Good and bad innovations in the housing sector - General background and a policy proposal

WORKING PAPER

Lena Borg

Abstract

Purpose – The purpose is to propose a classification system for techniques to increase awareness of the uncertainties and risk connected to new techniques and materials, especially when the buyer is a non-professional client. The new classification system should increase information flow and decrease the problem occurring in principal-agent relationships in terms of moral hazard. The aim is also to shift the focus of the discussion from the quantity of innovations to how incentives can be created to further "good" innovations and to reduce the risk of "bad" innovations. The paper explores how housing firms in Sweden, municipal and private firms, are positioning themselves to implement new techniques and contracts in the construction sector.

Design/methodology/approach – The paper combines a literature review with an on-line questionnaire in combination with three face-to-face semi-structured interviews. The key data were collected from actors that build for their own management.

Findings – The paper reports two main findings. First, actors that build for their own management are risk-averse. Second, it seems that a classification system could be a good way to handle the uncertainties and risk connected to innovations in the housing construction sector. The study also underlines the need for an active public sector which takes responsibility for helping the sector to open up for more firms that will invest in the right kind of innovations.

Originality/value – The paper is one of the few that focus on discussing the potential of shifting the focus from the quantity of innovations to how incentives can be created to further "good" innovations and to reduce the risk of "bad" innovations. Also, it proposes a two-step classification system for new technical innovation to achieve increased transparency and reduced information asymmetry in the construction sector.

Keywords: Innovations, Housing construction, Procurement, Incentives

JEL codes: L74, O31, R33

1. Introduction

Innovation is widely agreed to be a necessary factor for firm performance (Rogers, 2004; Keupp et al, 2011). Earlier studies have shown that manufacturing firms that innovate in order to improve their production outperform their competitors measured in terms of market share and profitability growth, for example (van Egmond-de Wilde de Ligny and Mohammad, 2011). More innovation-friendly business environment in combination with lower barriers to trade would enhance competition and nourish the flow of innovation and knowledge (OECD, 2007).

The concept of innovation is distinguishing from the concept of invention in that as long as a new technique is not implemented in the production, it is 'only' an invention (Davidson, 2013). The invention becomes an innovation when it is used by a firm. An innovation can also be seen as an iterative process of events new to the institution, while an invention, on the other hand, is used to refer to a unique and single event, new to the world (Hardie et al., 2013; Davidson, 2013). In this article, the focus is on the step between invention and innovation: do incentives in the specific case lead to the use of the 'good' inventions and to the introduction of the 'good' innovations? The concept of innovation is discussed in more detail in section 3.

For decades, the construction sector has been criticised for a low level of innovations both in construction procedures and in development and diffusion of technical solutions (van Egmond-de Wilde de Ligny and Mohammad, 2011; Davidson, 2013). Quality failures and lack of performance control systems have also been debated. The traditional design-bid-build (DBB) contract has been criticised as being the most conservative contract type and unfavourable to innovation, but still the most dominating procurement contract type (Walker and Hampson, 2003).

There have been numerous measures to promote the maximisation of new forms of procurement contract to overcome the low level of innovations. Procurement of performance-based contracts based on functional demands (e.g. design-build (DB) contracts) and even the more holistic contract forms such as bundling design, build, operation and maintenance (e.g. Private Public Partnership (PPP), or design, build, operate and maintain (DBOM)) have been discussed as successful ways to increase the rate of innovation, mainly amongst the more complex projects, as the common view is that these type of contracts provides the contractor more degrees of freedom (Nyström et el., 2014). It is also argued that contracts which encourage team integration and long-term responsibility for the construction quality improve innovation outcome by taking a holistic view of the whole process and allowing knowledge to be utilised and shared between projects and within firms (Blayse and Manley, 2004; Walker and Hampson, 2003). Performance-based contracts and different ways of bundling are also said to increase quality when the contractor has the responsibility for a longer period (see e.g. Bennet and Iossa, 2006; Martimort and Pouyet, 2008). But this has also been questioned, for instance, by Leiringer et al. (2009) and Lind and Borg (2010). According to Blayse and Manly (2004), the performance of any contract type can be enhanced through the application of relationship management techniques, such as partnering and alliancing, to projects, including projects with the criticised DBB contracts (Winch, 1998; Eriksson and Osipova, 2011).

The debate in Sweden and the majority of articles (see e.g. Bröchner, 2012; Forsman et al. 2012, Rundquist et al. 2013; Pellicer et al., 2014) about innovation is presently focused on the number of innovations, and it is more or less taken for granted that more innovations are better than fewer. It is also assumed that the innovations are successful and lead to more efficient production and not only to reduced short-term costs. However, history shows several examples of less successful innovations in the construction sector with costly consequences, at a later stage either for the client, the contractor or society at large, e.g. application of External Thermal Insulation Composite Systems (ETICS) on wood frame structures. This new way of treating façades has been very popular in new construction in Sweden but has shown to be sensitive to moisture entering the structure within a few years after building has been completed. This indicates that new construction methods are not always well tested, and/or that something appears to be wrong with how risks are allocated, i.e. the incentive structure.

