

REVIEW

Identifying the Barriers to Change in the UK Housebuilding Industry

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In the UK, the sustainability agenda for housebuilding is now over ten years old, dating from the 2006 launch of the Code for Sustainable Homes as the benchmark for the reduction of carbon emissions in all new housing. The government's 2015 decision however, to dismantle the Code for Sustainable Homes and remove the 2016 Zero Carbon targets, has meant that with little warning, the sustainability industry has had to start fending for itself. Without the incentive of tariffs to focus the minds of the developers, the sustainability industry is now looking vulnerable, and the realities of having to be financially viable are coming home to roost. But our statutory requirement to reach an 80% carbon reduction by 2050 has not changed, and neither have the reasons for achieving it.

During that time, the sustainability agenda was a key driver for innovation within the housebuilding industry. However, rather than focusing on the many benefits that innovation can bring, in this paper the authors look at the barriers to adoption of innovation and asks whether these barriers have been fully understood by those who are accusing the housing industry of complacency for its failure to reinvent itself. The main method used for investigating what these barriers might be was a series of industry interviews, carried out across all the sectors defined as being part of that decision-making process, in order to better understand how their motivations might differ, and if so whether this disconnect could be preventing the progress that all individually profess to want but none appear able to deliver. The findings suggest that a more informed approach to promoting or considering any innovative product within the housebuilding industry could avoid many of the barriers currently being confronted head on.

Keywords: Housing; Sustainability; Motivators; Barriers; Risk

Introduction

Until recently, legislation has been a powerful component in the initiation of change within the housing industry geared around the reduction of carbon emissions, and whilst this has not completely disappeared, it is no longer the driving force it previously was (Pitt, 2014). Since the government's decision to dismantle the Code for Sustainable Homes and remove the 2016 Zero Carbon targets, with little warning the sustainability industry has had to start fending for itself. Without the incentive of tariffs to focus the minds of the developers, the sustainability industry is now looking vulnerable, as decisions to adopt sustainable solutions are now being taken on their merit alone. To some extent this sudden transition could be seen as a problem of the sustainability industry's own making, since whilst they have been waiting for the housing market to transition to a carbon-based mind set, that market

has been waiting for the sustainability industry to transition to one of financial viability. As yet, neither party seem ready for this coming of age, and this disconnect in expectations could be adding further to a collective inability to move forwards.

It is this disconnect, potentially existing in many guises across the housing industry, that the authors set out to investigate in this research. The use of sustainability based products as the vehicle for this and of the concrete industry as a case study within that was appropriate, but only defines a subset of the wider issues at stake. The Farmer Review (Farmer 2016, p. 6) and many other government white papers beforehand have recognised the systemic problems that the housing industry faces in its attempts to modernise itself, but all previous attempts have arguably failed to resolve them, suggesting that there is still more to be discovered about this reluctance to change.

In this paper, rather than focusing on the many benefits that innovation can bring, the authors look at the barriers to adoption of innovation and asks whether these barriers have been fully understood by those who are accusing the housing industry of complacency whilst continuing to deploy the same unsuccessful solutions.

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Methodology

The starting point for this research was to define the housing industry by all those who might have an influence over the decision-making processes involved in choosing how and what to build. The resulting diagram shown in **Figure 1** shows four sectors that potentially have very different perspectives on what should dictate those decisions, defined here by the ‘three dynamics of sustainability’, economy, equity and ecology (United Nations, 2000).

To test this hypothesis, that it is fundamentally a lack of understanding between these sectors of each others’ needs and motivations that leads to uncertainty that in turn limits the industry’s ability to adopt innovation, it was decided to carry out a series of in-depth interviews across the sectors involved. This in turn was based on a thorough search of the literature focusing on sustainability, housing and innovation across this and other disciplines, later extended to look at the role played by risk, in response to the information gathered. Whilst this search unearthed many relevant papers covering all of these areas in turn, there was a clear lack of papers applying the theories of risk to the adoption of innovative solutions within the housing industry.

The interviews themselves were semi structured and allowed for each sector to interpret a series of simple SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis questions about concrete solutions, in a way that brought out their own perspectives of the housing industry as a whole and its relationship with change. The coding of the interviews was an inductive process allowing different themes to emerge, with the information being extracted on many levels to establish trends, comparisons and contradictions between interviewees and between sectors. Much of how the research methods evolved stems from these findings, including the decision to create a public survey to reach that sector more effectively and to carry out a thorough review of government white papers

relating to the housing industry to gain a further insight into the government’s perspective. Together, these three approaches ensured that all opinions were gathered to provide a clear picture of where the disconnects were to be found.

Findings from the Research

In this paper, the authors focused on a proposed solution to the barriers found to be preventing sustainable solutions from being adopted by the mainstream housing market, based on the findings from the methods described above and published here for the first time. A selection of these findings are discussed, but as a way of validating the approach being proposed. For now, the salient points to mention about the findings would be that there was a broad consensus in how each sector perceived or understood the other sectors: All sectors, for instance, saw the public ‘end users’ as ill-informed and inconsequential in terms of their influence over what was being built on their behalf. This effectively corresponds to an industry basing its business model on a perception of its client’s perception of what housing should offer, but even then not prioritising that above its own needs.

Following on from that, the other salient point would be an overall lack of evidence behind much of what was ‘known to be true’. The housing industry as a whole would appear to operate on a level of perceived realities: Government documents are seen as reliable and trustworthy – without any actual evidence of the validity of their sources (Sasse, 2017) – whereas company literature is recognized as being, at best subjective. The house building companies themselves, in the absence of much data beyond their promotional literature, are victims of their own secrecy and often misunderstood, even at a governmental level (Communities and Local Government Committee, 2016, p8). In general, and exemplified later, there was much evidence of a lack of understanding of

