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Architectural design research: Drivers of practice

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ABSTRACT

Research, professional practice, and learning in architecture are becoming increasingly integrated as the understanding of research and practice is transforming and research assessment criteria are expanding. This changing research landscape has created more diverse iterative and cyclical design research processes and opened new areas of exploration and experimentation in architecture. Building on existing tripartite design research models, such as research 'into', 'for', and 'through' or research stages of 'processes', 'products/outcome', and 'performance/impact', this paper uses the concepts of 'process-driven', 'output-driven', and 'impact' to analyse and classify current architectural design research practices. This framework is used to clarify how research criteria are differently understood in academia and practice, explore the challenges arising from translation between them, and analyse the methods commonly used. While focusing on the UK context, the paper offers transferable insights while using some international case studies.

Introduction

Research is increasingly assessed in terms of public impact. For example, the Research Excellence Framework (REF) in the UK introduced impact criteria to emphasise the value of research beyond academia (REF 2014). This was in response to a growing focus on measuring research not only in terms of benefits for an academic but increasingly also for a professional and public audience. This has challenged the meaning of research and diversified its processes, methods, and outcomes. As research and its assessment is historically rooted in academia, tension has arisen when framing research in practice through terms familiar to the academy. This study asks how research criteria might be understood differently in architectural practice and

academia, what challenges arise from their translation, and what methods and approaches are commonly used in architectural design research?

Research in practice is regarded as a process in which design practice becomes an accepted and qualified part of academic research (Joost et al. 2016). However, this relationship is not always that clear, as design can be considered a discipline (Cross 1982) that has not been historically part of traditional research. Likewise, while architecture has its distinct disciplinary knowledge (Till 2005) and architectural practice can contribute to its knowledge production, architectural design research in non-academic organisations in the private sector, public sector, and third sector is only recently becoming more prominent in research in architecture.

A changing economy and increased competition are leading to growing design research in architectural firms that is naturally practice-based (Groat and Wang 2013), with architects becoming interested in the evidence base that can explain the impact of architecture on the built environment and the benefits for its users. This shift is evident in the importance given in the UK by the Royal Institute of British Architects (RIBA) to knowledge acquirement (Founding Charter of RIBA 1837), with their vision for 2020 underpinned by innovation and improving practice effectiveness and outcomes through research and knowledge sharing (RIBA 2014), which is identified as one of the five key principles for the future of the architectural profession (RIBA 2016). There is thus a deliberate blurring of the traditional boundaries between practice, research in practice, and established academic research practices.

The key methods and means of architectural design research, such as drawing and writing, have been invaluable to the architect for over 500 years (Hill 2013). However, debates on architectural design research are still emerging, with definitions greatly varying. Architectural design research is used in this paper to denote practice-based or practice-led research focused on architectural design practice and design thinking (Fraser 2013; Luck 2019). Research frameworks, manuals, commissions, research councils, professional bodies, academia, and practice have all established different sets of criteria, classification, subject coverage, range, and focus for research in architecture, but are often dominated by an academic perspective. In addition, even though architectural design research has commonalities with design research in other disciplines (Luck 2019), there is a broad range of design research and methodologies in architecture, all with different interpretations of what common core research criteria such as 'originality', 'significance', and 'rigour' might mean (Biggs and Büchler 2007).

The following is a critical analysis of how these various definitions overlap or differ, how architectural design research is assessed, and how the value of research is more generally understood in architectural practice. The United

Kingdom is used as a context for the discussion, as it has a long-established tradition of nationally evaluating the quality of research since its first Research Assessment Exercise in 1986, however, cases for study include relevant examples from outside the UK and focus on larger research-intensive architectural firms. The shortcomings and potentials of architectural design research will be discussed, and possible actions to enhance research practices and process will be suggested based on insights gained from an analysis of the processes and outputs of current design research in architectural practices.

Overview

Architecture has been taught in England at least since the 1840s, when the University College London appointed Thomas Leverton Donaldson (1795–1885) as its first chair of architecture. But research in art, design, and architecture has only relatively recently gained greater importance in the UK. When polytechnics obtained university status following the Further and Higher Education Act of 1992, a previous focus on practical training had to make way for a new academic focus (Rust, Mottram, and Till 2007). This also applied to architecture, which had been widely taught at polytechnics. With this, a reconsideration of the relationship between practice and research had to take place and practice-based research was increasingly considered as formal research.

