The Value of Architecture II

Demonstrating the value of design through research in European architecture practice

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Contents

Part one: Introduction

This first section sets out the project aims, the background and approach taken to support the adoption of simple research methods within architecture so that practitioners and their clients can demonstrate the social, economic, cultural and environmental value of their work.

Architects are adept at solving complex built environment problems in creative, inclusive and innovative ways and are therefore well placed to assist with addressing some of the major societal challenges faced by the world today, not least the Climate Change Emergency, and the aftermath of COVID 19. However, they don't generally think of themselves as researchers and are often excluded from debates about research, research funding and innovation. (Samuel, 2018). Additionally, architects have a communication challenge and need to explain the worth of their work in terms that make sense to decision makers—in particular those who finance it, but also to the general public. Therefore, the focus lies on finding evidence and facts of value created by architectural design and planning that would supplement the compelling visuals and story-telling that architects are good at already.

Value is created jointly, requiring many considerations and involving many types of expertise. Solutions must be found that create value at many levels, both for those who use the buildings and the built environment daily, and for society as a whole. The aim of this report is to support the development of research in architectural practice across Europe. Meaning finding suitable tools to document and evaluate the different types of value creation. This will enable architects to demonstrate the value of what they do, diversify their services and become more resilient, whatever the size of practice or the sector that they work in.

The report is in four parts. Part One - this introductory section - provides the background and methodology for the report. Part Two is a contextual review of research in practice, which draws on interviews with experts from across Europe, combined with an academic and grey (industry) literature search. Part Three focuses on the impact of feedback on the design process and the project itself through Post Occupancy Evaluation, and how it can be used to demonstrate the value of design. Part Three also features a series of eight inspiring case studies from across Europe that highlight the important role that feedback can play in developing practice-based knowledge, and evidencing and communicating the value of architectural services. The case studies also show that Post Occupancy Evaluation can be just as much about intangible social or cultural impacts as it is about the technical or environmental aspects of building design; it doesn't have to be complex or expensive, and can be undertaken within practices large and small. Further, Post Occupancy Evaluation is a really important foundation for 'Pre Occupancy' design based on a knowledge of what works. Part Four – contains the executive summary recommendations addressed to architects, policy-makers, clients, universities and academia.

Background

In 2018 the Architects' Council of Europe (ACE) sent out a call for evidence on the Value of Design and the Role of Architects through their network. A review of the evidence submitted pointed to significant gaps in knowledge, in particular on the contribution that architects can make to meeting the triple bottom line of sustainability: social, environmental and economic and in addition cultural value (ACE, 2019), usually evidenced through some kind of Post Occupancy Evaluation. It included an extensive bibliography which has not been replicated here. The evidence was patchy with several European countries entirely unrepresented and it was difficult to find suitable project examples. A set of practical recommendations was included in the first report to help move architectural education, research and practice in the direction of evidencing value. These include the need to develop:

1. The mainstreaming of Post Occupancy Evaluation across the European Profession, as a key tool for architects and their clients to support the quality of future projects and commissions, and identify good practice, as well as economic, environmental, social and cultural value.
2. Regional, national and international networks of architects and academics, to share research knowledge, best practice and expand capacity to undertake research within architectural practice.
3. Strategies to address gaps in knowledge covering all parts of Europe, and all value and project types.
4. Guidance tailored to architects so that they can evidence and communicate design value, through open-access case studies and research resources.
5. Tools to quantify and monetise design value, for example through Social Return on Investment and Whole Life Costing calculations, so that the long-term economic value of good design is included in procurement, and embedded within public policy.
6. Expanded definitions of architectural practice, to encapsulate the breadth of work and capture the true contribution that architects bring beyond the stereotype.

This second report touches upon all six of these strands, but is focused on the first, and arguably most easily actioned of the recommendations, the development of Post Occupancy Evaluation in European architectural practice.

Methodology

This is the first Europe-wide investigation into research in architecture practice. The project team, from the University of Reading School of Architecture, launched the project at the ACE Assembly in Barcelona in November 2019. A call for evidence was made through ACE to its Member Organisations. Other calls were made through the European Association of Architectural Educators (EAAE) and ARENA the European Architecture Research Network, with negligible response. The project was also advertised extensively on social media. The team was particularly keen to target countries that were poorly represented in the first report, notably in Southern and Eastern Europe.

The majority of contacts came to the team through a "snowballing" method of recruitment, beginning with existing contacts. Purposeful rather than statistical sampling logics were applied, with respondents selected on the basis that they were likely to generate rich information about research in architectural practice in different parts of Europe (Curtis et al. 2000). As shown in Table 1 below, the team undertook 20 in-depth semi-structured interviews with practitioners, academics and policy professionals across Europe who are deeply involved in research.

Table 1: Experts interviewed for the study

Role / organisation type	Home location / scope of work
Researcher / Large architecture practice	Denmark / Norway & Sweden
Researcher / Large manufacturing firm	Belgium / Across the EU
Architect / Large architecture practice	The Netherlands /Norway, France & Germany
Academic / University architecture department	Poland / UK
Researcher / Large architecture practice	Denmark / Germany, Switzerland, Belgium, Sweden, Austria & UK
Architect / Small architecture practice	Romania
Architect / Small architecture practice	France
Academic / University architecture department	Slovenia
Policy advisor / Governmental or non-profit	Belgium / Across the EU
Policy advisor / Governmental or non-profit	Germany
Academic / University architecture department	Italy / Across the EU
Policy advisor / Governmental or non-profit	Spain
Architect / Municipal client	Spain
Commissioner / Municipal client	Germany
Policy advisor / Governmental or non-profit	The Netherlands
Academic / University architecture department	Italy / Across the EU
Architect / Medium architecture practice	Ireland
Architect / Small architecture practice	Bosnia & Herzegovina / Poland
Architect / Small architecture practice	Spain
Academic / University architecture department	The Netherlands

The interviews were carried out between December 2019 and March 2020. The majority of interviews were recorded, with permission, and transcribed. The remainder were written up as interview notes by the project researchers due to problems with technology or provided in written form by respondents as a way to overcome language barriers. Together with input from a cross-Europe advisory group, regional contacts developed through social media and a limited literature review, these interviews form the basis for the contextual review below and enabled the team to identify value cases studies, based on a diverse range of Post Occupancy Evaluation methods, for inclusion in this report. The project builds on extensive work on the development of research and Post Occupancy Evaluation by the project team for the Royal Institute of British Architects (see for example Hay et al, 2017; Samuel, 2017). Both research and reporting were undertaken largely in English, against a backdrop of the UK's departure from the European Union.

Part two: Review of research in European architectural practice

This section sets out the challenges and opportunities facing architectural practitioners in Europe. It begins with a review of the current context for research (notably the Climate Change Emergency), before discussing the geography of research in architectural practice. This leads onto a discussion of ways in which research can be incentivised, one of which is research funding, and concludes by examining the role that the universities and schools of architecture can play in raising levels of research and innovation across Europe.

Context

Practices of all sizes have much to gain from developing a distinctive research offer that sets them apart from others in the field (Mirza, 2018), attracting clients and talent alike in the process. This isn't just about architecture practices that focus on technology. Even architects with a cultural focus are increasingly under pressure to measure their impact through the recording of visitor numbers and internet hits, and have to be proactive in promoting their design research through written publications, events and exhibitions. The documentation of impact in these ways has become key to securing further cultural funding. Architects in the EU are classified as 'Business Services' (EU, 2015) and there is much to be gained by practices in every sector in refining those services through research.

Developments in technology such as: service delivery through Apps; big data; digital twin models, Building Information Modeling, modern methods of construction; locative media; mapping; user generated content; gaming; Geographical Information Systems; robotics; eye tracking; 3D printing; scanning; biomimicry; biotechnology; augmented reality; agent based modelling and Artificial Intelligence mean that architectural practice as we know it is set to change rapidly (see for example Siemens, 2020), especially with the advance in globalisation (Raisbeck, 2019). Leading architects are working with other disciplines to advance these technologies in design and construction through research and innovation projects (RIBA, 2019a). Other practices are focusing on analogue innovations, including new kinds of user experiences that require real world interaction, education (including hands on making) and transformative encounters such as cultural performances and events.

Whilst some architects remain wedded to an architect-as-artist paradigm, the need to embed evaluation and learning within the building industry, has come into sharp relief as the impact and risks associated with climate change and ecological breakdown become more apparent, and more urgent in the minds of citizens and governments (IPPC, 2018). The construction industry as a major driver of energy demand and emissions in the EU, has a responsibility to improve the energy and resource efficiency of existing buildings and new construction projects (European Commission, 2020). This is being tackled with more stringent building standards embedded in policies at the European, national and regional scale (European Parliament, 2019; EUR-Lex, 2010); as well as the funnelling of European and national funding towards research and development projects that seek to reduce the environmental impact of buildings, construction materials and methods (European Commission, 2019a). In addition, architects have a clear role to play in contributing to meeting the goals embedded in the European Green Deal roadmap to reach carbon neutral status by 2050 (European Commission, 2019). The challenge of retrofit and renovation of existing public and private buildings have been highlighted as a key priority area, as has the integration of the circular economy within construction projects, and the move to digitisation to aid the climate-proofing of building stock (ibid).

In line with the UN Sustainable Development goals (UN, 2015), there has also been a move to understand the impact of the built environment in contributing to a holistic definition of sustainability. This is reflected in EU and national policies and declarations (European Commission, 2019b), and in the raft of assessment tools and certifications that go beyond energy, to consider broader environmental, social, cultural and economic impacts. These include HQE in France (Cerway, 2016), VERDE in Spain (GBCE, 2019), and DGNB in Germany (German Sustainable Building Council, 2020). As well as certifications available internationally such as BREEAM (BRE, 2020), Passivhaus (2015), and WELL (International Living Future Institute, 2020). From this perspective, the built environment has a role not just in limiting carbon emissions, but in positively contributing to carbon reductions; mitigating against the effects of a changing climate including the risks of flooding, extreme temperature and resource shortages; the improvement of the environment through the cleaning of air and water and the promotion of habitat and biodiversity; and the facilitation of healthier, happier and more sustainable lifestyles amongst citizens.
Architects have a unique skill set and holistic overview

of building projects meaning that they are well placed to tackle complex societal challenges. Architects enjoy very different levels of protection of title across Europe (European Commission, 2014; Heintz, Roohé and Stenfert, 2018), different ways of framing their activities (European Commission, 2019c), as well as very different levels of job satisfaction and pay (ACE, 2018). The profession has been weakened by an undermining of their role through increased competition from other fields, and a reduced perception of the value they bring based on a misconception that their work is solely driven by aesthetics (Hyde and Jones, 2019). There is a clear need to demonstrate that the architects' work is crucial to drawing different strands together in the creation of a built form that is truly fit for purpose (Samuel, 2018; Willis, 2020).

The need to develop evidence is starting to be recognised, especially now that sustainability is becoming embedded at the heart of architectural practice - it can no longer be treated as an optional additional service. The agenda is being pushed by various institutions, including ACE and its member countries' architectural institutes, with a move to evidence how architects can contribute to meeting the UN Sustainable Development Goals (RIBA, 2019b). Architecture Creates Value by the Danish Association of Architecture Firms (2020) is a good example of this approach, featuring case studies of the social, environmental and economic value. It has also been recognised at grassroots level, as evidenced by the recent Declaration of Climate and Biodiversity Emergency which was signed by more than 2500 practices, of all sizes, across Europe (Architects Declare, 2020a-k). Crucially, this pledge sets out the importance of evaluating new projects against aspirations, and the sharing of knowledge generated on an open-source basis (ibid). Practitioners from across Europe have joined forces to reduce the 'performance gap' and thereby carbon emissions in new and existing buildings, based on research to inform and measure improvements in energy and resource efficiency (LETI, 2020).