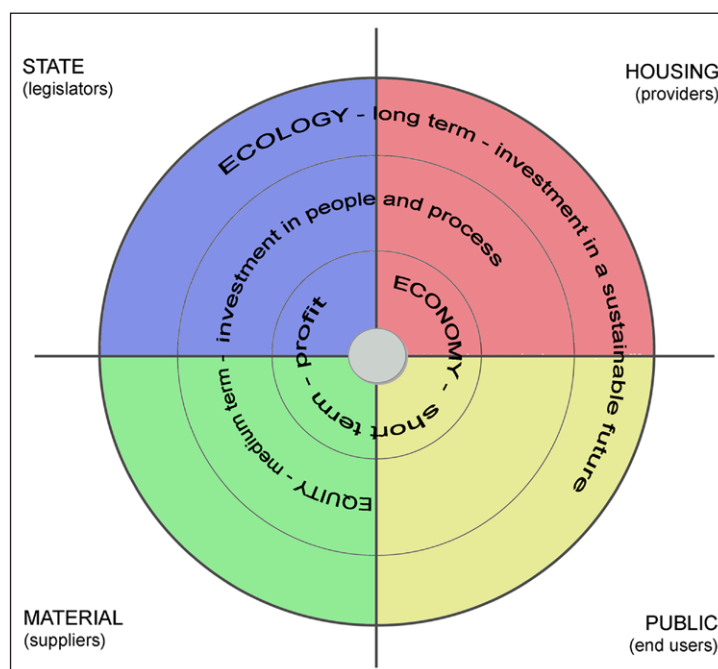


Figure 1: Diagrammatic representation of the main sectors within the housing industry suggesting the key motivating factors that drive all of their decision making to various degrees.

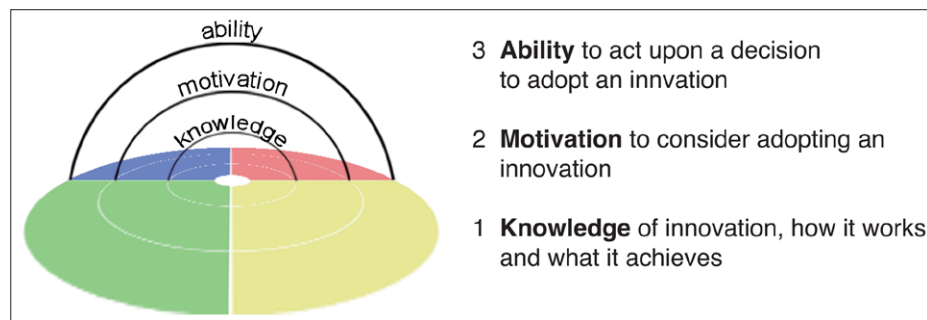


Figure 2: Three prerequisites for the adoption of change through innovation.

each others' roles, leading to a sense of uncertainty and distrust, and showing itself in a reluctance to take risks on innovative ventures.

Unmatched motivations

So far there is nothing here to suggest unmatched motivations as such, only a lack of knowledge about what those motivations might be, but supplanted nevertheless with a healthy dose of supposition. As a basis for strategizing, it is suggested that this is unlikely to result in the efficient promotion of innovative solutions even if sometimes those motivations are found to be mutually beneficial. Understanding what motivates the housing industry to make the decisions it does – and this includes all sectors that are part of this complex chain of delivery – is the first step towards a more successful dialogue, and whilst this should always include an educational role in promoting, in this case, the long term benefits of sustainability, it also requires the sustainability industry to understand the need for short term financial viability. The findings from the industry interviews shed light on how the perceptions held within these sectors and the lack of factual evidence lessens the industry's ability to recognise where the barriers to adoption of innovations would be least. There is, for instance, an unhelpful tendency for the mainstream housing industry's insistence on immediate viability to be seen by sustainability protagonists as commercial greed overriding the collective good that their agenda represents. This position, however, presupposes that this particular sector is firstly, informed, secondly motivated, and thirdly in a position to follow through with the changes being asked of it in considering an alternative solution to the status quo (**Figure 2**). All three of these requirements – knowledge, motivation and ability – it is suggested here are prerequisites of change, and together they represent a considerable journey for some sectors to make within what is an extremely complex and adversarial industry (Cabinet Office 2011, p. 3). Where those motivations align, however, that journey would be considerably easier to take.

Government intervention

The review of government white papers was then carried out to establish the extent to which the government's proposals recognised the importance of matching their own needs with those of the industry it has been trying to reform. Interviewing and surveying those across the sectors involved in the housing transaction had shown that it was very easy to make a strong and compelling case for the status quo and why innovative solutions in the hous-

ing industry so often struggle to become established. The Farmer Review, published in October 2016, and entitled 'Modernise or Die' recognised all of these barriers to change and defined them as the ten symptoms of a near terminally ill patient (Farmer 2016, p. 6). It talked about the complexity of the housing industry's structure and the poor communication and understanding that exists between its sectors. It talked about the uncertainty that hounds the housing industry due to government policy inconsistencies and the effect that our cyclical economy has on investment, training and ultimately on our skilled labour supply. And it also talked about the many other papers that have preceded this review, making similar observations (**Figure 3**), but all failing to have the impact intended on the productivity and output that is so desperately needed (Lyons 2014, p. 6).

The concern that arose from studying these white papers, and what led to the question being asked by the authors, was that despite recognising all the previous papers that were also well received in their time, there was no attempt here to question why it was that they were so ineffective, leading one to question whether this latest review will be treated any differently. The Farmer Review itemises and deals with the many symptoms of the inertia that has beset the housing industry, but there is still a tendency, reflected also in previous papers (Morrell, 2010, pp. 5, 34), (Eclipse Research Consultants, 2009, p. 4) to then settle on complacency as the root cause.

"I am very clear that if we do not address in short order how the construction industry operates and delivers, we will see a long-term and inexorable decline in its fortunes. This is not just another 'must do better' school report where the industry and its clients shrug their shoulders and carry on as normal." (Farmer, 2016, p. 5).