In 1999, the Bologna Declaration formally acknowledged within the European Higher Education Area that research in design-oriented disciplines is equal to that in other disciplines (Geiser 2008). Pedagogy thus became important to bridging how academic researchers are practising design and how architectural practitioners are researching design (Craig and Ozga-Lawn 2015). For example, while traditionally research questions are identified at the outset, in design research, 'the questions only emerge once certain processes of making and designing are already engaged with' (Rendell 2003). Therefore, whether in the academy or practice, research and design were seen as opposites that attract, and explorations of architectural representation were seen as essential to architectural design research (Hill 2003).

Today, the common research assessment criteria of 'originality', 'significance', and 'rigour' in its different disguises are widely applied to all three main types of research: basic, applied, and experimental research (OECD (Organisation for Economic Co-operation and Development) 2015; Innovate UK 2020). However, when framing practice-based research, contradictions arise from how established research definitions in the academy are often less relevant to practice. The tension has become apparent in design-oriented disciplines such as architecture, and led to several debates on its

meaning, types, and stages over the last decades (Frayling 1993; Archer 1995; Cross 1999; Rendell 2004; Till 2005; Jenkins, Forsyth, and Smith 2005; Geiser 2008; Fraser 2013; Hensel and Nilsson 2019). Despite differences in approach, they have all consistently argued for the need to establish a unique definition of design-related research, but also continued to predominantly frame this in terms arising in an academic context.

Perhaps most influential, if we take Frayling's (1993) famous tripartite model for practice-related research, traditional research falls largely within his 'into' and 'for' practice classification, whereas research 'through' practice opens new research trajectories and means, commonly referred to now as practice-based research. Frayling's strict division of design research methods and outputs has been questioned, especially by Australasian schools of design research that foreground multi-modal forms of enquiry that are often linked to issues of representation (Wiszniewski and French 2019). At the same time, his model has been advanced by others to better define the meaning, processes, methods, and outcomes of architectural design research. In a prominent example, written as a position paper for the RIBA Research Committee, Till (2005) divides the stages of architectural research into 'architectural processes', 'architectural products', and 'architectural performances'. His model tries to integrate research in both the academy and practice, considers interdisciplinarity, and justifies architecture as a research discipline. A more recent comprehensive review of design research in architecture edited by Fraser (2013), similar to Till distinguishes research types by stressing differences in 'processes', 'outcomes', and 'impact'. A version of this tripartite classification is adopted in this paper to clarify and discuss architectural design research.

Building on Till's and Fraser's distinction of research stages according to notions of 'processes', 'products/outcome', and 'performances/impact', which can be read as a differentiation of Frayling's definition of research 'into' practice, in the following the paper uses the terms 'process-driven', 'output-driven', and 'impact' to combine these and differentiate research outcomes. The proposed is also like a research classification advanced by Rust, Mottram, and Till (2007) in 'Practice-led research in Art, Design and Architecture', in which research projects are distinguished as producing either an artefact or process or as being located between these two. In this study, process-driven research is understood in relation to contextual relevance (proposal), documentation (process) and output (product), whereas output-driven research in terms of immediate design outcomes. While output-driven research often includes research processes, unlike in process-driven research, these are typically not planned but iterative. As the different forms of enquiry are all concerned with research 'into' practice, there are naturally some overlaps between them. Especially impact is created by both

process-driven and output-driven research and achieved through—at times similar—architectural design practices and design thinking specific to architectural design research. In the following, the overlaps, and differences of process- and output-driven research are analysed by first focussing on the methods used and then discussing their relation to impact.

Conventional research definitions tend to prioritise processes over outputs, emphasising three commonly expected key features: research questions, research context, and research methods. While architectural design research is also defined as a structured process (Collins 2014), how this process uses the means and methods of practice is often not well defined, with Fraser, for example, simply referring to activities such as a site review, a visit to an archive, or an experiment with materials. In another example, the RIBA generalises the forms of research in architectural practice as concerned with knowledge management, design development, formal research projects (sometimes funded), and practitioner PhDs (RIBA 2014).

A key problem arising from this is that the value and purpose of design can be understood differently in academia and practice. While in academia the focus is on conceptualising a problem, with design used to explore new directions for theory construction (Janssens 2012), in practice the purpose of design tends to be more immediate in finding tangible solutions to concrete design problems. Thus, while academic research in architecture typically focuses on a larger (or theoretical) question or problem, architectural design research tends to foreground a design- or practice-related problem.