The geography of research in European architectural practices

There is clearly much to celebrate in terms of the research that is being undertaken, however the results of previous studies combined with the findings of this report, show that research is not widespread, and where it does occur is unevenly distributed. The last ACE Sector Study included for the first time a question on whether practices offered Post Occupancy Evaluation (POE) as a service. It found that after the UK the countries that were most likely to offer POE were Romania and Italy, but we were unable to find evidence to back this up (ACE, 2018). Whilst there are clusters of activity within parts of Northern and Central Europe, architects working in Southern and Eastern European countries appear to be considerably less active in the research arena. Wilkinson and Pickett (2019) have identified a correlation between 'civic participation' (including participation in professional groups) and income inequality across Europe (p.57). We speculate that there is a correlation between the countries with low levels of income inequality and high levels of research.

The reasons for geographic disparity need to be explored further, but evidence drawn from the experts engaged in this study, point to the significant influence that particular economic and political contexts have on the capacity of architects to engage in meaningful research activity.

The impact of the global economic crisis, may, in part explain the lack of examples received from Southern Europe. As one sustainability specialist from Greece highlighted, "the 'collapse' of construction activity during the last decade of the economic crisis" meant that "there was no 'space' [or] interest in [research] initiatives. Another respondent reported that in Spain, where construction rates are low, and development budgets are squeezed, employing an architect has become a 'nice to have' rather than a necessity. In a context where "they [clients and developers] don't think they need an architect, why would they evaluate projects afterwards?"

In parts of Eastern Europe, research does not seem to be on the agenda because the building industry is grappling with more fundamental issues. As one architect from Romania explained - "in the construction field there are more basic problems. [Research and evaluation] is considered to be the next level. We have to solve things like laws that are contradicting each other, and the decrease in public authority in buildings." This contradicts the findings of the Sector Study (mentioned above) which found that Romania is a leader in POE, suggesting there may be some confusion about the term (ACE, 2018).

Even in countries where research is more common, it is not undertaken in a consistent way. As one Irish respondent reported, research in practice is seen as a "developing and emerging [field] but it has been like that forever" and has never become part of mainstream practice. In addition, where research is undertaken it is overwhelmingly focused on driving down energy-use. Whilst this is crucial, the influence of people, their behaviour and interactions with technology and the building fabric in reducing energy demand is often left out. The notion of moving beyond energy to address a more holistic and people-centred view of sustainability remains, as one practice researcher from Denmark stated, "pretty unusual", but is an area of considerable potential.

Incentivising research in architectural practice

There are clearly some shared conditions that inhibit research in architecture becoming a standard part of practice across Europe. These include common barriers highlighted in previous studies relating to the culture and

business of architecture (Bos de Vos et al. 2016; 2019). Crucially, respondents from all countries highlighted the demanding business context in which architects work as a key factor. According to one Irish based architect, project-based work with its focus on delivery and meeting deadlines, makes it hard for practices to "lift their heads above their drawing boards." In addition, undertaking and resourcing research can be a difficult proposition for the majority of architects who "don't have a business model that produces a lot of cash outside of project-based work." In addition, as one respondent from the Netherlands noted - "in the contract between the client and the architect, POE is not included [and] architects are not paid for it."

"The way that architecture works is not very helpful from the architects point of view. The competition based business model [is] focused on winning projects, getting them done and then moving on. There is a barrier [to research] in this model."
(Architect, Denmark)

In the UK, Research and Development Tax Credits have been an incentive for practice research (RIBA, 2017), with a similar scheme existing in Norway (The Research Council of Norway, 2019). According to one respondent, one of the challenges faced by practices seeking to benefit from the Norwegian scheme, is the requirement that research and development projects should be clearly defined and separate from a company's day-to-day business. POE provides a useful frame to define a discrete research activity outside of individual project work. Another issue is the tendency of tax credit schemes to be based on an industrial engineering model with other types of research, for example research with people, not counting as 'real' research. Some accountants are much better than others at navigating this territory and securing rebates for their practitioner clients. Further research is needed to understand how practitioners might benefit from tax breaks in other parts of Europe.

Professional indemnity insurance could be another incentive for practice research. Many architects cite concerns about insurance as a disincentive to POE, as they are worried that defects may come to light that would otherwise have remained hidden (Hay et al. 2017). In other industries research based practice is rewarded with reduced cost insurance premiums and warranties. As the insurance industry is set to become more data driven, we anticipate performance data playing a greater role in insurance. In the UK the RIBA Insurance Agency (2020) has changed the wording of its policy to incentivise POE. Further research is needed to understand the role of insurance in encouraging research across Europe.

Resource constraints in architecture are stated as being a significant barrier to the development of research in practice. Despite this, evidence drawn from the practices featured here show that there are multiple ways in which European practices of very different sizes can build research capacity. Amongst larger architectural practices research and development is a key part of business planning. For these firms, research is seen as central to refining, improving and proving the value of their work. As one Danish respondent articulated, by focusing attention on, "what architecture does, rather than what it is," research enables architecture to be seen as a "catalyst" for meeting the goals of "'organisations, people and society as a whole". Crucially this reorientation enables practices to go beyond mission statements that express their intentions, to a position of being able to show the value of their work based on evidence.

"It can be hard to articulate what is great about a project, you are kind of stuck, and say it has a nice aesthetic. I think it is important to have a coherent narrative based on evidence - not an ideological position." (Architect, Romania)

"Clients are unaware of what architecture is … we have to argue and make the case to clients that it is about more than just taste, but is about spatial quality. We need to move beyond a basic expectation that architecture is about fashions, to show its real problem solving capacity and [contribution to] quality of life."
(Architect, Slovenia)

From a marketing perspective, research findings are particularly effective in enhancing a practices' credibility, reputation and brand. Thought leadership is increasingly being recognised as an important element of practice marketing and a way of accessing potential clients before

the resource hungry process of bidding. This experience chimes with existing research such as the Future Value Chains of Architectural Services project at TU Delft (2017), which highlights the importance of good business practice, and the relationship between business strategy, evidence of value and research (Marina Bos de Vos, 2018). Developing relationships with clients in a relatively relaxed research setting is an opportunity to develop potential future collaborations. Anecdotally practices have found that revisiting projects to solicit feedback has sometimes resulted in further commissions.

Putting aside funds for research and knowledge management or setting aside dedicated time for research strategy is central to maintaining an advantage in an increasingly competitive market. However, amongst those engaged in this study the business model is not entirely clear, with most pursuing a variety of routes to finance research activity.

"What is the business model for a private company to do this? The question is who is going to pay for it? I think that could be the greatest barrier. We are working on it ... but that is the challenge." (Practice researcher, Denmark)

Many firms have a research lead or research champion responsible for promoting and developing research across the organisation. The London based Research Practice Leads group (2016) (including membership of some 40 practices, some large and some small) meets together quarterly - one way of sharing best practice. Larger practices, with more resources, see the value of investing in their research capacity directly, by employing specialist staff who are supported through business overheads or research and development tax credits. Collaborations with other professionals and manufacturers working in the building industry, such as the Velux Model Home 2020 programme (Velux, 2020), is also a way to benefit from research without having to finance the work directly.

Practices are also beginning to offer research as a service they offer to clients. The development of innovation and the diversification of services is key to resilience when the construction sector goes through one of its regular recessions (Samuel, 2018). Some practices see potential in the 'design thinking' space that has so productively been occupied by organisations such as IDEO (2020). As one Danish architect explained, having invested and pulled in external funding to develop research, "what we are trying to do now is to take that knowledge to use in a consultancy space. We are stress testing what we can add value to, and thinking about how we sell this as a service." A key part of this comes in "having a better understanding of core value propositions in specific contexts, so we can help our clients see that [research] is valuable."

Research may be of particular value to public organisations who own and commission multiple building projects, as well as those who seek to understand the impact of, and then justify, the investment in new buildings and infrastructure as a way to support wider public policy goals.

"In the case of a public institute, for example a municipality responsible for education, [research] is a way to actually go back to the politicians and to the citizens and say that is what we got out of building our schools. [Buildings] are expensive, you have to justify the investment, and why it is a good idea." (Practice researcher, Denmark)

It is also of value to private clients, both in supporting the business case for a particular building project, and to provide evidence to show the public benefit of a development when seeking approval, or funding, from a local municipality. As one Danish practice research explained, "the value of working like this [comes] in providing … the right knowledge so they can argue towards their municipality why it is a good idea to create a project like this."

The move towards a research and evaluation orientation, has also been aided by the more widespread client-led application of socio-environmental performance certifications in some parts of Europe. For example HQE (Cerway, 2016), VERDE (GBCe, 2019), DGNB (German Sustainable Building Council, 2020) and BREEAM (BRE, 2020).

"If there is a certification, you have to get the proof that the building works, it's incredibly important for the clients, [and] that is what we are aiming for." (Architect, The Netherlands)

Building upon research and evidence of what works has also been central to leading architects' responses to the key challenges we face globally, not least the climate crisis, and the threat of Coronavirus (COVID-19). These include vital contributions to the development of healthcare facilities (Jessel, 2020; Weessies, 2020), and future-oriented design research to meet the challenge of sustainability at all scales (Cavallo et al, 2018, C40, 2020; Petcuo and Petrescu, 2015, UNstudio, 2020).

An ability to demonstrate value with data impacts on the profession's ability to win projects or demonstrate value in an extremely competitive environment (RPL, 2020). Some innovative clients are starting to use Outcomes or Value Based Procurement as an alternative to traditional building contracts (Samuel, 2018). When 'procuring for value' (CLC, 2018) the team collaborates to achieve certain specified measurable outcomes, for example embodied carbon or organisational performance. Outcomes based procurement is particularly appropriate for modern methods of offsite construction that don't require complex building contracts. A performance based leasing model is used in the Cradle to Cradle Park 20/20 Bosch Siemens Building in Amsterdam (Scott, 2014), suggesting this is likely to be a possible direction of travel in the future. According to one respondent, value based procurement is also being trialled in Norway in the development of public projects, including transport infrastructure and education buildings.

Across policy and the construction industry there is a growing recognition that, for too long, the procurement of buildings has been focused on profit and economic development to the exclusion of social and environmental value, the particular expertise of architects (RIBA, 2019). Architects, particularly small practices, have great difficulty in answering the kinds of Pre Qualification Questionnaires necessary to bid for, or win, projects because these are generally set up based on a paradigm that comes from engineering. Nor are they generally able to back up their claims to expertise with quantitative data. Greater clarity is needed about the way that bids are assessed. It may be that public procurement needs to be based on the triple bottom line of sustainability (social (including cultural), environmental and economic value), with measures framed to enable architects to articulate the particular value that they bring to a project (for example the employment of graduates and interns, connecting communities, encouraging active lifestyles and fostering positive mental states). At the same time architectural practices need to improve the way that they collect and manage data about their activities. Evidence drawn from practices already engaged in this work, shows that it doesn't have to be a complicated or resource hungry process (Dye & Samuel, 2015; Hay et al. 2017).