As well as this being an unproductive diagnosis, the authors' findings from the interviews, suggested that the housing industry is not so much reluctant to consider change, as unable to, due to the unrecognized levels of risk that its individual component businesses are being asked to take. The comments made by interviewees also suggested that the perception of risk is central to the reason why the sustainability agenda is failing to transition from a government incentivised proposition to a business led proposition. In this respect, the sustainability agenda is no different to any other agenda that requires changes to be made. Any change involves an element of risk, some-

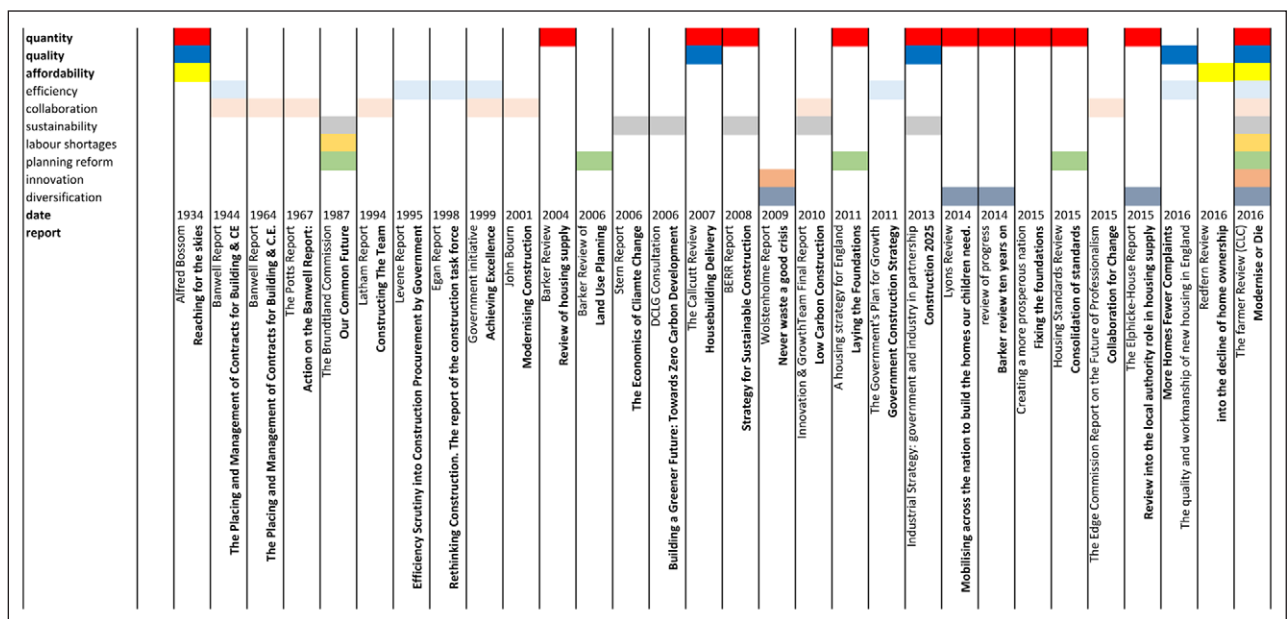


Figure 3: Timeline of researched government white papers relating to construction since 1934 and the symptoms addressed.

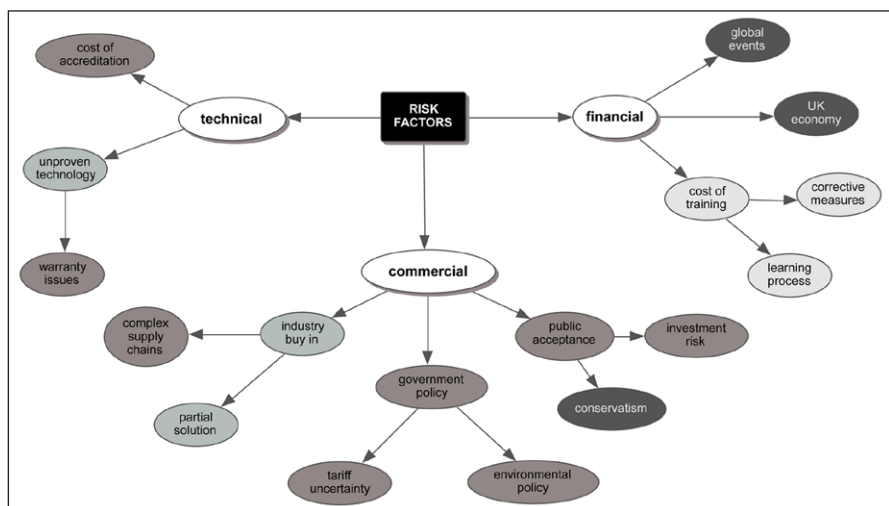


Figure 4: The risk factors confronting the housing industry. Darker shades represent less controllable risks.

thing which many businesses are founded on, but risk has to be manageable. What emerges in the housing industry is that there are high levels of complexity and uncertainty, both of which are risk escalators, to a degree where the risk becomes untenable, and the status quo, no matter how discredited, becomes the safest short term option. The Zero Carbon Homes standard, both in its inception and its demise, exemplifies the impact that enforced innovation is claimed to have had on small businesses.

“The costs and complexity of running a SME house builder business have been increasing steadily over the last 25 years and have had the effect of driving many smaller firms out of the market” House Builders’ Federation, (Lyons, 2014, p. 106).

This is perhaps where the crux of the problem confronting the UK housing industry is to be found, and the reason why so many government initiatives, dating back over an incredible eighty years have failed to bring about the changes that were intended. They have failed to under-

stand the barriers to change from the perspectives of the many individual companies that make up the greater industry. Those small businesses need there to be a direct benefit to them and at a definable and manageable level of risk. And whilst sustainability is only one part of this call to action alongside increased productivity, quality and affordability, the overriding and undiagnosed problem at a governmental level might lie in their failure to recognise the disconnect between risk and reward as the main barrier to change (Figure 4).

Technical risk: New innovative solutions are seen as high risk because they are technically unproven, open to the threat of competition, and potentially difficult to warranty. New technologies require many bodies across all sectors to be convinced of their necessity, viability and practicality before they will be accepted.

Commercial risk: From an implementation perspective, new innovative solutions are seen as high risk because of their dependence on vacillating government policies, tariffs and regulatory targets, the need for businesses in complex industry supply chains to be willing