At the same time, a widely discussed challenge of research in general is that researchers often struggle to communicate research efficiently to public audiences, which is central to achieving research impact (Till 2005). Especially publicly funded research is impact focused (Samuel 2017), which is measured in relation to the value it brings to a wider non-academic audience. However, with architectural design often naturally having a public audience, stakeholders, and clients as well as diverse communities of practitioners, and architectural design research being closely linked to design and its audiences, it has more diverse networks for dissemination and a strong basis to achieving impact.

The value of architectural design research, especially when conducted in practice, commonly lies in tangible research output, which is both its strength and potential. However, it is important to remember that 'frameworks of architectural value should focus on processes of architecture and the benefits that architectural skillsets bring to a project' (Samuel et al. 2015). For example, funded by research grants and external partnerships, the global architecture and planning firm Gensler has a Research Institute that is committed to unlocking new solutions for practical design questions or issues.

To further draw out some of the key differences in how research can be understood, in the following architectural design research is discussed through examples of process-driven and output-driven research and the impact they produce.

Process-driven research in architecture

According to the RIBA report How Architects Use Research (2014), in architectural practices research can range from being structured and general to highly process driven. Frequent areas of research focus are environmental sustainability and energy efficiency, the analysis of precedents, and research into materials, products, and construction techniques. Another emerging area of research is public participation in design, especially processes of co-design with tangible outcomes (Luck 2018). While public research funding directly accessible to architectural practices is still not common, joint research and knowledge exchange between academy and practice is increasing.

Research funding for higher education institutions or commercial businesses applies different assessment criteria of research, which determines the research supported and produced as well as the definition of research itself. But there are even critical differences within the same sector, for example, the Higher Education Statistics Agency requires institutions to conform with the Frascati definition of research that uses the five criteria 'novel', 'creative', 'uncertain', 'systematic', and 'transferable' (OECD 2015), while the REF highlights the importance of 'process', 'novelty', and 'effective sharing' of knowledge in the research evaluation (REF 2021). Yet, a privileging of process-driven research and the importance of public research value is generally shared by all.

Process-driven research undertaken in architectural practice generally relates to (1) experimentation with materials and prototypes, (2) participatory design, and (3) quantitative research. This can produce both tangible and intangible research outcomes and might follow an academic, experimental, or intuitive process. In either case, the research process, including data collection, documentation, and analysis normally follows a planned process. Similar to the dominant 'academic' research definition within higher education institutions (Jenkins, Forsyth, and Smith 2005), process-driven research can be characterised by its contextual relevance (proposal), documentation (process), and output (product). To better understand process-driven research in architectural practice and to discuss it in terms of emerging strengths and weaknesses, the following cases offer clarification of its key characteristics.

First, experimentation with materials and prototypes is common in large practices such as Arup, Buro Happold, Foster + Partners, and Zaha Hadid Architects. For instance, Foster + Partners have a Material Research Centre and Information Centre, which studies current and new materials, products, companies, technology, innovation, sustainability, and technical issues directly relevant to the development of their practice. Examples of this research are the Lunar Habitation (2012) and Mars Habitat (2015) projects that explored adaptive building systems in extreme environments. For Lunar Habitation and its research into the possibility of 3D printing buildings, Foster + Partners were part of a consortium that included the European Space Agency (ESA). Based on this research, Foster + Partners later proposed the Mars Habitat for a NASA-backed competition. Since these were process-driven research projects, their insights and findings were well documented to ensure the transferability of knowledge. The projects were thus planned for a variety of design outcomes and with the intention to inform future projects.

Second, participatory design research usually takes place at a building or neighbourhood scale within an urban context. Gensler, Hans Haenlein Architects, Levitt Bernstein, Spark Architects, muf, FLUID, A Small Studio, and Golzari-NG Architects are some of the many practices of different size using participatory design research in their work. A notable example of process-driven research using participation is DWELL (Designing for Well-being in Environments for Later Life), an architectural design research project funded by the Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), and Arts and Humanities Research Council (AHRC) and led by the practice-focused academic and practising architect Sarah Wigglesworth from the University of Sheffield. The multidisciplinary project included researchers from the fields of architecture, urban planning, and public health and worked with local participants, housing providers, developers, and Sheffield City Council. Interviews and focus group discussions were conducted before inviting residents to participate in the co-design of their neighbourhood. The DWELL project built upon participatory research traditions found in the social sciences and used an evidence-based approach to co-design, which the project termed 'participatory design research'. One of the key strengths of this research approach is a cyclical and interdisciplinary research process of designing and reflection, in which ideas can be tested and refined (Park, Ziegler, and Wigglesworth 2016).