The research funding context in Europe

The role that architecture plays in contributing to the public good, means that architects should be in a good position to take advantage of the variety of public and charitable research funding opportunities available nationally, and provided through the European Union. Some of the practices featured in this report have organised themselves so that they can apply for funding sources of this type to develop their research capacity. This has included establishing a research and development 'sister' organisation, as well as constituting as not-for-profit Non Governmental Organisations with a social mission (for example atelier d'architecture autogérée featured in the ground breaking R-URBAN case study below).

At the national level the practices engaged in this study have been successful in receiving funding from charitable institutes and foundations for projects which have a clear community benefit (for example AART featured in the Parkhusene case study below), national funding opportunities and particularly those focused on energy and climate change, and more localised funds from for example, local authorities who are interested in understanding and improving the environmental and organisational performance of their public buildings (see for example the Limerick County Hall case study below).

Whilst it is positive that architects are starting to secure research funding in these ways, the availability of funds varies across Europe. There appears to be a more generous funding context in the Netherlands (see for example Click NL, 2020). Variations in research funding can relate to strong variations in the percentage of GDP allocated to research and innovation at a governmental level. Even in countries where there is more money available, research funding for architecture is difficult to access.

> "I'm not sure its a practical way of doing [research]. It happens ... because we want to do it. It lacks structural coherence, it doesn't sit within an institutional process but sits on its own." (Architect, Ireland)

Some architectural academics have been successful in accessing European research funding opportunities. These include the European Union's Life + Programme of Environmental Government which supported R-URBAN (2020), and the Horizon 2020 research and innovation programme which provided funding for ADAPT-R (Zupancic and Pedersen, 2017), Positive City Exchange (Limerick City & County Council, 2020), Triple Areno (2018) and REDWELL (2020). The European Commissions' Marie Skłodowska-Curie fellowships have allowed architects to undertake PhDs, and experienced architectural

researchers to gain knowledge in new areas (European Commission, 2020b; see also the Knowledge Exchange case study below). Industrial PhDs have played an important role in driving research in Denmark (Innovation Fund Denmark, 2020). In addition, architects have taken a key role as part of cross-disciplinary teams on the development of digital tools and technologies to drive energy retrofit across Europe, these include BIM Speed (2020), the Build-Up skills advisory app (Geckotech, 2020), and RenoZEB (2020).

However, it should be noted how few practices appear to have had access to European Funding - rare examples are Foster and Partners, White Arkitektur and BIG - international firms who are part of the Innochain European Training Network (2020). Understanding how to apply for European funding requires persistence and time that practices don't generally have. In addition, current funding streams are overwhelmingly focused on energy, and do not take into consideration the broader aspects of sustainability, nor the architect's role in bringing the social, technological and spatial strands together through design. An examination of the EU CORDIS database of funded projects reveals projects that involve architects under the search team 'building,' but only a long list of computer based projects under the term 'architecture' (EU Publications Office, 2020). Architecture sits uncomfortably between Creative Europe (2020) funding which is focussed on the cultural and creative sector and Horizon 2020 which is more technical.

The interdisciplinary nature of the profession means that architecture sits uneasily across funding councils. Architects generally have difficulty explaining what they do to funders who are often working from a medicine or engineering paradigm. When asked who should evaluate a project bid architects cannot find themselves in the web-based drop down menus specifying research fields (for example COST). This means that their work is likely to go to the wrong type of reviewer, minimising chances of success. At the same time the low profile of architectural research means that few reviewers will be familiar with architectural ways of working. Advocacy is needed to ensure that architects are not marginalised from the process.

According to respondents there are a number of barriers to applying for EU funds amongst small to medirum sized practices. These include the investment of time and resource required to apply, the low chances of success, and the administrative burden imposed on those who receive an award. More support needs to be given to practices to develop the skills and capacity needed to apply for research funding, both through collaborations with academics, and with support from the professional institutes. For example the Royal Institute of Dutch Architects (BNA, 2019b) offers a very positive route into practice research funding. A research problem is identified by the Institute working with stakeholders who contribute to a fund for the exploration of that issue. A competition is held for cross disciplinary teams to develop design research solutions. The results, written up as reports are made freely available as a resource to its members (ibid).

The role of the universities and schools of architecture in facilitating research in practice

Schools of architecture have a major role to play in helping students to develop research skills which can be developed in practice. Whilst there is a strong throughput of practitioners into schools of architecture in the form of part-time teaching staff and reviewers, it seems that practitioners are rarely brought to collaborate on staff research. High ranking schools across the globe are starting to recognise the importance of making space for research collaboration with practitioner teachers if they are to keep their edge.

In Europe, schools of architecture have largely been exempt from the Research Excellence Framework (REF), reviews of research which have become such an accepted part of life for academics in the UK, Hong Kong and Australia. Universities in Scandinavia are also developing a similar process. Whilst the REF has had negative impacts, not least exacerbating the division between schools and academia, it has had the positive impact of forcing UK architectural academia to express its work in terms of research that can be understood across disciplines and has helped the trajectory of architectural research in this country (Samuel, 2018).

Practices who have developed research capacity have usually benefited from long-term collaborations with research institutes and academics. Practices such as Zaha Hadid Associates have a synergetic relationship with schools such as the Architectural Association in London where studios focus on practice based research endeavours, with talented students subsequently being employed by the practice.

The widespread use of industrial-PhD placements across Europe, with the express aim of linking up researchers with practitioners, have been particularly fruitful, leading to innovation in research methods, technologies and design, and the luxury of longer-term studies that are difficult to resource in the context of commercial practice (Innovation Fund Denmark, 2019) .

Amongst respondents interviewed, working with PhD researchers has been invaluable in developing practice knowledge of a range of topic areas, including the development of methodologies to understand performance and value, and strategies to embed research knowledge into the design process, and translate complex research findings into concrete spatial interventions.

In small firms PhD research undertaken by practitioners

can actively feed into the development of research knowledge and capacity within the practice.

"The PhD research has enabled us to spend some time to think about and probe our projects, and contribute to the practice in a way that is not possible day-to-day on projects which can be quite hectic." (Architect, Romania)

However, the connection between academia and practice context in setting and pursuing the research agenda are not as well established in architecture as in other disciplines. As one Irish academic explained, "I see a very different context in science" and sectors such as manufactoring and pharmaceuticals "where you have industry led PhDs happening very regularly, and industry priorities tend to lead funding and drive knowledge in the university context."

The development of research is a core element of the activities of the European Association of Architectural Educators (EAAE, 2019) however its profile as a 'key competency' of European Architecture Schools could be higher (see for example EAAE, 2017). The current validation criteria for European Architecture Schools (see for example ARB, 2012) tend to put emphasis on the artistic dimensions and fail to give students a grounding in research methods, and do not equip architects with "the right skill set" to engage in research "in a critical way" (Practice researcher, Denmark). In many European schools students are taught by practitioners who themselves have little understanding of research and don't tend to teach design as a research discipline.

Studies of design value have been undertaken within academia (see for example Barrett et al. 2015; Eberhadt et al. 2019; Nordin et al. 2017; van Liempd, Oudgenoeg and Leseman, 2020; Salvado et al. 2019; Weijs-Perrée et al. 2020). However, they often sit in disparate fields such as Building Science or Environmental Psychology. Whilst these may be supported by ad-hoc relations between architecture and other disciplines, they do not appear to be systematised. In addition, the knowledge that is being generated in academia, is not being passed into practice or teaching in many instances.

Despite the recent growth in books about practice based research (for example Hensel and Nilsson, 2016; 2019), respondents noted that the vast majority of knowledge generated in academia is not accessible to practitioners (and most is written in English). As one academic from The Netherlands explained - "I don't think many architects read academic journals [which] make[s] it important to publish more accessible articles, design [and] policy guidelines" suitable for a practioner audience.

There is a clear need for cross-disciplinary work, focusing on the value of design, that is coordinated within architecture departments, and makes-use of the strong ties that Schools of Architecture have with practitioners working on live projects.

"There is a gap in what knowledge is, how you produce it, and how you work with it. [Research] in theoretical and academic contexts is hugely different to design - there is a big disconnect. How can you bring that closer to design? Maybe we need to engage architects in [research] in ways that are more relevant to what they are doing." (Architect, Demark)

The development of POE studies, utilising a wide range of methods that explore the impact of architectural practice and building designs on society, culture, the economy and environment, offers a clear arena where architects and academics can come together to generate and apply research findings in real world contexts.

Lastly, students need to develop relevant skills to support research in practice, such as bid writing, research methods, data collection and management, as well as high ethical research standards (which are a prerequisite for research funding). Member states need to ensure that there is a place for these high level skills in the university curricula, particularly at postgraduate level.

Conclusion

This section has set out our findings on the state of practice based research in architecture across Europe and the value of embedding research into architectural practice, both for the profession and clients, but also wider society. It explores the drivers that are pushing forward the adoption of research in a more consistent and widespread way, and the opportunities these changes bring for architects both in practice and academia. The final section of the report illustrates these aspects with a set of case studies that bring to life the value and use of POE from leaders in the field who work across academia, research and practice in the EU and beyond.

Part three: Post Occupancy Evaluation - Creating value from feedback

This third section focuses on Post Occupancy Evaluation, a clear area where architects and academics can come together to develop practice-based knowledge into environmental, functional, social, health, cultural, heritage and economic value.

At one end, value is a question of what is good, what makes sense and what has meaning and relevance—or what does not. Value is based on perceptions, which are again based on cultural ideas and philosophy. Values are ethical virtues and aspirations. At the other end, value is about describing things and phenomena with precision, be it conceptually or numerically. Valuing is about describing characteristics and qualities, some of which can be described or measured using numerical values.

Architectural value cannot be simply calculated in monetary terms, as the value of design varies completely depending on the stakeholder (subject) and scale (object). On the one hand, depending on the subject evaluated, it is measured in monetary terms for an investor, e.g. higher rental value, increased asset value, reduced maintenance and better resale value, just to mention an few; whereas, the client profits from good design in terms of quicker permissions, a more efficient and safe construction process, increased public support and generating a good reputation; and for the occupant the benefits include e.g. fewer disruptive moves, reduced security expenditure, reduced maintenance costs, greater accessibility, increased occupier prestige, better health and well-being.

Another aspect of value is the relationship of a building with its surroundings and cultural context; society's expectations at the time are also important. Value for money might be added, based on cost-benefit assessment that variously includes tangible and intangible components.

Values can be grouped into economic, environmental, functional, social, health, cultural and heritage values.

Economic value

The economic value of good architecture could bring a prime cost reduction. The skills and expertise of the architect can provide cost-effective solutions to complex problems, not only saving money during renovation and in use, but providing extra benefits in terms of increased space, easier access, more efficient working and living conditions, which have an economic value attached to them. Additionally, lifecycle costs can be reduced, since clients are interested not just in the productivity of the building process, but also in the occupancy costs in relation to their own economic objectives. Clients are now becoming interested in a new and most important concept: measuring the productivity of building use through time. Costs can also be saved through better management, bringing together a multi-disciplinary team consisting of designers, cost consultants, representatives from client organisations, end users, stakeholders, and, in some circumstances, members of the wider community in order to identify the purpose of the project itself and the activities it has to accommodate.

Environmental value

Sustainability is related to the environmental value of architecture, having greater regard for the orientation of the site, local topographical and environmental factors, and designing and fine-tuning buildings that take advantage of these to minimise energy use and provide comfortable and pleasant environments in which to work and live. From an ecological perspective, resilience was initially defined as a 'measure of the ability of ecological systems to absorb changes of state variables, driving variables, and parameters, and still persist'. Therefore, resilience, as well as sustainability, is not a specific building attribute, which could be quantified, but a complex management process of the built environment dealing with the long-term evolution of buildings and infrastructures. Good architecture contributes to building resilience against extreme weather conditions, such as heat waves and floods, but also against critical events such as earthquakes.

