole (2009) note there is a difference in the way that standards and regulations assume building occupants will act and their actual behaviour. Their research shows that building occupants' awareness and knowledge is a key factor in shaping building occupants behaviour. Brown and Cole highlight the potential conversion factors according to a capability perspective such as occupants' tacit knowledge, the building context and cultural factors.

This framework will be useful for those engaged in building management, design and research, including post-occupancy reviews, health promotion interventions, fit-outs, and architectural design development—wherever occupant physical activity is valued. Feedback on the format, focus and potential applications of the framework are needed to progress beyond this first iteration. In the coming months we will be facilitating a consultation process with experts in building management, design, evaluation; and community health promotion to better understand how this framework might be best shaped to inform practice. Green Star and LEED are particularly influential building evaluation systems, which are themselves constantly evolving. An ideal eventual outcome of this research would be to have this framework inform the industry standard evaluation tools such as Green Star and LEED. A recent example of the evolution is the introduction of the Green Star Communities category to the evaluation suite, which includes evaluation of 'healthy active living' and walkability within the criteria.

6. Conclusion

In this paper we present our work to date in developing an Active Buildings Framework as a tool to help systemise information and knowledge about people's movement in buildings. The framework presented here opens a promising line of enquiry. It is a start point from which to critique building design or to

develop an audit from a capability perspective. The planned next steps in the research are to engage with built environment and health promotion professionals to gain feedback on the usability, scope, and potential for application of the framework.

The value of this modular Active Buildings Framework is that it can be used to guide critical enquiry and reflection on the way in which buildings support or present barriers to people's physical activity. When evaluated, this framework will have the strengths of the audit: the potential to frame strong arguments in advocacy and to suggest improvements to the built environment. By learning from capability theory this framework recognises the importance of the intersection of contextual and individual specificity to understanding people's movement within buildings.

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