Third, practices including ArchiMetrics, Baca Architects, Feilden Clegg Bradley Studios, HASSELL, Hawkins Brown, Hutchison Locke, and Monk (HLM) Architects, and Hunt Thompson Associates (HTA) use quantitative methods in their research such as Post Occupancy Evaluation (POE),[1] Building Performance Evaluation (BPE), and Building Information Modelling (BIM). For

example, HTA conducted the Home Performance Labelling pilot study with Building LifePlans (BLP) Insurance for the Housing Forum with the help of a range of architects including Alison Brooks Architects, Levitt Bernstein, PRP, and Pollard Thomas Edwards, who provided the BIM models for analysis. The pilot project delivered information to users about the performance of their homes and how to improve them. Evidence-based data was collected from project collaborators and assessed using BIM and BLP's Butterfly tool. The key strength of this research approach is robust and integrated documentation of the processes and data that are analysed to develop research insights and findings. Being fully integrated with practice activities, this type of research is particularly attractive to clients with a long-term interest in their building performance (Coucill and Samuel 2013) and offers a cyclical process of research in which one project informs the next and its design process.

To summarise, process-driven architectural design research produces more conventionally recognised research value, since it has a planned research design and process. Projects are usually part of collaborations between industry and academia, include a robust documentation of the research process, and typically produce outcomes with transferable knowledge and insights. Furthermore, they often represent cyclical research processes that inform future projects. For instance, outputs and evaluation criteria of quantitative process-driven research such as POE/BPE are usually made publicly available. However, there are also potential weaknesses. The impact and value of process-driven research can be less certain, as it does not necessarily produce instantly tangible results or applications and might have more long-term benefits. For example, the value of research to the client in quantitative process-driven research such as BPE might not be immediate or clear in some cases, especially where the client only has a short-term interest in a building.

Output-driven research in architecture

Archer (1995) states that research is 'a systematic inquiry whose goal is communicable knowledge', which has become a widely accepted definition of research (Fraser 2013). Architects produce knowledge through design ideas and practice (Fraser 2013), with architectural design research increasingly expected to form part of the process when designing a project (Schumacher 2002). However, there is an ongoing discussion about when an architectural design process or practice-based studies might constitute research. Till (2005) argues that designing a building is not research, but the processes leading to the object and its aftermath are a means of knowledge production. To consider design outcomes as architectural design research, a set of criteria can be considered that need to be met: design outcome should be

reproducible in different contexts and the relevance of research questions or problems must extend beyond that of the design of a single building.

Knowledge production through architectural design research requires that the means of practice are both instrumental to a research inquiry (Rust, Mottram, and Till 2007) and form an intrinsic part of the project undertaken (RIBA 2014), must be aimed at deepening understanding, and provide tangible outcomes for practice (Vaughan 2017). Most design research in architectural practice is therefore technical and functional in nature and project-focused (RIBA 2014). The most immediate and tangible research outcomes are usually a design solution for a building, a structural system, a prototype, or a material component. Moreover, since communication is more directly integrated into the aims and outcomes of practice, design research in architecture often exploits its ability to engage with the public in new ways such as participation, performances, exhibitions, and publications.

But output-driven research is harder to differentiate from architectural practice itself, therefore, is less common than process-driven research and largely undertaken within industry. However, the government's vision for the UK construction industry for 2025 emphasises the importance of research for commercial innovation to support the transition to a digital economy and the rise of smart construction (BIS 2013). This shows that governmental support for research in the UK construction industry and thereby practice-based research in general but also in architecture is growing.

Output-driven architectural design research can be generalised as (1) immediate design outcomes and (2) studies of elements and material components. It generates stand-alone projects that offer a singular design solution as an output, normally derived from a unique or project-specific research process. These research projects are directly linked to practical experience. The following cases clarify the strengths and weaknesses of output-driven research in architectural practice.