Functional value

Most criteria found in literature are related to the functional value of good architecture. Good design layouts could support a longer lifecycle of the building. Examples could be an enhanced functionality, fitness for purpose, or loose fit. The functional value can also be raised by improving daylight access; considering the floor to ceiling height in order to improve the user's experience, allowing for better air flow and lighting conditions. The use of building mass to improve thermal comfort can be influenced by design. In addition, safety for occupants (fire prevention, minimising earthquake/flood damages) and construction workers (health and safety on construction site) can be improved by good architecture of the functional design.

Social value

The social value of architecture lies in delivering more liveable, sociable spaces. Good design may lead to lower crime rates, lower demand on health provision and possibly even better educational attainment in the long term. A UK initiative, the

Research Practice Leads, is working with the RIBA to develop a toolkit for the measurement of the social value of architecture. When looking at national policy papers, it can be noted that in Sweden the government states that planning and design have a positive impact against social segregation and decline. There have been studies trying to quantify the social return of investment, for instance in a health care centre in the UK.

Health value

The value area of health and well-being and its relation to productivity is direct, given the ability of buildings to provide heat and coolness, light and shade, companionship and sanctuary, excitement and rest. It has been demonstrated that buildings which actively pursued sustainable design, have also enhanced the occupants' perception and use of the building, which in turn has increased its economic value, as well as its social sustainability. The health-related value of an architectural design is most vital for the user/ occupant. In recent years, sustainable building design has moved from an approach centred on energy efficiency to one centred on occupant experience trying to link sustainability rating systems with comfort of occupants and conservation of natural resources. Research in the area of sustainable building design and the well-being of the user focuses on energy performance, daylight, ventilation, acoustics and occupant feedback.

Cultural Value

Architecture's cultural value lies in its nature as a public good or externality, affecting positively or negatively both interiors and the surroundings. These effects are usually determined by those who commission the building, often through a lack of awareness or care. The cultural value of good architecture is derived from increasing the community value and is hence strongly linked to the social value. For instance, it could be found that an improvement of the public realm quality, resulted in an increase in community cohesion and activities, or the provision of better public amenities (i.e. parks, fountains, electrical charging, benches, sport facilities). Good architecture emphasises the important influence of the design and relationships between objects and their built and natural surroundings on our quality of life. The so-called 'Baukultur' is an application of conscious, well-debated design to every building and landscaping activity, prioritising cultural values over short-term economic gain.

Built heritage value

Architecture adds value to cultural built heritage in terms of an increase in building resilience and durability by protecting a building's character, enhancing its preservation and proposing an integration with the surrounding environment. This design value is based on the conception that every age has a certain spirit or set of shared attitudes reflecting its intellectual and cultural climate, a certain worldview, sense of taste, collective consciousness or unconsciousness that is in fact utilised when designing. Therefore, the built heritage is part of our culture and history, and safeguarding it is vital for future generations.

In 2018 ACE signed the Davos Declaration with Ministers of Culture and Heads of Delegations of the European Cultural Convention, UNESCO, the European Commission, ICOMOS International and Europa Nostra, amongst others, highlighting that 'The value and irreplaceability of Europe's landscapes and cultural heritage must be underlined, with the emphasis not only on cities and urban areas but also on peripheral and rural areas and their interconnectivity.'

Definition and benefits

Post Occupancy Evaluation (POE) is the process of going back to a building after it has been realised, to understand how far it meets the needs of clients and building occupants, as well as the wider impact it has on the community and environment (Hay et al., 2017a,b). The POE process provides value-neutral prompts to stimulate stakeholders to make testable observations about their experiences of buildings and the built environment effect on the different values described.

POE can be undertaken by practices of all sizes and is not just about energy but can take account of intangible aspects of experience such as atmosphere and identity. The focus of a POE study relates directly to the kind of information the client and designer need. Whilst most cover environmental aspects, many extend these to include a more holistic analysis of social, cultural, health, heritage and economic value. The value case studies presented here showcase the best of this research, evidencing the contribution architecture brings to:

- Encouraging social interaction amongst students and staff in Ørestad College, Copenhagen;
- Promoting health and wellbeing amongst tenants through the retrofit of social housing in Brussels;
- Re-using materials and resources in Venlo City Hall;
- Promoting the sharing of assets amongst local businesses and communities in Parkhusene, Aarhus;
- Building community resilience through R-URBAN - a network of interlinked citizen-led projects in Paris;
- Supporting organisational aims to deliver effective library services to communities in Barcelona;
- Enabling sustainable lifestyles through co-housing in Leeds and improving air quality in Wraclaw;
- Reducing energy and resource consumption in Limerick County Hall.

The architects featured in these case studies have seen huge benefits from undertaken POE research. It is central to learning from successes and problems, evidencing performance and value, and improving the products and services they deliver. From a marketing perspective, the findings from POE studies are particularly effective in enhancing a practice's credibility, reputation and brand. POE research can also be powerfully utilised to influence changes in the wider policy-world based on evidence (for example the Knowledge Exchange case

study below), including justifying a development project or approach, or raising the bar in terms of environmental quality, community engagement and impact (as illustrated in the Venlo City Hall case study).

"For us as a business the main benefit of POE is to qualify the next project and make better architecture which has more impact. Being able to show the impact of our work makes us more attractive to future clients."
(Practice researcher, Denmark)

Supporting POE in practice

The value of undertaking a POE is clear, however many architects struggle to see how they can apply it as a standard part of their practice. A key problem is an issue of resourcing, including research skills, time and ultimately money (Hay et al. 2017). The value case studies show that practices of all sizes can overcome resourcing barriers and integrate POE into their work. But in any case, it must be negotiated and made clear beforehand who pays for the additional work, depending on who benefits from the additional information gathered through POE. The beneficiaries can be private and public clients but also municipalities who commission POE. The POE does not necessarily have to be carried out by architecture practices, but they can encourage others to do so. For example, municipalities, private and public clients.

Larger practices with more resources invest in POE activities because of the competitive advantage that comes with being able to prove their worth. They also offer POE as a service to private and public sector clients, who increasingly see the benefit of understanding how their buildings perform in-use and contribute to meeting wider organisational and policy goals.

Practices of all sizes benefit from collaborations with research institutes and academics as a way to access EU and national research funding opportunities (see for example the Parkhusene case study) and develop research capacity through student placements and industrial PhD programmes (as shown in the Ørestad College case study). For micro-practices, partners themselves have benefited from undertaking PhD research. Collaboration with other professionals and manufacturers working in the building industry is also a way to benefit from POE work without having to finance it directly (see, for example, the RenovActive case study).

POE does not have to be an intensive process but can be based on very simple methods that can easily be embedded within existing ways of working. This means that POE can be successfully adopted by smaller firms. Indeed, R-URBAN by 'atelier d'architecture autogérée' is an example of best-practice, showing the widespread influence that a small practice can have through the documentation of social and environmental impact.

"You can get going with POE without going down the heavy academic route. It's about a mind set and taking the first steps. It could just be picking up the phone and asking the right questions of stakeholders." (Policy advisor, Germany)

Methods

A range of approaches and methods can be used as part of a POE. The technique applied will depend upon the focus of the study and the resources available.

A light touch POE might involve a building walk through to identify strengths and weaknesses in the design, combined with a short survey, interview or focus group with building users. It might be based on photography and mapping to observe and document how people occupy a particular building or space (Cooper Marcus, 2006). It could seek to capture increased revenues, for example the number of coffee sales before and after a café refit. It could also focus on the value of architects who take a participatory approach to design and construction, as well as those who have an active role as instigators, fundraisers and programmers of local community projects. In this context, a POE might capture data about the number of people engaged in events or activities, the skills and capacity generated by their involvement, and even, the numbers of jobs created as a result.

A more comprehensive POE process might consider more complex questions, in more depth, and combine a number of methodologies to gain a more holistic view. For example, a POE of an office building might focus on internal environmental quality using sensors, combined with data on health and productivity gathered through surveys and monitoring of staff absences. An evaluation of a housing project might explore the energy efficiency of a dwelling, combined with qualitative insights that draw to light the impact of occupant behaviour on energy use. A private developer or company might be most interested in understanding the long-term value of their investment, through the integration of whole-life costing or Social Return on Investment methodologies (Watson et al. 2016), and value calculations of materials and components that can be reused at the end of a building's life.

There are a range of excellent resources available online (RIBA, 2019) and in print (Cooper Marcus, 2006; Latimer et al. 2015; Praiser et al. 2015; Stevenson, 2019), providing accessible, general and sector-specific guidance on POE methods for a practitioner audience.

Learning from feedback

In order to gain the most value from POE research, the practices featured here have also carefully considered how to capture and feed-in POE knowledge so that it influences the design process. Larger practices with in-house research teams actively involve research staff in the early briefing stages of a project so that POE findings can inform design developments. This is based on learning gained from carrying out multiple POEs on similar projects produced by the practice, or from an academic literature review of building studies of the same type, for example health (Ulrich, 2008), education (Barrett et al. 2015), or sustainable office buildings (Baird, 2010). This research knowledge is particularly valuable when included as part of a competitive bid process. On winning a project, practices find it extremely useful to undertake POE studies of a client's current accommodation, to draw lessons that can be fed into briefing and to establish baselines of performance that can be measured against when the new building is occupied.

Practices of all sizes highlight the importance of sharing POE knowledge within their organisation. This includes summary and more detailed POE reports that are accessible to all, combined with internal learning sessions and presentations, as well as the distribution of POE knowledge externally through presentations and contributions to publications, and the uploading of POE information to shared databases and websites (BUS,2017; BRE, 2020). This contributes to the development of learning across the building industry, as well as helping to build a practices' reputation in a particular field or area of work (Hay, et al. 2017a, b).

Value case studies: Post Occupancy Evaluation in practice

The eight value case studies featured below are intended to inspire practitioners, academics and clients to undertake research into the performance and value of architecture. They show the diversity of approaches that can be taken to POE, which is a creative rather than bureaucratic process. They illustrate that practices of all sizes can get involved in POE research, and that their capacity can be enhanced and developed through collaborations with other organisations and disciplines. Ultimately, they evidence how investment in architecture pays dividends, making tangible the economic, environmental, social and cultural value of good design.

Ørestad College, Copenhagen

Key research partners: 3XN Architects, GXN Innovation, Roskilde University
Practice size: Large
Project type: Education
POE value type: Social

3NX Architects are driven by a user-centred approach to design, and a belief that good architecture can enrich people's lives and well-being. In 2007, the practice established an independent innovation unit, GXN, to develop new research projects and investigate the social and environmental sustainability of their projects.

Part of this work has involved the development of POE methodologies to explore the success of existing buildings, validate design decisions, and feed-in learning to inform the design of new projects. In order to progress their approach, 3XN Architects and GXN Innovation hired the industrial PhD researcher Mille Sylvest, from Roskilde University, to develop a mixed methods approach to the evaluation of buildings-in-use. This has subsequently been applied to a number of case study buildings, including Ørestad College (Sylvest, 2017).