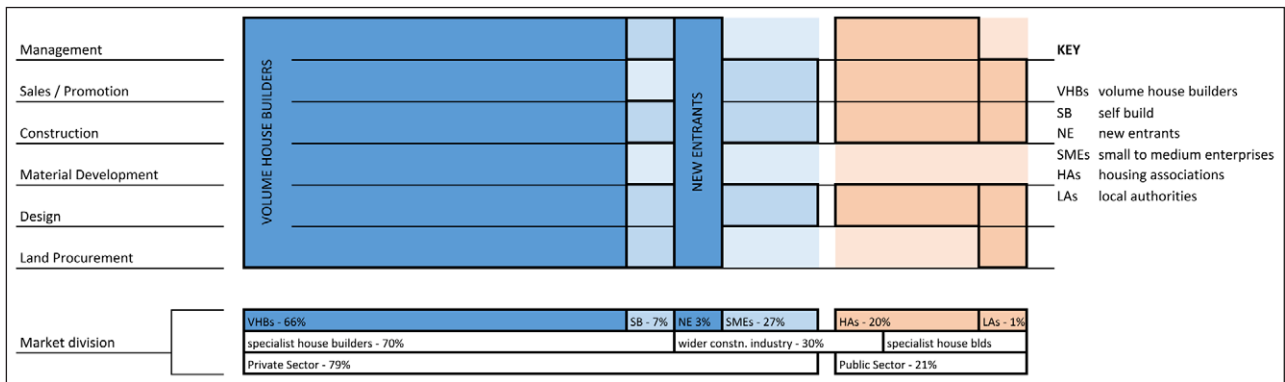


Figure 5: Market division by provider showing level of control over the housing delivery system.

to participate, itself dependent on their need to be beneficiaries in their own right, and the unknown factor of public acceptance, due either to conservatism or an unwillingness to risk their own investment.

Financial risk: Once the decision has been taken to participate, there is the direct financial risk associated with costs of promotion, of training and reskilling, of possible corrective measures at the outset, plus the risk associated with the impact of unknown future political, economic and environmental events.

Fix or avoid?

What began to emerge from this review and the interviews, specifically those undertaken with developers operating in different sectors, was that there were two alternatives to consider. The first was to limit these risks by changing the way in which the housing industry operates, and the second, to accept the way in which the industry operates as unchangeable and to avoid those risks by taking an alternative route. As suggested at the outset, the proposal being made in this research is that the alternative route might be a more realistic option, and that eighty years of attempted intervention has proven that any government’s ability to make wholesale changes that influence our entire housing delivery system is limited and should not be relied upon.

The question raised by this position therefore, was, is there an alternative route that bypasses these more immovable barriers that we should be considering? The answer to that was a conditional ‘yes’ because it is already happening, albeit not yet on any meaningful scale: The focus of the current government’s latest drive to revolutionize the house building industry is off-site manufacturing (DCLG, (Department for Communities and Local Government) 2017, p. 48), and whilst off-site manufacturing is where this drive is centred, the real revolution is in how this is now being orchestrated by some sectors as an independent operation. Off-site manufacturing has been paraded as the housing industry’s panacea to increased productivity before, and if we are to include its precursor, ‘prefab’ housing – the same solution in all but name – it is a solution that has been available to us since the First World War. What is different about this incarnation is the fact that the ‘New Entrants’ who are propagating this model, are not attempting to woo the existing developers or dovetail into their existing business models, but are instead setting up their own self-contained operations, which in some cases,

such as with Legal & General, include land procurement right through to property management with a long term interest in rental returns (Farmer, 2016, p. 38).

In some respects, this is merely a recognition of how successful the volume house builders’ business model is, since what they are doing is recognizing their model as a vertically integrated market solution, something that often gets missed because of the fact that theirs is also a very broad market, soaking up two thirds of the whole (Figure 5).

“The standard UK business model is that of the volume house builders. They typically manage all the stages of housing development themselves; from land purchase through to selling the completed homes and taking development and demand risk.” (Lyons 2014, p. 104).

By controlling all stages of the operation, no matter how narrowly defined that market might become, the number of transactions and the risks associated with these begin to diminish, making the proposition of innovative solutions more appealing. The important message, therefore, and the reason why this is only a conditional ‘yes’ in answer to the question posed, is that this particular solution to the barriers that are preventing progress is not off-site manufacturing per se, but in defining vertically integrated solutions by their ability to work for specific markets where that innovation is un-resisted and uncontested, and therefore representing a lower risk.

If, for instance, this particular solution were allowed to grow to encompass more than the basic, modular, easy to access sites that the New Entrants’ build-for-rent model is currently pursuing, it would begin to run into the issues that off-site manufacturing has historically run into, such as the limitations of a standardized solution, the limitations of tight sites, and of client inconsistency (Ross, 2002, p. 20).

“There’s a lot of hype around off-site construction but it’s spin – it’s not reality. The reality is the majority of housing construction takes place on relatively small sites where the adaptability of traditional masonry build is a key driver. Unless homes are being mainly built on big sites where the replication of large numbers of units and components is possible, nothing will beat the flexibility and efficiency of masonry.” Mike Leonard, CEO Building Alliance, (Gardiner 2016).

But on site or off site, and the complex decisions that that argument entails remains a definable decision to be taken, whereas future events, the uncertainties, such as the onset of the next recession, are as uncontrollable as they are inevitable. When the next downturn does come, off-site manufacturing’s relative efficiencies will begin to diminish alongside its diminishing throughput, and the investment costs will begin to bite. The risks that stem from the complexities of the housing industry can be taken or avoided, but the uncertainty of many ‘future risks’ remain fundamental barriers to innovation that cannot be avoided, only accepted.

Defining a sphere of influence

In reality, creating a self-contained bubble in which to operate as the New Entrants are attempting to do is as unrealistic as attempting to correct the marketplace in which the rest of the housing industry has to survive, and the real challenge is in defining the scope of that bubble and how to deal with the problems that remain outside of it. What cannot be brought ‘inside the bubble’ to be controlled must be factored in as an accepted risk. That interface, if pushed to its extreme is arguably the interface between what defines the existing market now and the expected market in the future. A knowledge of the current state of affairs with all its inherent complexities can be researched and a level of risk associated to any strategy based upon that, but future risk is an altogether different proposition. Outside of the ‘now bubble’ is a whole world of financial, social and environmental unknowns that are all interrelated and influenced predominantly by political forces over which the housing industry only has occasional control. Whilst the interviews suggest these are known to be there, they are rarely given the consideration they deserve, but this is not to destroy the original argu-

ment. The best route to progressing innovation, it is suggested, is to limit that associated risk, which requires the housing delivery system to focus its efforts on reducing risk levels in the present whilst recognising those in the future as risks to be accepted, but not ignored.

The principle behind narrowly defining the market in which to promote an innovative solution is to arrive at a point where that market presents a negligible risk because the proposed innovation represents the best solution over any other. The major unknown risk left in this scenario is that of future events, and that then becomes the point of discussion. How well can future outcomes be predicted and either controlled, ie brought inside the bubble, or protected against? Environmentally, this is a familiar debate, with resilience planning increasingly being seen as the solution to environmental unpredictability (McPhearson, 2014). But the same principles could be applied to our political environment. Any strategy also needs a degree of resilience against those uncontrollable political and economic events to maximise its chances of survival.