First, CSK Architects' research project Solid Cork Building Envelope (2015–2018) is a good example for output-driven research, as it led to an award-winning architectural project, the Cork House (2019). The research was part-funded by Innovate UK and the EPSRC under the 2015 Building Whole Life Performance competition. Matthew Barnett Howland and Oliver Wilton started initial design and prototyping at the Bartlett School of Architecture by experimenting with solid expanded cork blocks to explore the application of plant-based materials in construction. In collaboration with the University of Bath for structural testing and the Building Research Establishment (BRE) to evaluate fire performance and rain tightness, a small Cork Cabin prototype was created, with insights generated from it then further developed in the Cork House project. This is hence the design outcome of an iterative and planned design and research process that follows several stages of experimentation and

prototyping. Although having qualities of process-driven research, this research project is aimed at a tangible singular output using an iterative research process.

De Rijke Marsh Morgan (dRMM) also use experimentation with materials and prototyping in their Timber Studio research. Their work established and validated the structural use of hardwood for cross-laminated timber (CLT) for the first time in architecture and was realised in their award-winning Kingsdale School (2004) project. The school design was, alongside material experimentation, a participatory project undertaken in collaboration with the school and the local community, with the aim of developing a new model of retrofitting. dRMM designed and developed projects at varying scales in the following, based on their research on this new material technology, ranging from installations, temporary structures, prototypes, and single units to that of housing developments. The research and innovation represented by the CLT studies is an integral part of the larger practice research and practice agenda to reduce carbon emission in the built environment.

Second, a well-known example of research in architectural practice is AMO, the research, branding, and publication arm of the Office for Metropolitan Architecture (OMA), co-founded by Rem Koolhaas and led by Samir Bantal. AMO's work aims to produce architectural knowledge in forms other than that of a building (De Graaf 2016). The outputs of their research largely follow an iterative and speculative process, inhabiting a space situated somewhere between design and the formulation of new (research) agendas, in other words, between the territory of the profession and the client. The research also feeds directly into the creative design processes of OMA, in cases such as the Seattle Public Library (2004).

Third, UNStudio is another well-known example of output-driven research in practice. Founded by Ben van Berkel and Caroline Bos, it has two dedicated research teams, UNSKnowledge and UNSFutures. In 2019, UNStudio developed the Coolest White in collaboration with Monopol Colors, a fluoropolymer coating system with total solar reflectance and abrasion resistance for building façades. Coolest White is designed for overheated urban environments, mitigating urban heat island effects by reducing the temperature inside and outside of buildings. This project is a good example of long-term design value and solution developed in an evidence-based and planned process of innovation with industry-partners that deals with a specific problem of design that can be applied to general building conditions.

To summarise, output-driven architectural design research produces tangible outcomes, usually following either an iterative and speculative or an evidence-based and planned process. It often feeds directly into the creative processes of design in architectural practice and is a form of research aimed at immediate design innovation. Output-driven research can also include

Table 1. Summary of the process- and output-driven architectural design research in practice.

	Process-driven research	Output-driven research
General focus	(1) Experimentation on materials and prototypes	(1) Design outcomes
	(2) Participatory design	(2) Elements and material components studies
	(3) Quantitative research	
Examples of practices/Projects	Foster + Partners (Lunar Habitation and Mars Habitat)	CSK Architects (Cork House)
	Sarah Wigglesworth Architects (DWELL)	OMA/AMO (Seattle Public Library)
	HTA Design (Home Performance Labelling)	de Rijke Marsh Morgan (Kingsdale School)
	HLM Architects (Thoughtful Design Toolkit)	UNStudio (Coolest White)
Types of research	Post Occupancy Evaluation (POE)	Digital fabrication techniques used in non-standardised architectural components
	Building Performance Evaluation (BPE)	
	Building Information Modelling (BIM)	
	Participatory design research	Participatory design research
	Experimentation with materials and prototypes	Experimentation with materials and prototypes
	Construction and fabrication techniques in design and building processes	
Research features	Planned research design and process	Iterative or evidence-based research process
	Part of a larger collaboration	Industry-partners
	Robust and integrated documentation	Singular solution
	Produce transferable knowledge and insights	Difficult to differentiate from practice
	Cyclical research process	Feed the creative process of practice
	Value is less certain	Immediate impact, directly measurable
	Results might be not immediately tangible	Tangible results
Impact	Short-term, mid-term, long-term, but potential for immediate impact. Focus on social, environmental, and economic as well as ethical research problems that conventional research often overlooks.	
Audience	Privileging of professionals, the public, policymakers over academia	

participatory processes, therefore overlaps with established process-driven research approaches in the social sciences. Output-driven research is transferable beyond the initial project it was developed for. However, much of this research remains tacit, usually for commercial reasons since the intellectual property right can be a defining characteristic of its value (Rust, Mottram, and Till 2007). One of its potential weaknesses is that it is sometimes difficult to differentiate output-driven research from normal practice when formally assessed against conventional research criteria.