Completed in 2007, Ørestad College was designed to support the clients' ambitions to promote interdisciplinary education, and a culture of openness, communication and collaboration amongst staff and students. The College is designed around four boomerang shaped floor plans which are rotated to create the overall frame of the building. Four distinct study zones, divided between different high-school grades, occupy each level, and are designed to provide flexible space to suit different teaching and learning styles. Each floor is open to a large central atrium and stairwell, which forms the main circulation space in the building, and provides a central community zone for the College.

The POE of Ørestad College explored if, how and in what ways the building facilitates communication and social interaction amongst users. The research paid particular attention to the use of space in the main atrium and stair, to explore how far the design supports different sorts of social connections amongst the staff and student body.

The POE was undertaken using the following methods:

- Building observations of the layout and functions of the space, general behaviour patterns amongst users, and detailed observations of particular users activity and social interaction.
- Activity mapping including photographic and video recordings to understand the frequency and location of different types of interaction.
- Semi structured interviews with staff to understand their personal use and experiences of the building.

The findings from the POE research show that the building design contributes positively to the social-life of the college.

Staff reported that the open design, which allows increased visual contact across the building, has increased their knowledge of co-workers, led to learning by seeing how others teach their classes, and prompted collaborations and the sharing of knowledge.

> These are very open environments where there is a large degree of interaction, and where it is impossible not to be in contact with others and exchange experiences about large and small matters. This ranges from how the last period went, to how we solve some larger problems.
> (Staff member)

> Generally the building prepares the ground for reflection and mutual exchange of experiences, precisely because it is so open. It becomes clear what works and what does not work.
> (Staff member)

Being able to see others and their activities not only creates opportunities for learning, but also a feeling of being part of a larger social community.

> It makes you happy to be in this building. Because of the light and because there is space around you, and because you become part of a sort of social organism. That is, you are constantly a part of something bigger, and you are constantly reminded of that because you can see so many people.
> (Staff member)

Staff valued the availability of informal meeting points around the building, including the central stair which provides students with a natural place to walk and chat, large landings which provide opportunities to stop and talk, to wait for others, as well as vantage points to see or be seen.

The POE also highlighted that whilst the atrium and staircase are good for affording chance meetings and interactions, they are not ideal places for effective or prolonged meetings to take place. Another finding was that the available meeting rooms with glass walls, were not always appropriate for holding difficult or private conversations, particularly with students. This learning has fed into the development of 3XN Architects and GXN Innovation's approach to the design of spaces for interaction, which now include more private and enclosed spaces that lead off from larger sociable areas.

Overall the success at Ørestad, has been in the very close link between the organisational vision, values and culture of the College, and the building design.

In this case, POE has had clear value to 3XN Architects and GXN Innovation as a way to develop practice-based knowledge of what has worked, to strive for continuous improvement in all their projects, and, crucially, to articulate the intangible but centrally important social and organisational value that they bring to clients and users through their building designs.

RenovActive, Brussels

Key research partners: VELUX Group, Le Foyer Anderlechtois, ONO architectuur
Practice size: Small
Project type: Housing
POE value type: Environmental, social and economic

Research and development are central to the way that the VELUX group develop, test and market their products. A key and high profile aspect of this work has been the development of demonstration buildings across Europe in collaboration with local architects, to showcase and test innovation in the integration of VELUX products into modern housing designs.

Since 2001 the focus of these demonstration projects has been on reducing the environmental impact of new build homes, whilst also improving the quality of the indoor environment in terms of thermal comfort, light levels and ventilation through the Model Home 2020 programme. Working with academics from Aalborg University, VELUX developed a holistic POE methodology to test the performance and impact of these demonstration houses in-use (Olesen, 2014). This involved the monitoring of energy use and indoor environmental quality over the period of a year, as well as the deployment of a seasonal questionnaire that captured the experiences and perceptions of 'test' families living in the demonstration homes.

Building on the knowledge developed through these projects, the VELUX group has in more recent years turned its attention to the retrofit and renovation market. It is well known that the residential sector is one of the largest consumers of energy in Europe, and that there is a need to dramatically improve the energy efficiency of dwellings (Tzeiranaki et al. 2019). Crucially, the bulk of this work needs to focus on existing housing stock, and particularly the two-thirds of homes that were built prior to 1980 before building energy performance standards were in place (Monteiro et al. 2017).

Within this market there is a particular opportunity in the social housing sector to promote building retrofits, which offer a range of environmental and social benefits

to landlords and tenants. These include the scaling effect that comes from tackling larger numbers of dwellings, including reduced energy use and carbon emissions at a community level, and waste reduction from the avoidance of large-scale demolition and reconstruction projects. At the same time, retrofit projects can also fulfil social landlords objectives to improve the health and wellbeing of their tenants. Alongside increased energy efficiency which should result in lower energy bills, retrofit has the potential to tackle other housing quality issues, including damp, indoor air quality, thermal comfort and noise (Monteiro et al. 2017).

In 2016 VELUX worked with ONO architectuur and the social housing provider Le Foyer Anderlechtois, to develop an approach to low-energy retrofit called 'RenovActive', and apply it to the renovation of a dilapidated 1920's semi-detached suburban family home on the outskirts of Brussels. The project sought to develop an affordable and replicable model of retrofit, that could be rolled out across similar housing stock in the area, and would bring measurable improvements in energy performance and water consumption, and indoor environmental conditions including daylight levels, comfort, and air quality.

The design of the renovation was based on six main elements:

1. An attic conversion to release the upper floors' potential, increasing natural light and improving ventilation and heat control.
2. Increased window area to draw in more natural light.
3. An open stairwell to enhance daylight and distribute efficient airing via the stack effect.
4. External sun screening including awning blinds.
5. Hybrid ventilation system which combined mechanical and natural ventilation.
6. Improved thermal envelope including extra surface isolation, new roof construction and new windows.
7. A building extension which added much needed extra space to meet the needs of modern family living.

Following rigorous testing in use, based on the same POE methodology developed to evaluate the performance of VELUX's Model Homes 2020 projects, the RenovActive demonstration project proved to be extremely successful. Gains included marked improvements in daylight levels, thermal comfort, indoor air quality, energy demand, energy supply and performance, and freshwater consumption. Crucially, the approach is also affordable, as it stays within the budgetary limits set by the housing association for renovation projects.

"As a social housing company, one of our obligations is to achieve social objectives that are defined by key performance indicators. One of these indicators commits our company to take occupant costs into consideration, which in this case is rent and heating combined. We have also committed ourselves to seek solutions that lower Co2 emissions from our communities, to focus on air quality and water quality in our houses[and] to provide healthy homes for our tenants. In the RenovActive house, we are very close to solving these challenges."

(Housing manager, Le Foyer Anderlechtois)

The success of the RenovActive House has led to the allocation of funds to the renovation of 86 further houses, and the potential replication of the approach across 225 houses of the same type owned by Le Foyer Anderlectois in the area.

The VELUX group and their partners, have sought to expand the application of the principles applied to the RenovActive House, and to share learning, by developing an Active House quality stamp applied to projects that are evaluated on the basis of the interaction between energy consumption, indoor climate conditions, and impact on the environment. The Active House website includes an open source database of all projects that have fulfilled these criteria, including a summary of the main issues and solutions used, a description of designs and a summary of performance data gathered as part of the POE process (Active House, 2020).

City Hall, Venlo

Key research partners: Kraaijvanger Architects, The City of Venlo, C2C Centre, University of Maastricht
Practice size: Large
Project type: Offices
POE value type: Economic, environmental and social

In 2007 the City of Venlo embarked on an ambitious project to apply Cradle to Cradle design principles, which seek to reduce waste and carbon emissions through the continuous material recovery and reutilisation, on a building scale through the redevelopment of the City Hall. Built on the edge of the River Meuse, the new building sought to be a catalyst for economic change in a post-industrial district in need of regeneration. In addition the City Hall was envisaged as an icon to promote Venlo as a centre for innovation in Cradle to Cradle design.

Following an open competition, Kraaijvanger Architects were selected, based on their vision to embed Cradle to Cradle principles in their approach. Early on in the design process, the design team and client set out a list of desired outcomes that they wanted to achieve through the building design. These included:

- Improved external and internal air quality, leading to increased health and productivity amongst staff using the building;
- Minimisation of waste-water in the building, and the enhancement of water quality;
- The use of healthy materials, which can be recycled and re-used without denigrating their quality;
- The integration of renewable energy in the building design, with the ambition to generate more energy than is used.

These objectives were consolidated into a series of 'road maps' put together by the architect to guide the development of the building. These were referred to at every stage of the design process to ensure that all decisions contributed to the meeting of core aims.

As a result the final design embodies the guiding aims through a series of important design moves:

- The maximisation of greenery through a 2,200 m2 living green wall inside and out, green roofs, and a 'greenhouse' at the top of the building to improve internal and external air quality. This is combined with solar chimneys to create a natural air flow around the building.
- The reduction of water consumption through rain water harvesting for the green wall, and the purification of 'grey' water through a reed filtration pond.
- The use of cradle-to-cradle certified products, supported by the development of a 'material passport' that documents the material constituents, along with how to dissemble, recycle or return them to the manufacturer.
- The rejection of non-renewable energy, including gas, and its replacement with energy efficiency measures to reduce demand, combined with onsite renewables including 1,000m2 PV cells on the Southern facade, and the use of solar water heaters.

Once occupied, a number of POE methodologies were applied in order to understand the environmental performance of the building, and its broader social and economic value.

The building has met its targets in terms of improved internal and external air quality through the integration of greenery inside and out, including the absorption of 30 percent of sulphur and nitrogen oxides in the air in the vicinity of the building. In addition the integration of over 100 plant varieties into the building design has increased biodiversity of the site which has now become a haven for insects and bird life. Onsite renewables generate approximately 50-60 percent of energy used in the building, with the remainder is supplied by off-site renewable sources. It was not possible to source C2C certified materials and products for the whole building, however the use of C2C products has been maximised, and certain materials have been avoided, such as paint and glue, in order to aid the recovery of materials in the future (C2C Centre, 2020).

In order to understand the links between improved environmental quality and health, the University of Maastricht carried out a before and after study, comparing the new building with the previous City Hall, and found that there had been a reduction in the number of employee sick days compared to those in other buildings.

Alongside the environmental and health benefits, the project has also been analysed from a financial perspective. The Cradle to Cradle design principles, and the development of the material passport, have enabled arrangements to be made with suppliers for the eventual buy-back of products. This means that a guaranteed financial residual value can be defined which - alongside savings in operational costs due to efficiencies and more productive staff - means that the building is forecast to deliver a 12.5% return on investment by 2040 (Ellen MacArthur Foundation, 2019).

In addition, the building design has had other effects on the local area and economy. In the procurement of building materials and products, the architect worked with suppliers to move towards and acquire C2C certifications for their products, thereby stimulating the transition to the economically profitable principles of C2C production. In the immediate vicinity of the site, renovations of old and redundant factories have led to the addition of 72 new dwellings that had C2C principles applied in their design and construction. The experience of procuring the project, and its tangible success, have led to the integration of circular models into government projects and procurement policies. The principles have also been integrated into the facilities management of the building. As an icon of sustainable innovation, the building has also played a key role in updating the city's image - which is increasingly associated with innovation and C2C economic opportunities. The City Hall alone has received over 32,000 visitors between 2016-2018, and Venlo itself has continued to grow in expertise in C2C practice with the creation of a Cradle to Cradle consultancy and training centre (Ellen MacArthur Foundation, 2019).