Risk reduction

Whilst the example of the New Entrants and their risk avoidance policy of maximising control of their vertical market is very relevant, that option is not immediately open to all participants. The more realistic starting point is for those many small businesses that make up the housing industry to work together more effectively, to understand each others’ motivations, and through that, define those vertically integrated markets where there are mutual, financial benefits and the opportunities to develop collaborative ways of working. In other words, increasing their spheres of influence by reducing the industry barriers whilst accepting those outside of that as beyond their control (Figure 6).

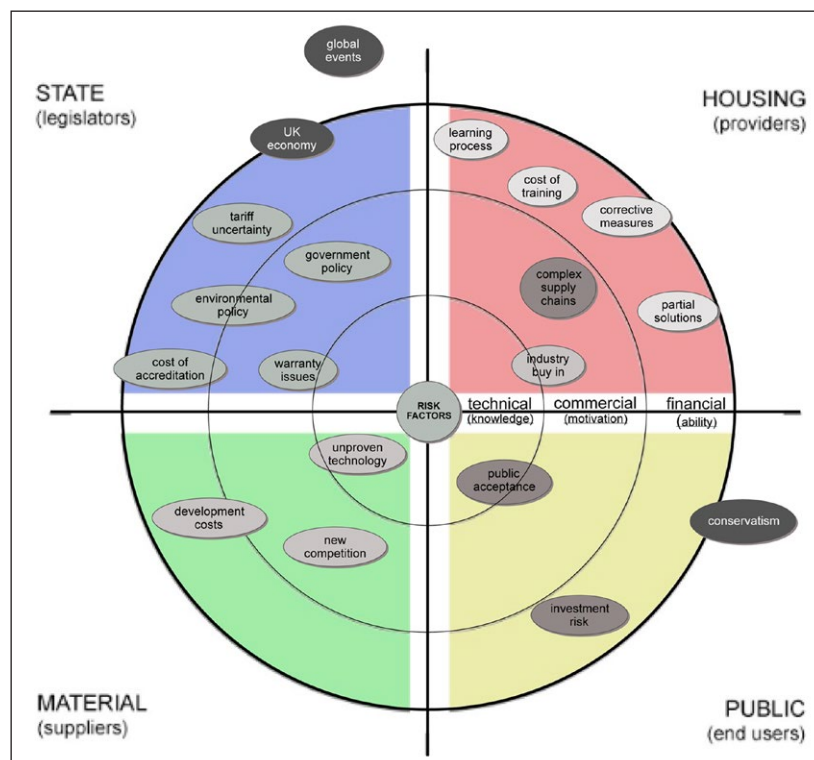


Figure 6: Risk factors by sector inside and outside the housing industry’s sphere of influence.

The purpose of the work from which this paper has been taken was to first prove that these disconnects between the sectors within the housing industry were indeed there and in part the cause of the industry's resistance to change, but also to develop a model by which the industry could mitigate the risks associated with that change by defining markets that represented the path of least resistance for them to pursue.

Perhaps the most essential development that this process has highlighted was the need for BIM as the backbone for further collaboration. BIM is both the catalyst for change the industry needs, and the change most in need of a catalyst, in that it requires a pre-existing level of collaboration to ensure that all parties embrace it in near unison. Currently the government's requirement for BIM to be used on all public works has been the main driving force behind this need to 'jump together', but that will only embed the process so far. Again it is the New Entrants with their level of control throughout the whole build process who are in the strongest position to demand its use, and once established, benefit from its ability to strengthen communication channels between the sectors involved.

Developing a visual representation of this model for the collaborative route to innovation became a central objective of this research, to show the complexities of the housing industry structure, the motivations within it, and the associated risks being confronted. The components of that model evolved as shown in the diagrams throughout this paper, with many of those components being derived from work in other fields that have recognised similar needs and barriers to overcome.

To summarise, the housing industry itself has been defined by all those sectors that impact upon it, divided into the four participating categories of Material Supplier, State Legislator, Housing Provider and End User, each then further subdivided by the motivating factors that drive them, defined under Economy, Equity and Ecology, or financial, social and environmental (**Figure 1**). But change requires more than just motivation. There also has to be adequate knowledge of that innovation, and then once motivated to consider it, there has to be an ability to follow through and implement that change, and this across all four sectors to mitigate the risks associated with that change (**Figure 2**). These risk factors in turn have been categorized as those relating to technical development (Keizer & Halman, 2007), commercial implementation (Lutzenhiser, 1994) and financial commitment (Lazonick & Mazzucato, 2013) (**Figure 4**). Individual businesses, operating within their own disconnected sectors have their own spheres of influence where they can control the level of risk associated with the adoption of change from their perspective (**Figure 6**), but have little control or influence over the industry as a whole.

This last diagram therefore represents our current housing delivery system with many small businesses operating in silos within a very large and complex industry, with most of their risk factors existing outside their individual spheres of influence (Farmer, 2016, p. 33). What the authors are suggesting is needed is for more collaboration between these sectors rather than within them, creating

larger spheres of influence, whilst focusing on smaller more appropriate segments of the market that can be defined by their inclusion within these new larger bubbles of shared risk (**Figure 7**).

The task for this research was to develop a new model that showed how that collaboration could be achieved to the mutual benefit of all those involved without the levels of risk normally associated with the adoption of any alternative solution. It recognized that a better knowledge and understanding of those other sectors was the key requirement in this process, but also recognized the reality of time constraints, and therefore the need for that process to be thorough but efficient. The development of that model evolved through a series of case studies designed to look at the issues uncovered regarding knowledge, motivation and ability and how they represented levels of risk, depending on the perspectives of those sectors that need to collaborate if innovation is to flourish:

The three 'levels of attainment' required for the adoption of innovations shown in **Figure 2** – knowledge, motivation and ability – in terms of risk, relate to technical risk, (how does it work, or 'knowledge'), commercial risk (why do we need it, or 'motivation') and financial risk, (how do we pay for it, or 'ability'). All of these are key elements of the model, but their relative importance and the level and exposure to risk they represent is dependent on the role of the participant. For the innovator, the commercial risk of finding a secure market might be the greatest barrier, whereas for the property developer it might be the technical risk of trialling an unproven technology. And for the end user, the financial risk of investing in that technology could be the main consideration. Whilst that might seem to represent a shared risk when looked at holistically, this is not how it appears to each individual at the time of making that decision, and individual risk for collective benefit is not a good recipe for driving change. A true sharing of risk, which is what the authors suggest and is also backed up by Lazonick & Mazzucato in their paper on 'The risk-reward nexus in the innovation-inequality relationship', is that the best way for innovation to be considered, let alone adopted, comes from a close collaboration based on mutual benefit. That in turn requires a foundation based on a knowledge and understanding of each others' needs and motivating factors that this research has shown to be weak to non-existent.