Impact

Based on the above analysis of process- and output-driven architectural design research, it is evident that predominantly different research processes can be identified clearly as a rigorous research activity in the conventional academic sense. Process-driven research tends to have planned and cyclical and output-driven research iterative and emerging research processes. Yet, there are important differences in the potential impacts produced by either

type of research (see Table 1). Since a shift in research assessment towards impact over a decade ago, impact has become a core consideration of funded research (UKRI (UK Research and Innovation) 2020). With professional bodies and industry-oriented funding organisations considering research as essential to the business of architecture, they have also made impact criteria central to their work (RIBA 2017; Supplemental Charter of 1851). Both in academia and practice, impact and related communication requirements have therefore become important to conducting architectural design research.

Impact is directly linked to the central question of practice, what value architecture has to offer and—specifically in the context of architectural design research—what kind of evidence exists to support its claims. Increasingly, there is thus interest in understanding and expanding the meaning and value of design research in the applied discipline of architecture to its practices (Geiser 2008; Fraser 2013; RIBA 2014; Hensel and Nilsson 2019). For example, Leon Van Schaik (2019) claims that the continuums of a successful design can only be integrated with practice through research. Ranging from small to global firms and from commercial to speculative research, almost all large architectural design and engineering firms such as Arup, Gensler, Buro Happold, Foster and Partners, Zaha Hadid Architects, OMA/AMO, Aedas and AKT maintain today research departments to remain commercially competitive and create new knowledge for practice, but also to contribute to larger disciplinary discourses. The cases discussed in this study mainly relate to research in large firms, but the examples show that smaller offices can equally drive design innovation and create new precedents. This is now commonly measured in terms of impact.

Impact is fundamentally a form of research assessment and can be argued in three ways: commercial, cultural, and social (Samuel 2020). Thus, the process-driven and output-driven research classification discussed in this paper might be better reframed now in relation to impact and its target audience. First, architectural design research tackles technical, material and performance-related issues by employing design innovation with a value for practitioners, which are evaluated against how evidence-based data can be effectively used in future applications. Therefore, the key beneficiaries of this type of research are practitioners. Second, both process-driven and output-driven research projects in architecture can be seen as increasingly dealing with issues beyond conventional academic research in architecture, such as issues of social justice, climate change, and affordable housing, which have great social, environmental, and economic values for the public. Therefore, the impact can be both long term and short term and measured by their relevance to issues of public concern. Third, architectural design research may focus on external drivers such as supply lines and labour, which benefits policymakers and the construction industry by supporting the

implementation of the Green New Deal or realising Just Cities. Thus, this form of research often deals explicitly with increasingly imperative ethical questions of practice that have a wider value for the general public. This impact can be evaluated against the implementation of new policies and public benefits. While policy-based and social research often have a mid-term to long-term impact, technical, material, and performance-related projects tend to have shorter-term and immediate impacts. But architectural design research undertaken in practice can have both immediate and long-term benefits, and research projects can follow iterative and cyclical processes.

Architectural design research projects generally have greater potential to benefit wider audiences including professionals, the public, and policymakers as well as academics. For instance, many of the new RIBA publications focus on the value architecture brings to the users and stakeholders, including the Social Value Toolkit (SVT) and Post Occupancy Evaluation. While the SVT places emphasis on the social value of the product, the building, or the place (Samuel 2020), POE highlights learning from both successes and failures to address issues of quality, safety, and sustainability (Macdonald 2020), with the RIBA recently demanding that POEs become mandatory for all publicly funded projects. These shifts are increasingly integrating research activities into everyday practice.