Pakhusene, Aarhus

Key research partners: AART, Alexandra Institute, Innovation Fund Denmark
Practice size: Large
Project type: Mixed-Use commercial and residential
POE value type: Social, economic and environmental

Located in the Aarhus Docklands, Pakhusene is a mixed-use development consisting of offices, shops, a gym and medium density residential apartments. The wider redevelopment of the Dockland area seeks to support the environmental and economic ambitions of the City of Aarhus, to tackle the climate emergency (City of Aarhus, 2016), and develop a diverse economy by fostering conditions that support small and medium sized enterprises to flourish (Academy of Urbanism, 2016). Furthermore an important vision for Pakhusene was to "give back" to the surrounding community contributing to a vibrant city life in and around the buildings. In Pakhusene, AART architects proposed a design strategy that would contribute to these agendas:

1. By enabling businesses and non-profit organisations to share facilities as a way to reduce waste.
2. Minimising costs, encouraging networking, the sharing of knowledge and skills at the local level.
3. Opening up several of the building's shared facilities to public use by the local inhabitants.

This strategy was developed in response to academic studies showing that up to 29 per cent of space occupied by organisations is under-utilised (Andersen and Christensen, 2015). In Aarhus, which is the second largest city in Denmark, this corresponds to 600,000 square meters with an annual operating cost of around DKK 300 million (Statistics Denmark). In other words, many organisations are spending considerable resources operating 'dead space,' and have much to gain from sharing rather than owning or renting facilities. In Pakhusene, AART architects designed a scheme that reduced the amount of 'private' office spaces, and instead developed communal facilities including a fitness centre, harbour bathing area, canteen, meeting rooms and events venues such as a large roof terrace.

© AART - Surveying residents in Parkhusene

In 2018, 1.5 years after occupation, AART architects collaborated with the Alexandra Institute to develop an applied research method in order to understand how far the goals of the Pakhusene scheme have been realised in-use. Following a workshop session with the design team, in which the vision and intention of the project was identified, an overall research design was developed, and specific research tools identified. These were based on qualitative methods in order to understand the social, environmental and economic value of the project from the perspective of stakeholders and building users. The post occupancy evaluation consisted of:

- Qualitative interviews with representatives of the companies who rent office space in the building;
- Qualitative interviews with 15 employees who use the buildings and shared facilities on a daily basis;
- Qualitative interview with building owners; and
- Two days of ethnographic observations.

In addition, the POE sought to calculate the additional space that shared facilities brought to different types of businesses in Parkhusene.

There are clear benefits to both small businesses in the area who now have access to an average of 270 per cent more square meters of high-quality facilities compared to their privately let offices, and to larger companies who gained access to 30 per cent more space. In addition, building owners who rent out office space in Pakhusene reported that shared facilities are not only well-used during the working week, but are also a source of revenue in the evening and at the weekend as venues for parties and gatherings for the local community, such as the Wednesday communal dinner in the canteen for the inhabitants in the area. Furthermore, local people use the gym, shop and street-level bakery.

In addition to the clear economic value that shared facilities bring to business owners and landlords, respondents in the POE also highlighted the social value that comes from the sharing of space by different users. This includes networking, collaborating and building business opportunities with others, as well as the less tangible benefits such as a sense of community and positive atmosphere.

"One of the things I appreciate about working in Pakhusene are the many shared facilities. It results in a vibrant atmosphere out here 24/7, which creates a good energy around the building."
(Berit Grotkjær Jensen / Competence Manager at MOE)

"One good argument for choosing Pakhusene was the tenant composition out here. There are other tenants that are ideal partners for our law firm, and there are some synergies that have already begun to bear fruit."
(Jesper Hedegaard / Partner at Interlex Advokater)

The POE concluded that what organisations give up in terms of control of their own square meters, is gained in terms of relationships that the environment of Pakhusene facilitates.

This research project has led to the systematisation of POE into the design process at AART architects. Where possible, the practice first carries out an evaluation of an existing space, and uses this as a comparative baseline for the POE in order to measure the benefits that come from the new development. An internal research team collects knowledge from AARTs own POEs, external POEs and academic research. This knowledge is activated internally through presentations to employees, and participation of researchers in the development of future projects together with architects and engineers. Knowledge from POE and research is used both as creative input and inspiration for the architects, and also supports a knowledge-based decision-making consultancy service for clients.

AART architects see a number of benefits in embedding research into the way they work. Being able to evidence the value they bring to their clients brings additional business opportunities to the practice, supporting the claims they make as part of competition entries, and helping to develop their reputation as leaders in their field. In addition the practice sees POE as crucial to creating more sustainable buildings that make best-use of natural, human and economic resources, based on the knowledge of what actually works, rather than on assumptions that may be incorrect and simply repeat past mistakes.

R-URBAN, Paris

Key research partners: atelier d'architecture autogérée, EU Life programme, Public Works City of Colombes
Practice size: Small
Project type: Regeneration strategy, community facilities
POE value type: Environmental, social and economic

Established in Paris in 2001, atelier d'architecture autogérée (aaa) is a non-profit NGO that aims to instigate and support development in disused urban sites that contribute positively to the social and environmental life of the communities in which they are located. The practice is committed to a participatory approach, which means working with ordinary citizens to enable them to have a say, not only in accepting or rejecting a proposal, but participating in the whole cycle from choosing a plot, developing a brief, designing, constructing and using a building or space. The structure of their involvement means that aaa always have a long-term role in their projects, helping community organisations to transition from co-management to the self-management of the projects they initiate.

This approach was pioneered in the early 2000s through a series of action research projects, including Ecobox (aaa, 2001) and Passage 56 (aaa, 2006), created to enliven underused plots in Northern Paris by encouraging residents to transform them through the construction of community spaces and assets using recycled materials, the creation of community gardens, and through the curation of cultural activities. The practice learnt a lot from these projects including the:

- Strength of working as a network of interested parties including local residents and workers, community organisations, academics and students.
- Importance of focusing on the development of physical assets alongside the programming of activities that would enliven them.
- Capacity building potential of providing spaces which encourage citizens to do things together, and learn from each other.

© atelier d'architecture autogérée - Recyclab, Paris

The small scale of these initial projects limited the impact aaa could have. As a result the practice sought out an opportunity to scale up their approach through the development of a neighbourhood wide strategy. In 2008 this ambition was realised through funding from the European Commission, which led to the development of the R-URBAN strategy, centred around the suburban area of Colombe in North Western Paris.

R-URBAN is based on a network of complementary resident-run facilities, that are designed to tackle the climate emergency, as well as social and economic deprivation at the local level. R-URBAN seeks to increase self-sufficiency by closing the loops between production and consumption at the neighbourhood scale, by:

1. Promoting the sustainable production of materials including water, energy, waste and food.
2. Harnessing and developing local skills, building upon existing community assets and the strong civic culture in the area.
3. Developing a network of activity hubs focused on recycling, food growing and housing.

In 2011 aaa and their partners received further EU funding to realise the R-URBAN plan in Colombe. Working with the local community and municipality, two pilot projects were built to implement and test the approach. These include:

AgroCité - an agricultural hub, including a farm and community allotments; a wooden pavilion that accommodates a shop, classrooms for workshops and events, and a greenhouse for growing food under glass. AgroCité also supports the development of experimental devices and techniques, such as compost heating, solar-energy production and aquaponic gardening.

Recyclab - a recycling and eco-construction hub, consisting of a number of facilities for the storage, recycling, reuse and transformation of locally salvaged materials into building materials. The hub also runs practical workshops to initiate the spread of eco-friendly practices, such as reducing, repairing and reusing waste.

The plans to develop a third housing hub Ecohab were disrupted as a result of the dismantling and renovation of AgroCité to make way for a car park on the municipally owned site.

Despite this set back, the impact of R-URBAN has been wide ranging. The team have been careful to document the quantitative impact of the project, both through the recording of the number of people engaged in events, talks and workshops [2500], the number of active community members volunteering time [250], to the number of jobs created and sustained as a result of the project [200]. In terms of economic benefits, for an apportioned annual investment of €250,000 during the first five-year period in Colombes (including the costs of building and management of the two hubs), the yearly return on investment (which includes the value of ecological and environmental repair embedded in the hub's activities) grows gradually over time, reaching almost €2 million in 2016.

The environmental impact of the project has also been investigated. According to aaa In comparison to traditional buildings of a similar size and programme, R-URBAN has resulted in annual reductions in C02 emissions [37.3 tonnes], waste [330 tonnes] and water consumption [24.5K m3]. In addition 50 per cent of the energy used is produced locally from renewable sources.

aaa have also gathered evidence that points to the qualitative impact of involvement in R-URBAN on the individuals involved, including the development of skills and enhanced professional trajectories, community cohesion, changes in patterns of everyday life including opportunities to eat organic food, and the health benefits of communal food growing activities.

"We believe a lot in this project. It is a place of resources for all, which creates a social bond. We need today islands of greenery, places where we can share, exchange [and] mix experiences."
(Annie, Agrocite 2015)

The availability of the R-URBAN model, through the dissemination of knowledge and resources generated from the project in an open-source format, has also meant that the approach can be used and adapted in different contexts. The model has already been reproduced in other suburban contexts in the Parisian region, such as Bagneux, where a new Agrocite has been built in 2019 and a Recyclab will be launched in 2020. It has also been rolled out in other countries, including R-Urban London.

The resilience of the project can be summarised in the successful relocation of AgroCité and Recylab, which have fulfilled design intentions by being dismantled and repurposed in a new site. In this way aaa point to a very different type of architecture which is less about building a-new, but rather is concerned with re-inhabiting, re-occupying and re-using spaces in the city in an innovative, and truly sustainable way.

Library Architecture Unit, Barcelona

Key research partners: Diputació de Barcelona, International Federation of Library Associations and Institutions
Practice size: Small (in-house)
Project type: Public libraries
POE value type: Social, cultural and environmental

The province of Barcelona covers a population of 5.5 million people living in 311 municipalities within Catalonia. The Diputació de Barcelona, supports the provision of public services within the municipalities, ensuring consistent service and quality is provided to communities. The library service is one area that Diputació is responsible for, providing support to a network of 227 public libraries and 10 mobile units, which reach 98 per cent of the population.

Alongside providing advice in the running of effective library services, The Library Architecture Unit within the Diputació supports town councils to plan and create high quality library buildings. The architects who work in the Unit have specific expertise in designing public library buildings, and have accumulated a pool of knowledge and expertise through their involvement in the commissioning of multiple library buildings, across diverse municipalities in the province.

Over the last 15 years the Library Architecture Unit has sought to systematise their approach to project evaluation, in order to learn from the successes and weaknesses of existing built projects. In 2004 a team of architects and library staff developed a questionnaire that has been used to reflect on the design and functionality of existing library buildings. This methodology has been refined over subsequent years, with the team taking a central role in the development of a POE survey for the International Federation of Library Associations and Institutions (IFLA) in 2013.

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The POE survey covers a wide range of issues, including:

- Location: including its integration into its neighbourhood, and orientation in relation to light, noise and climate.
- Accessibility: including travelling to, getting in, and moving around the building.
- Sustainability: including the shape and orientation of the building; adaptations to local climate; strategies to reduce energy use and other natural resources.
- Safety and security.
- Flexibility of the building to accommodate a diversity of uses.
- Indoor environmental quality including acoustics, thermal comfort, light levels and air quality.
- Service areas and the efficacy of spaces that are designed for interaction with customers, or to be used by particular groups such as children and young adults.
- Maintenance.