Validating the Process – The Industry Interviews

The following three examples of the barriers to innovation, based on the findings from the interviews undertaken, are all related to the use of concrete in ways that are in competition with alternative technologies. We look at how and where the concrete industry has chosen to promote these solutions, the possible reasons why these strategies might not be successful, and the alternative approaches that could be considered based on the policy of risk sharing, risk acceptance and risk avoidance discussed above. The 'offer' in each of these examples represents the current situation as defined by the interviewees from the concrete industry. The 'outcome' that follows is also based on information provided by interviewees, but

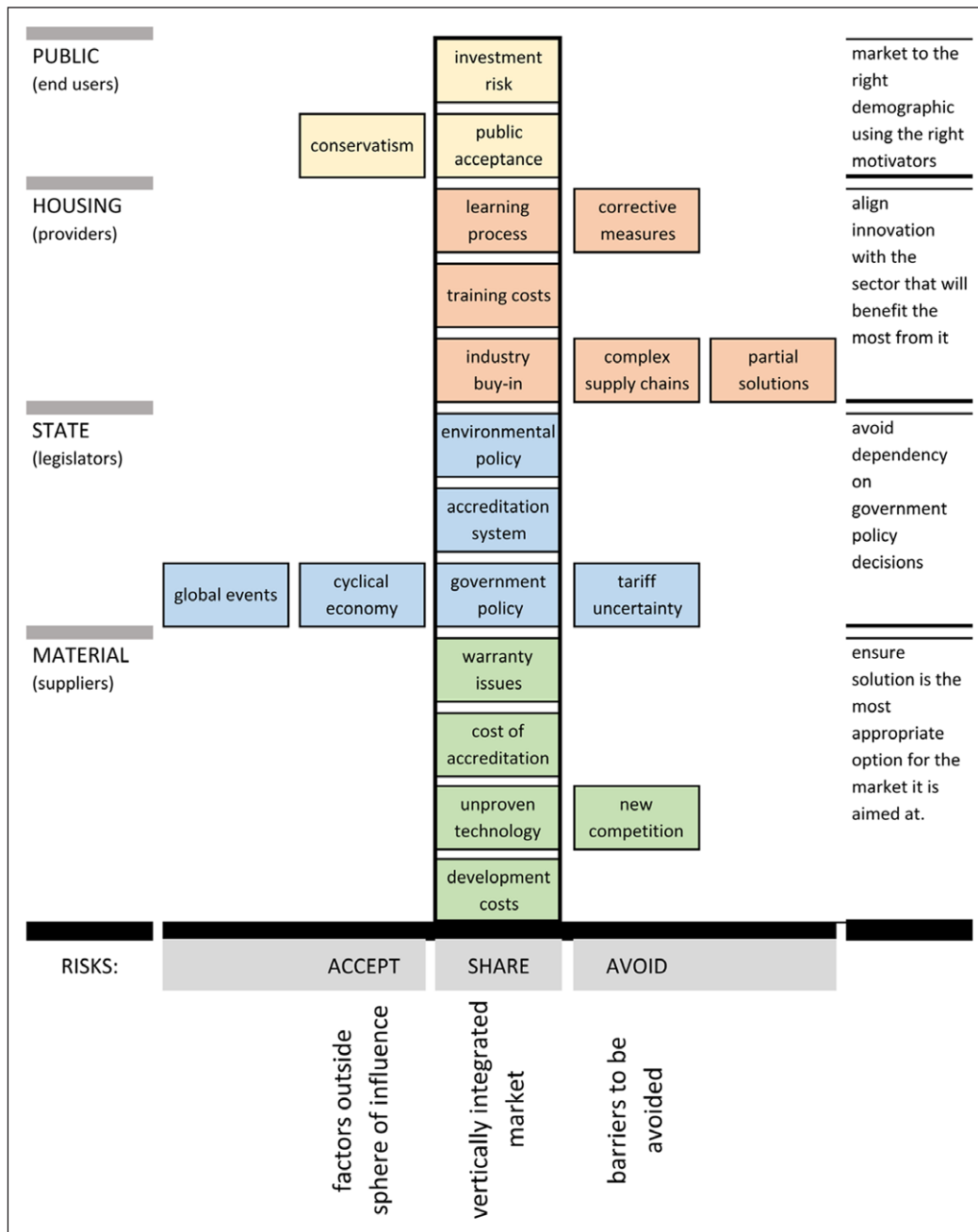


Figure 7: Vertically integrated market model defining markets by acceptable levels of risk.

from different sectors, and defines the disconnects that are preventing adoption. The final section, the 'alternative', shows how by combining the knowledge from all sectors, a mutually beneficial solution can often be found.

The use of beam and block flooring for first floor construction within housing to increase thermal mass

The offer: The volume house building market, representing about 66% of our current new housing provision, almost universally uses some form of timber joist at first floor level. The concrete industry has recognized the potential benefit to sales in convincing this market to change to using concrete beam and block flooring instead. The marketing of this solution has focused on the thermal mass benefits, and the consequent reduction in heating and cooling costs, plus the additional benefits relating to sound proofing and fire risk (The Concrete Centre, 2009).

The outcome: The technology itself is not new, so on this occasion, it is its promotion to the market that represents the investment, but the market they are focused on is not interested for many reasons. The proposition represents a risk for the volume house builders and a benefit for their customers. Their risk is entirely financial as the solution will increase costs, both in terms of materials and time, in terms of trunking for services and floors that will require a screed finish that takes time to cure. The financial reward, however is marginal, as the change represents an improvement that their customers do not prioritise over purchase price, and are therefore reluctant to pay for.