Conclusion

Conventional academic research tends to have homogenous characteristics, for instance, audience and author usually belong to the same community of researchers and there are established research practices. Particularly in architecture, architectural design research innovation has not formed an integral part of its wider research culture. For example, evidence-based research in the built environment has been largely carried out by other disciplines (Samuel et al. 2015). Yet with an increasing recognition of the value of research to architectural practice and the value of design to the economy and public concerns, there is growing interest by, and support for, architectural practitioners to undertake research.

Research in practice can challenge conventions of academic research and affect how research is conducted as well as its research aims. For example, while social sciences research typically anonymises qualitative data, identifying participants and where they live is often essential to architectural design research, especially when taking place in a specific place and involving co-design. Applied research can directly connect ethical research and research questions to concrete outcomes for practice and tangible values for users, for

example, when dealing with issues of sustainability, climate change, or social justice, and enhance the impact achievable by architectural design research.

However, for a meaningful discussion to take place between practitioner and academic research, better knowledge transfer between academia, practice, and architects is needed. As Samuel (2020) emphasised, solid, rigorous research is not enough, but a rigorous, critical, and skilled architect can add social, cultural, and commercial value to a project. There is a great need and potential for significant impact from research in practice that is ethical, rigorous, and evidence based.

A common key test of academic research is if it has a planned process. As discussed, while both process- and output-driven research in architecture can meet this criterion, it is less essential. Yet, as the analysis shows, process- and output-driven research are often linked, with both typically having a research process and design outcome, although different methods and processes characterise various approaches. Research value and impact are thus less dependent on the approach taken than the rigour with which it is implemented. In fact, both approaches might exist in parallel and there are great opportunities in combining their strengths to create more rigorous processes of design innovation and design thinking with public impact and value.

While this study focused on the UK context, many of the observations and insights are transferable. To conclude, the key potentials of architectural design research and the actions that might enhance research practice can be summarised as follows:

- It is often not fully planned, tends to be iterative, and enables design experimentation or uses design innovation.

  – Actions to enhance this potential might include setting clear overall design aims and objectives, planning the analysis and evaluation needed between iterative stages of research, and identifying and managing project delivery risks early on.
- It can have an immediate impact that is directly measurable and tangible.
  – To maximise the impact, there should be a planned pathway to impact that can be further developed during the research process.
- It can include participatory processes and/or can directly engage with public audiences as part of its research activities.
  – Actions to improve research practice includes setting out clear aims and selection criteria, developing ethical participation and engagement protocols, and ensuring that research ethics are complied with.
- It can have greater agency and impact dealing with ethical, social, economic, or environmental issues than traditional academic research.

– Actions to enhance research practice and impact include pathway to impact integration and impact prioritisation while giving consideration to methodological appropriateness and robustness of research processes.

The study of processes and evaluation criteria of architectural design research shows that it can have a strong social and economic value and can enhance ethical and responsible research by giving it more immediate pathways to impact. Thus, the characteristics and potentials of architectural design research can be restated as *cyclical and iterative processes of research in which the means of architectural practice, often in collaboration between practitioners and stakeholders, produce design innovation and thinking with tangible impact and commercial, cultural, or social values*.

One strength of architectural design research is that it can often be tangibly measured by users and the general public. For example, COVID-19 lockdowns have made people aware of the value of well-designed homes, with the quality and size of dwellings having had an immediate impact on the wellbeing and health of occupants (NHF (National Housing Federation) 2020). The strength and problems of that immediate impact of architectural design can be better instrumentalised in evidence-based architectural design research.

While this paper has analysed the larger context, there continues to be a critical lack of detailed studies on the value of experimentation and innovation in architectural design research. A prominent characteristic of this type of research is that it is iterative or cyclical and therefore has a circular relationship between research questions, process, and impact unlike many more conventional forms of research. To fully understand architectural design research and its strengths or weaknesses, it is essential to analyse how design research might differ between diverse types and sizes of architectural firms, including why emerging small architectural practices increasingly engage with research and how this shapes their practice.

Notes

1. POE is usually associated with BPE and performed together. They ideally take place one year after handover and the evaluation information is shared and made public (Williams, Humphries, and Tait 2016). In an example of POE/BPE, HLM Architects developed the Thoughtful Design Toolkit enabling designers and commissioning clients to define, develop, and assess their building projects through evidence-based data. This process is quantifiable, directly related to practice, and can be easily documented. This type of research produces guidelines and databases and can inform the briefing process. This creates a virtuous circle of information.

Disclosure statement

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Notes on contributors

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