In 2014 the team adapted the survey to be used in the Barcelona province context, and used it to carry out a POE of 10 public libraries in their network. In order to draw conclusions that were as complete as possible, a wide variety of library buildings were evaluated, built at different periods and in different municipalities. The survey was answered by managers in collaboration with library staff, and technical services teams.

Key learning from the POE include:

The importance of a city centre, or town square location, near shops and amenities in attracting a large number of library users, and ensuring that the library building is a revitalising point in the cultural life of a community.

- The success of large entrance areas, with clear visibility inside and out, and link to spaces that can be used for cultural activities and exhibitions.
- The value providing space that is flexible enough to accommodate different uses, including new services and cultural activities.
- The impact of the orientation and facade treatment in ensuring that library buildings maximise natural light, but do not overheat, combined with natural ventilation to reduce reliance on energy intensive air-conditioning systems.
- The need to consider acoustic requirements to ensure sufficient noise absorption particularly in areas with high ceilings that house busy, multipurpose areas.
- The importance of locating vandalism hot spots, such as toilets, near busy parts of the library where staff are present.
- The value of a large number of high-quality study spaces for quiet work, with ergonomic furniture.

These findings have informed subsequent library designs, and highlight the reasons for the overall success of library buildings in the Barcelona province. The POE process has also led to the detection and correction of errors, and in some cases has demonstrated the need to invest in making improvements to existing buildings. Learning from the POE has also been shared widely, via the IFLA (2013) survey which is available for other librarians and architects to download, a conference and publication of methods and findings reporting on POE research undertaken in library buildings internationally (Latimer and Sommer, 2015).

"We consider vital the evaluation of libraries some time after their opening, with the purpose of detecting if the forecast expectations were met, and if the libraries are functioning well."
(Director, Library Architecture Unit)

Knowledge exchange: From Sheffield to Wroclaw

Key research partners: Wroclaw University of Science and Technology, University of Sheffield, LILAC
Project type: Housing
POE value type: Environmental, social and economic

Post Occupancy Evaluation (POE) is an underdeveloped area in the Polish building industry (Baborska-Narozny, 2017). Whilst larger multi-disciplinary offices may undertake a light touch POE based on short walk-through observation with the person-in-charge, small architecture practices are unlikely to undertake any evaluation work on their built projects due to limited capacity. The need to apply POE methods is an emerging interest in the Polish academic community, and this is particularly evident amongst architectural researchers with a specialism in sustainable design.

In order to develop capacity in the field of POE in Poland, Dr Magda Baborska-Narozny, an architect and academic from Wroclaw University of Science and Technology, embarked on a Marie Curie Fellowship in collaboration with Professor Fionn Stevenson, a leader in the field of sustainable design and building evaluation from the University of Sheffield. The fellowship involved a total immersion in POE techniques over two years, and its application to case study buildings (BuPESA, 2015).

In 2013, not long after residents had moved in, an in-depth POE was undertaken of LILAC, an eco-housing project in Leeds designed by White Design (2020). LILAC is made up of 20 dwellings accommodating 35 adults and 10 children, a shared 'Common House' that contains a communal kitchen and pantry, dining room, multipurpose room and laundry, as well as communal gardens, and food growing spaces. The buildings on the site are constructed using the Modcell timber frame system with infill from straw bales, with other low carbon systems integrated into the design including PV systems for on-site energy generation (LILAC, 2020).

The POE involved a number of different methods which were applied over a 15-month period including semi-structured interviews and home tours with 20 households,

user-guidance evaluation, a BUS questionnaire (BUS methodology, 2017), a construction audit, monitoring of temperature and humidity for a year and thermal imaging (Baborska-Narozny and Stevenson, 2014). The POE also applied community based participatory action research methods, with the aim of empowering households to understand and get the most out of their homes in terms of energy and ventilation practices. In addition, the POE explored how the development supported the development of resilience and adaptability amongst residents in response to the impact of projected climate change, and potential resource and energy shortages (Stevenson et al. 2016).

The findings of the POE research were wide ranging, touching on the environmental and social value of the housing development. These include:

- The social value of the common house which supported the sharing of skills in areas ranging from cooking to DIY.
- The benefit of providing space for food growing, impacting positively on diet and changing shopping habits.
- The efficacy of measures to cool the building in the context of a warming climate, including a large exterior pond, and opening windows allowing for cross-ventilation.

The POE also led to a number of immediately actionable changes that householders could make to improve performance, and maximise the efficacy of the technologies embedded in their buildings (Baborska-Narozny et al. 2016; Stevenson et al. 2016). These include:

- Using the excess PV energy generated during the day, by changing the habitual use of household electrical appliances and the communal laundry, to take advantage of the off-grid energy generated.
- Recommissioning all of the MVHR system in all dwellings due to problems with the installation of the mechanical ventilation heat recovery (MVHR) system.
- Improving understanding amongst residents about the importance of ventilation, leading to the sharing of information about the condensation and air quality risks involved in keeping internal temperatures low, windows shut, and the ventilation system switched off..
- Correcting inaccuracies and miscommunication in the handover of dwellings to residents, particularly with regard to making use of all the technology systems, through the revision of guidance for handover procedure and development of a bespoke home user guide illustrated with photos.

Following the completion of the fellowship and the knowledge gained from the hands-on application of POE, Magda Baborska-Naronzy worked to adapt the approach to the Polish context (Baborska-Narozny, 2017).

In Wroclaw the most pressing issue faced by the municipality, its partners and the inhabitants, was the need to address local air quality, and decrease domestic reliance on coal (Adamczyk, et al. 2017). In 2018 a light touch POE was undertaken to understand the frequency of the distribution of different heating systems across an urban quarter consisting of 422 dwellings in deprived tenements. Inhabitant feedback on heating was also sought. Based on a door-to-door questionnaire, a walk-through, a review of the documents in possession of facility managers as well as data from utility providers the POE highlighted the extent of the districts' reliance on solid-fuel burning as the primary source of heat (Baborska-Narozny et al. 2020). The feedback and walk-through revealed a huge variation in living conditions, particularly substandard in solid fuel heated households. Crucially, the POE illuminated the problems with replacing solid fuel burning stoves with electric heating without carrying out other energy efficiency measures. Poor households reported that they fell into fuel poverty as a result of a move to electric heating as fuel bills were higher. This led to under-heated dwellings, decreased comfort levels and increased problems with moisture and dampness. Ownership type analysis indicated most solid fuelled households lived in social housing.

These initial findings are now being evidenced through an in-depth case study of 15 dwellings in tenements in Wroclaw as a research component of DiverCITY4 (2020) initiative funded through the EEA and Norway Grants. Mixed-methods including monitoring data, interviews, and a comfort survey are applied. The results will inform policy shaping in relation to effects of clean air strategies on individual households. Evidence is needed to change the approach taken to the phasing out of coal by ensuring that the installation of electric heating is combined with retrofit improvements to the building envelope to increase overall efficiency, comfort and health of dwellings for residents of all cities facing air pollution challenges. The adoption of POE methods has been key to understanding the extent of the problem, and the efficacy of the solutions applied.

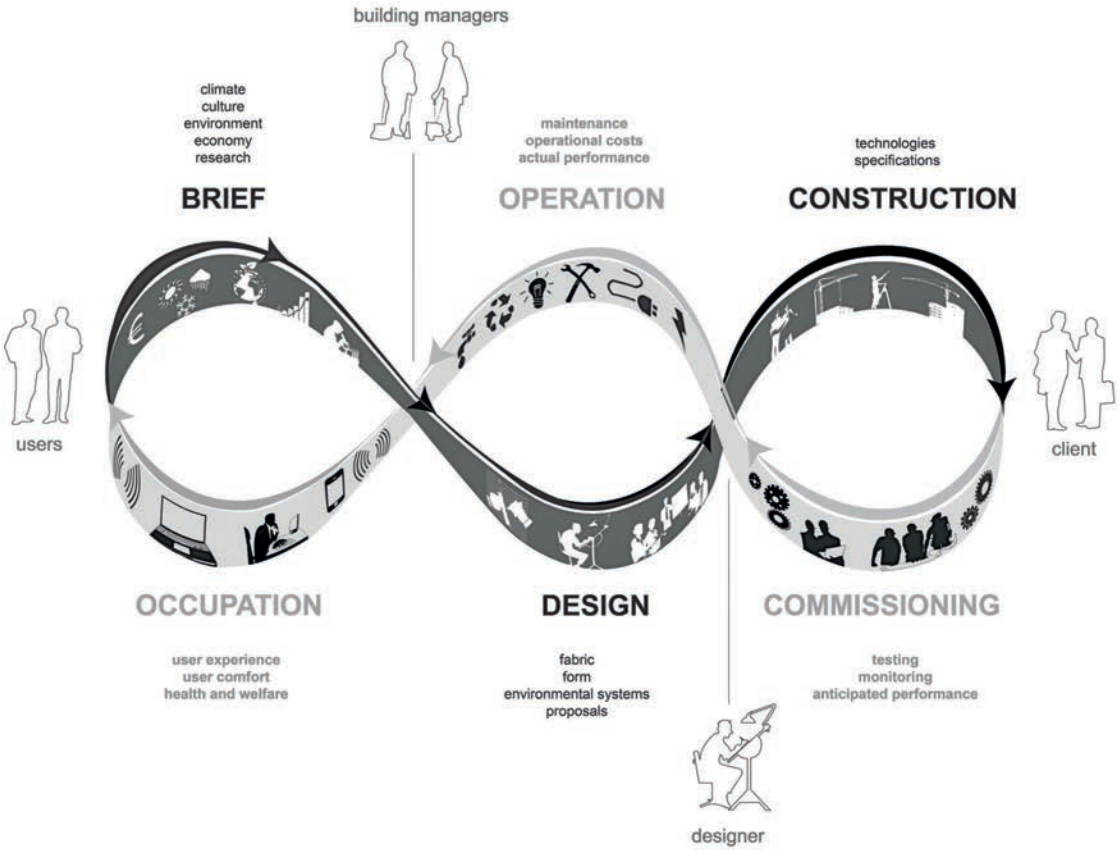
Limerick County Hall, Dooradoyle

Key research partners: Bucholz McEvoy Architects, PAC Studio, University of Limerick School of Architecture, Limerick County Council, Clare County Council, Limerick Clare Energy Agency
Practice size: Medium
Project type: Municipal offices
POE value type: Environmental and social

In common with the rest of the EU, energy consumption in buildings is a key contributor to carbon emissions in Ireland, representing 40 per cent of total energy use across the country (IGBC, 2019). The need to improve the efficiency of new and existing building stock has come to the fore as a key policy priority, as the move away from fossil fuels has become more urgent (Government of Ireland, 2019). Understanding how buildings perform in-use in terms of their energy consumption, and developing a robust evidence base to define what works in terms of building design and management strategies, is central to meeting this challenge. In particular, the growing evidence base that points to the gap between expected performance, and actual energy use in buildings needs to be explored and addressed (de Wilde and Jones, 2014; Robinson et al. 2016; Zero Carbon Hub, 2014)

Whilst the reasons for the "performance gap" are understood, not least the knowledge and behaviour of building occupants, and their use and interaction with the building fabric and technology, more work needs to be done to understand how these factors influence energy use within the particular social and environmental contexts of specific buildings (McElroy and Rosenow, 2019). In short, post-occupancy evaluation (POE) studies need to be undertaken as a matter of course in buildings that have been designed to be low-energy, both to develop general lessons about the effectiveness of designs, but also as a basis to define practical recommendations for building owners so they are maximising the potential of their building in providing comfort to occupants, whilst also meeting their low-energy targets.