Interviews with a major volume house builders (VHBs):

INT "But is that viable? Doing the first floor in beam and block rather than timber joists?"

PA03.03 *Ground floor it is. First floor I don't think there is any need to unless you are doing apartments, so no not really."*

INT *"So in a domestic house?"*

PA03.03 *"You don't need to. Because generally when you put a concrete floor in you've got to put a screed on in, and a screeded floor takes two or three days before you can walk on it."*

It will also involve reskilling and unless the solution represents a 100% replacement of their existing method, it merely represents the addition of another process. The benefits are also seen as marginal by their clients who are not driven by running costs as much as they are by purchase price.

PA03.1 *"If we offer something that the public don't put a value on, that costs us more than our immediate competitors who don't offer it, it just puts us in a worse position in terms of the return on capital. So do you offer something better that costs more? People welcome that but they won't pay a penny for it. They are not interested in paying any more even for something that will save them money in the future."*

Because the government has now removed the zero carbon targets that concrete's thermal mass would have potentially helped developers meet, the VHBs themselves have no vested interest in these factors beyond that expressed by their customers, and whilst there remains a housing supply shortage, their customers cannot afford to be too selective. In conclusion, therefore, this particular market, whilst being potentially very lucrative due to its size, is unlikely to be persuaded to change its ways. The reasons for this lie outside the concrete industry's sphere of influence, and for that reason represent a high risk to them and in all likelihood, an immovable barrier to change.

The alternative: The alternative approaches would be for the concrete industry to either grow its sphere of influence to incorporate these risks, or define an alternative market that lies within its sphere of influence and focus on that instead. The former would require the concrete industry to either become a developer of houses or provide land for developers with conditions attached as to how those houses should be constructed, both of which are worthy of consideration. The latter would require the concrete industry to define an alternative market where there is a closer fit between that market's needs and the sustainable message that the industry is promoting.

This alternative market, which they are far more likely to influence, is one where the developers have more than an indirect interest beyond the point of sale. It is also one where the benefits of concrete floors is backed up by a regulatory requirement to deliver a level of fire protection than cannot easily be provided by timber floors. Yet again, the market is that provided by the New Entrants, who are focused on high density apartment blocks requiring compartmentation, and being built for rental only with a business model based on fifty year returns for pension fund investments. This market might not be as large, but it is

well defined, under the direct control of one operation, and it is growing. And once established as a market, other more fragmented but equally appropriate markets such as student accommodation and retirement homes could be targeted in a similar manner.

The use of off-site manufactured panelised concrete construction for social housing to reduce build costs

The offer: The concrete industry is also very focused on the potential savings in construction costs to be realized from concrete panelised solutions, and has promoted this concept to the social housing market, where these savings would be most beneficial, and in their mind override any negative aesthetic associations that might exist.

The outcome: The development of concrete panels has led to many off-site solutions throughout Europe, but in the UK their use in residential properties has been limited since the post war housing boom that saw their use in the guise of over fifty system build solutions that flourished for a time before traditional material and labour supplies re-established themselves (Ross 2002, p. 5). For some these memories are still strong and the negative connotations with poor quality council housing still exist. But much of what is now associated with concrete as a material was in fact due to social and constructional experimentation, with concrete becoming the visual manifestation that remains as a perception, and often harder to counter than factual realities (Grindrod, 2011). For that reason, solutions that incorporate visual concrete elements need to be treated with caution, so as not to re-establish a link between the material and social deprivation amongst a younger demographic who may no longer have any direct link with that era.

The reasons given by those Housing Associations and Local Authorities interviewed however, for not wanting to consider concrete panelised solutions were far more prosaic. There were two main reasons, unknown to the concrete industry, as to why this solution was not currently seen as worthy of consideration: The first was that many of the sites now being developed for social housing are small brownfield sites that exist within existing communities. These sites are invariably difficult to access and also require housing types that can be modified to comply with planning requirements on a site by site basis (Gardiner 2016). No solution that provides standardized components that cannot be easily adapted, and that arrive on vehicles that cannot always gain access will be considered, as it will only provide a partial solution.

PA03.8 *"But the thing that really that made us cross it [concrete] off the list was the volume they required for it to be efficient in terms of what they were building, and everything comes on an articulated lorry, so I can't get it in to the majority of my sites. They're just not accessible for concrete. We have to get a fire engine on all our sites so they should be looking at that as a measure."*

Partial solutions mean duplication of designs, skills and organization which can easily offset any benefits gained.

The second reason for this being seen as inappropriate is the remit of Housing Associations to increasingly look to provide labour from within the communities they are providing for. Any solution that reduces their ability to do this, due to the components being delivered from elsewhere is seen as a negative.

PA03.8 *“I said to the timber frame guys with the offsite manufacture, because we pursue the Nottingham Pound and we go for local labour to reinvest our wages locally, that I wanted our joiners to put that up, and they said no.”*

These findings show how important it is to have communication channels that are operating on the same wavelengths. For the concrete industry, social housing appears to provide a good fit with the solutions they are offering, with resilience, durability, and low maintenance all high on their agendas, but within the hierarchy of importance, it only takes one critical factor to render all other benefits irrelevant. The essential requirement therefore is to ensure that the solution being offered works for all eventualities, not just a proportion, and that the key motivating factor on which all else hinges is understood.

The alternative: With this knowledge, therefore, what is the market that would be best placed to benefit from this solution, where the barriers to acceptance and the risk of failure would be least? To use the principle visualized in **Figure 7**, if public perceptions are so difficult to counter, they should be treated as unresolvable risks and avoided. There are possibly younger demographics however where concrete is seen as aspirational, or alternatively there are many ways in which concrete panels can be used without there being a visual battle to be fought.

PA04.02 *“there is a market for it (visual concrete) but there’s no point trying to shoehorn concrete into mass-market housing.”*

PA03.03 *“The concrete in the foundations is fine – there is no misconception with the average punter there and if we’re talking about concrete blocks all those sort of things again there is no negativity around concrete blocks, around masonry, no negativity whatsoever. The only negatively I hear of is when you talk about prefabrication in the industry generally, and naturally we try to avoid the term prefabrication because they put two and two together and think we’re talking about the pre-war houses.”*

Even within the volume house building market, where the end users are recognized as being at their most conservative, the use of concrete panels stamped to look like brickwork is being considered. Whilst this might not be seen as acceptable to many purists, it does nonetheless represent a ‘route in’ for an innovative change which, once made, would allow for panelised construction to take many other visual forms. The key to knowing which markets are the ones to target however is in understanding what motivates the market to consider the change in

the first place. In this instance it is not driven by speed of construction, or by aesthetics, or availability of materials, but by the impending shortage of skilled labour that has now been singled out as the main threat to the housing industry (Farmer, 2016, p. 32). The avenues once available to us as a country for correcting this situation are rapidly disappearing, with an aging workforce, a disinterest in on-site labouring as a career, partly due to the working conditions and partly due to the cyclical nature of the workload, and now Brexit, meaning that a move to off-site panelised construction is looking increasingly necessary, even if not as yet widely desired (Gardiner, 2016).

The aim therefore would be to define a market where panelised construction is most appropriate constructionally, most acceptable socially, without recreating the links with poor quality social housing, and most necessary financially. High quality urban communal living where privately owned accommodation is mixed with shared facilities and social spaces and aimed at a younger demographic with no negative preconceptions of concrete as a material would be a likely starting point. This represents a well-defined, base where a packaged solution could be marketed and a solution developed that becomes a vertically integrated business built on aligned principles and the potential for shared risk.

The use of concrete frame for high rise residential to reduce floor heights

The offer: Concrete frame has long been seen as providing the most affordable solution when building residential towers as opposed to commercial or office blocks where the wider spans needed mean that steel frame becomes a more viable option (Irwin, 2010). The calculations involved are complex and decisions can pivot on the incremental benefits that accrue from achieving thinner floor slabs, and the consequential savings that can be made in stairwells, cladding materials, and occasionally the number of floors achievable within the planning restrictions imposed.

The outcome: There are however, many other seemingly incidental considerations that can dictate the decision, sometimes at a surprisingly late stage of a building’s development, sometimes at the very outset, but resulting in alternatives being sought.

PA03.05.3 *“If we’d said we’re going to build all 88 in one go then I think that would make a lot of sense in concrete, because you’ve got the scale to justify the whole setup, but that would be very brave to build all 88 flats in that location in a market that is fragile.”*

Being aware of all these possible decision-making factors can help in formulating a strategy that will ensure that the preferred decision is taken, and once taken is adhered to.

The alternative: At a very basic level, the fluctuating price of steel is a variable over which even the UK has very little control, with global demand and oil prices dictating both price and availability (Matsumoto, 2015). With that factor very much outside the sphere of influence, it has to be recognized as a risk to be factored in and where

possible protected against. One way of ensuring that a sudden collapse in the global price of steel does not result in a concrete frame being replaced with a steel frame is to build the use of concrete into the design at either an aesthetic or an environmental level.

PA02.05 *“If you can get the buy-in from the architect early on and they know that they want that [the structure] to be concrete for various other reasons – performance for acoustics and for flooding and for thermal mass – and it’s embedded in their M&E strategy for keeping the building warm, then it’s much harder to take it out.”*

Any solution serving more than one purpose is more protected, especially if that purpose becomes central to meeting regulatory targets. But the size of the market where concrete could historically be said to have a clear advantage has recently been reduced by the arrival of CLT (Cross Laminated Timber) as an alternative structural solution. Currently the maximum height that can be achieved with CLT is eight stories, but already twelve has been achieved by using it in conjunction with steel (Wenlock Cross, Hackney, London). If the aim is to define a market as that where the proposed solution is the most viable of all the options available, the ‘sweet-spot’ for concrete in residential blocks is now over twelve stories. Interestingly, at the other end of the spectrum, low rise also becomes harder to justify financially as the need to construct concrete panels with enough strength to withstand handling and transportation means that there is more redundancy in the strength than is necessary for anything under four stories.

PA02.1 *“Often it’s just to do with transport strength and the strength of the unit to be able to crane it in and move it about. One of the drawbacks of ICF [insulated concrete formwork], is that it can only be a certain thickness, which means it can go 5, 6 stories, so why do it for a two-story home? It’s just over-engineered.”*

For a market to be stable and free from the variable benefits of other technologies, it is therefore necessary to continue ruling out those scenarios where there are other options that could compete until eventually arriving at an optimum market for that solution. In this case, geographical location would also be a factor to consider, with proximity to supplies, access to site, availability of skilled labour all being valid factors to consider. Returning to the original emphasis put on thermal mass as one of concrete’s main credentials, if this were to be employed in a high rise residential construction in conjunction with natural ventilation as a building methodology, air quality would also need to be considered. In some cities it is no longer safe to rely upon an unfiltered air intake, which shows how even what might seem to be an incidental consideration of air quality could become the one defining argument that dictates the decision to instead use steel frame, mechanical ventilation and a lightweight cladding system.

Conclusions

These are just three examples taken from a series of interviews relating to the sustainable use of concrete in housing as an example of the barriers faced by those promoting new innovative solutions, and how these barriers could be avoided by gaining a better understanding of the housing delivery system and the needs and motivations of those sectors within it. Whilst there were multiple examples such as these within the interviews undertaken, the main purpose of this study was not to focus on these specific cases, but to use them to test the approach being developed above as a process to be followed. By drawing attention to the unrealised breadth of the issues that can play a pivotal role in the decision of whether or not to adopt innovative sustainable solutions, the authors have shown how the case for innovation can in future be made more productively. They have also drawn attention to how complex these barriers can be and the importance of understanding and dealing with the root causes rather than the symptoms. Reaching those root causes requires the symptoms, such as the adversarial nature of the industry, a lack of interest in customer satisfaction, the removal of sustainability targets, etc. to be deconstructed until there are no further factors that can explain their existence. Only then will the full extent of the barriers to be addressed be known, and the feasibility of removing them assessed.

A main, if not root cause that has been exposed here is that of risk as a barrier to change, and also how deconstructing that risk by sharing it amongst a market defined by its mutual benefits and shared goals can make it more manageable. This requires better communication, and a better understanding of what it is that motivates each sector to react the way it does when confronted with change. The housing industry may not be complacent so much as ossified by its own complexity and the uncertainties it faces, which makes it increasingly difficult for any one business to jump for the fear of jumping alone. A degree of hand holding can only help.

Competing Interests

The authors have no competing interests to declare.

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