Over the last 10 years, Bucholz McEvoy Architects and PAC Studio have been at the forefront of efforts to develop a structured methodology to explore the relationship



© Bucholz McEvoy Architects and PAC Studio - The Feedback Loop

between building use and building fabric in Ireland, which has been applied to a number of their low-energy municipal office buildings (Bucholz and Petrie, 2010). In collaboration with the University of Limerick School of Architecture, and their public sector clients including Limerick County Council, Clare County Council and Limerick Clare Energy Agency, the practice has developed a deep knowledge of energy performance and comfort that both informs their work, and the guidance they provide to clients on how to make best use of passive heating and cooling systems such as natural ventilation and solar gain (ibid).

This work began with a POE study of Limerick County Hall, a large municipal building housing council offices and a debating chamber located in the suburban area of Dooradoyle. The brief for the building was to meet high environmental standards to reduce energy demand, and also create better working conditions for staff through strategies to maximise fresh air and natural light. Central to fulfilling this brief was the design of a large lightweight atrium facing southwest to drive natural ventilation, heat-up the building in the winter through solar gain, whilst minimising overheating in the summer months through timber screening. In order to understand how far this strategy was working in practice, researchers from the University of Limerick School of Architecture worked with Bucholz McEvoy and PAC Studio to apply a range of POE methods to the building once it was occupied. These included:

1. An analysis of energy use in conjunction with weather systems, occupation patterns and data related to the use of heating and other building technologies to manage internal comfort including ventilation and lighting
2. An anonymous user survey focused on comfort and satisfaction.
3. Interviews with building management and operational staff focused on issues and lessons in controlling the internal conditions to meet user expectations.

The results showed that the building was performing well in terms of energy-use, and that building users were satisfied with their work environment (Bucholz and Petrie, 2010). Key problem areas of the building were highlighted, and remedies put in place, including cold conditions for staff working in the reception area, problems with ventilation in the washrooms, and issues with fluctuations in the internal temperature in some parts of the building. Resolving these issues was important, not only to reduce energy demand, but also to overcome the often emotional response of staff, that came to light as a result of the POE, who felt their needs were not being considered.

A key finding from the study was the need for the building management team to communicate more effectively with staff, and to make them aware of the steps they could take to control their environment and maintain their comfort. These include responding to local weather conditions by opening windows, using shades, and wearing appropriate clothing.

This aspect came to the fore when during the monitoring period the boiler broke down for a week during the winter. At this point the research team suggested that no windows should be opened on the south facing facade in order to maximise solar gain and minimise fabric loss. By ensuring the windows remained closed, staff were able maintain internal temperatures above 18 degrees celsius by sunshine alone. These measures were combined with clear communication to staff who were kept informed and asked to adopt simple measures such as bringing in an extra layer of clothing to work.

For the client this was an extremely useful experience, and it led them to look in more detail at the way they were using the building, and they are now able to make adjustments to heating and lighting schedules in response to the seasons. This behaviour change was combined with a communication strategy which ensures that staff are now regularly informed, and feel empowered to work together positively to drive down energy use, whilst also generating comfortable conditions for everybody.

For Bucholz McEvoy and PAC Studio the learning from this and subsequent POE studies, have enabled a deep understanding of how their buildings' function, which has been fed back into subsequent projects and has been shared more widely so that others can benefit from the knowledge they have generated.

In addition, going back to their projects has moved the practice beyond an abstract view of buildings as materials and concepts, to a position of empathy and understanding of the value they bring through their building designs to the people who use them.

Crucially, this work has also shown that energy efficiency is not just about technology or building fabric alone, but comes in the interaction of these things with the people who use them, which is, as the architect Merritt Bucholz says, "what makes the occupancy part of post occupancy evaluation so crucial."

Whilst obviously important, there is a tendency to depend upon technological solutions in the drive for energy efficiency, rather than looking at the more complicated but crucial interaction between people, their physiological comfort and emotions, and their environment. As this study shows, these aspects are central to maximising the potential of the often simple solutions that we already have in our possession.

Part four: Executive summary recommendations

Architects

Research knowledge enables architectural practices, both large and small, to evidence their role in meeting the key challenges of our time, not least the Climate Change emergency, and in showing how the design and development of buildings and places contribute to meeting the economic, environmental, functional, social, health, cultural, and heritage aspects of sustainability. Practices need to adapt rapidly to take advantage of changes in technology and new research methods for capturing a variety of impacts, both tangible and intangible. Practices of all sizes can benefit from adopting simple and creative methods to show the value of their work, for example, in encouraging social interaction, promoting health and wellbeing, enabling sustainable lifestyles, reducing energy and resource consumption, and enhancing biodiversity. The collection of data on the value of architecture generated through research is essential to secure the architect's position as client advisor and leader of the project team, and in bolstering the business case for investing in design (ACE, 2018).

In order to promote the value of architecture, and capitalise on the potential of research and innovation, professional practices need to:

» Develop and market Post Occupancy Evaluation (the gathering of feedback on buildings in use) to demonstrate the economic, environmental, functional, social, health, cultural, and heritage impact of architectural services and to evidence the delivery of better project performance.
» Embed research strategy in business planning activities, as an integral part of future proofing and business resilience.
» Use thought leadership and research as a means to develop relationships with potential clients in a low-pressure environment.
» Up-skill existing staff in research and appoint a member of the practice as the research lead.
» Encourage Clients to commission POE
» Develop strategic relationships with local universities for collaboration on research and to access research funding.
» Disseminate research findings through practice websites, social media, publications, conferences, talks and shared knowledge repositories.

Policy-makers

Architects have a pivotal role to play in assisting policy-makers to meet the challenge of the Climate Change emergency, to develop new products, services and tools in order to meet this challenge, as well as contributing to the fulfilment of wider public policy goals to promote the health, wellbeing and prosperity of citizens.

In order to maximise the vital contribution that architects can make to these agendas, support is needed through policy procedures, funding, the maintenance of ethical standards and regulation:

» Data and research need to be at the heart of strategic planning, planning permissions, addressing the Climate Change Emergency, retrofit and renovation, and the development of SMART city strategy (Future Cities Catapult, 2017).
» Public procurement needs to be based on clear agreed measures that take into account the triple bottom line of sustainability (social - including cultural - environmental and economic value), with measures framed to enable architects to articulate the particular value that they bring to a project (for example the employment of graduates and interns, connecting communities and encouraging active lifestyles).
» Place-making plays a major role in attracting and retaining talent (particularly from the fast-growing Creative Industries) and in the development of research and innovation. Architects have a major role to play in designing places that encourage knowledge exchange, a role that needs greater recognition and support.
» Material related carbon emissions should be reported together with the other life cycle emissions. It is therefore essential that carbon emissions are labelled on products as a first step towards regulation.
» Post Occupancy Evaluation should be compulsory on all publicly funded projects. This is necessary to close the performance gap and enable architects and others to achieve carbon reduction goals, as well as other social and cultural objectives. Post Occupancy Evaluation is also a central tool in developing knowledge of how the design of public buildings and infrastructure can support the wellbeing of people and communities.
» Research funding streams, in particular small starter funds, need to be developed to encourage engagement from architecture practices most of which are micro practices and small to medium-sized enterprises (ACE, 2018), and to foster engagement with universities.
» Tailored investment in research and development is particularly needed in Southern and Eastern Europe.

» Research in architecture practice needs to be incentivised, for example through tax credits.
» National architecture school validation criteria in the EU member states needs to be revised to foreground research and innovation.

Clients

Clients, including investors, owners and end-users, are instrumental in setting the tone of a project through briefing and procurement. Clients who have a vested interest in the long-term performance of their buildings have much to gain from Post Occupancy Evaluation, particularly those who have declared a Climate Emergency within their organisation. Clients with large property portfolios benefit from learning about what works and what doesn't in their existing buildings and feeding that knowledge into the development of better briefs for new constructions projects and refurbishments. The development of data on impact can also help clients make the case to municipalities or funders to justify why a particular building project should go ahead. Fostering a culture of knowledge sharing and collaboration within project teams can have multiple benefits quite apart from the built project itself, these include better team working, brand enhancement, corporate social responsibility, thought leadership, staff retention and attraction, productivity as well as the development of new products, services and tools.

In order to benefit, clients should support research in construction projects by:

» Setting up projects to facilitate long term learning, research and development across the project team and into the client organisation.
» Consider the fostering of innovation and collaboration in the long term when deciding on forms of procurement (for example through outcomes-based procurement and project-based insurance).
» The evaluation of project bids and the development of frameworks that take into account social, cultural, environmental and economic value.
» Including and paying for Post Occupancy Evaluation in design and construction contracts, and as a core service provided by the project team.

Professional bodies

Post Occupancy Evaluation helps to find out what actually works. So, that society gets the buildings that are needed and the assurance that buildings are performing as they should.

Architectural institutions, including ACE, need to work with the EU Commission to ensure that:

» The crucial role of architects in responding to the Climate Change Emergency and creating sustainable cities and communities is understood and supported.
» Architects have access to the best quality research based knowledge.
» Architectural awards and recognition are increasingly based on evidence.
» Opportunities for practices large and small are created within the Horizon Europe (2021-2027) funding call.
» Opportunities to gain experience of developing interdisciplinary research projects are developed.
» Architectural practices have access to the ability and knowhow to respond to EU funding calls in an appropriate manner.
» Continuing Professional Development (CPD) modules on Post Occupancy Evaluation, research, intellectual property and data management are offered to architects in practice.
» Further research is undertaken on the amount of research that is happening in practice and how it might be supported.
» Insurance incentivises research and innovation in architectural practice.
» Architects have opportunities to apply for Research and Development Tax Credits.
» Professional education validation is keeping abreast with advances in knowledge and is addressing societal challenges.
» Interdisciplinary collaboration is encouraged by developing networks and knowledge across the built environment professions, and between practice and academia.

Universities and academia

Universities are instrumental in setting cultural expectations for architects, as well as framing what it is that they need to know. Major efforts are needed to bring universities and practices together to work on research and innovation, to develop new tools and research methodologies to explore design value and impact, to share insights and apply research knowledge in live building projects. There is also an urgent need to promote interdisciplinary co-operation, particularly with those fields such as facilities management who are already concerned with the collection and assessment of operational information.
In order to foster a research culture based on continuing improvement and learning universities should:

» Promote research and knowledge exchange with practice at every level.
» Encourage interdisciplinary collaboration with other faculties within and across different Universities.
» Work to open up academic knowledge so that it is made freely and readily available to practice in an appropriate form.
» Revise national validation criteria in the member states to reflect changes in the architectural role, most notably with regard to research, innovation and business.

- Foster an understanding in students that architecture is a a research discipline which has a constantly evolving body of knowledge.
- Encourage students and staff to write in an academic style to enable them to communicate with non-architects and foster interdisciplinary collaboration.
- Include Post Occupancy Evaluation as a core part of the student curriculum.
- Where appropriate provide research training to design teachers within schools to ensure that their skills are up to date and relevant.
- Allocate paid time to involve visiting practitioner staff in the research endeavour of the Architecture Schools.
- Where practicable open up school workshops to local practices to facilitate knowledge exchange and innovation.
- Collaborate with architecture practices of all sizes on EU and national research bids.
- Develop closer links with practices in order to develop the knowledge base and capacity to undertake Post Occupancy Evaluation studies on live projects.

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