Though the discussion about uncertainties and risk allocation linked to innovation is not new, it has not been given enough attention in the debate. Questions such as “Who should take responsibility if something goes wrong with an innovation?” and “When and under what circumstances is, for example, the risk transferred from the contractor/producer to the client/user/buyer and in what cases is the risk borne by insurance firms or the state?” remains. In the late 1990s and early 2000s, the façade construction technique that was considered to be innovative (ETICS on wood frame structures), was applied in the Swedish housing construction market. Years later, a number of faults were discovered with financial consequences for many of the parties involved. The legal and contractual framework for both the introduction of new techniques and the allocation of risk in the event of failure is important. The basic aim of this paper is to shift the focus of the discussion from the quantity of innovations to how incentives can be created to further "good" innovations and to reduce the risk of "bad" innovations. This is done both through theoretical arguments but also by giving some examples from the Swedish housing sector. The paper examines how housing firms in Sweden, municipal and private firms, are positioning themselves to implement new techniques and contracts in the construction sector. The role of long-term ownership is also investigated. Furthermore, the aim is to propose a classification system for techniques to increase awareness of the uncertainties and risk connected to new techniques and materials, especially when the buyer is a non-professional client. The new classification system should increase information flow and decrease the problem occurring in principal-agent relationships in terms of moral hazard, e.g. when condominiums or single-family houses are sold.

The structure of the paper is as follows. In the next section, the background and analytical framework is presented. The method and the data collection are described in section 3 and the results are included in section 4. Analysis and policy proposal are presented in section 5, and finally, conclusions are presented in section 6.

2. Background and Analytical Framework

2.1 'Good' and 'bad' innovations

The Organisation for Economic Co-operation and Development (OECD) describes innovation as either technical or organisational, where the first includes products or processes whereas the latter has more focus on organisational structures (Blayse and Manley, 2004). Toole (1998) defines technological innovation as the utilisation of technology, new to an organisation that improves the design and construction by decreasing the costs, increasing performance and improving the business. Mottowa et al. (1998) underline the fact that product innovations are new ideas which turn into a new component of a constructed product and have economic, functional, or technological value.

Innovation can take many forms and the theory of innovation draws on many disciplines and because of the creative process that innovation demands, the outcome may be positive or negative, i.e. successful or non-successful (Dodgeson and Grann, 2010). This is denoted as 'good' or 'bad' in this paper.

There is always an uncertainty when a new technique is implemented, as it is impossible to foresee the future and the outcome of an innovation. Good innovations are those that are successfully implemented and generate profits and benefits to firms and society. On the other hand, the consequences of innovations can be problematic because they are initiated before their profitability or social cost is fully documented (Widén et al, 2014). Technological changes, which many of the innovations in the construction sector constitute, have uncertain consequences, and in view of these uncertainties it is not surprising that they sometimes fail (Rosenberg, 1996).

A bad innovation is defined here as one that could either fail as soon it is implemented or as one that initially seems successfully implemented but ends up incurring unforeseen costs and problems, such as negative effects on health and safety, or broader negative environmental consequences (Widén et al, 2014) or simply not working in the long run. In a broader perspective, one could say that a good innovation decreases the life-cycle cost (LCC) at a given quality level whilst a bad innovation does the opposite.

2.2 Factors that influence/lead to 'good' and 'bad' Innovations

2.2.1 Asymmetric information, moral hazard and innovation

Information asymmetry occurs in a situation in which one actor, within an organisation or in a market, has more information than the other parties involved. This often appears in transactions where a seller knows more about the performance and quality of the product than the buyer (Xiang et al, 2012; Sorell, 2003) and this asymmetric information could, for instance, lead to opportunistic behaviour in terms of moral hazard (Williamson, 1985). Moral hazard problems often arise in a principal-agent relationship, where the principal is negatively affected by the agent's post-contractual change of action and is not able to evaluate the performance or honesty from the agent's side (Milgrom & Rogers, 1992).

Xiang et al. (2012) argue that a principal-agent relationship with asymmetric information is a key factor behind the problems in the construction sector as it increases uncertainty and risk.

It is argued that firms with internal expertise are more in favour of innovations, while those with external expertise and thereby less internal information are more likely to impose more restrictions on their contractors' ability to implement innovative solutions (Lampel et al, 1996). On the other hand, Lampel et al. (1996) continue, it could be suggested that firms with internal knowledge and expertise are better at making use of past experience in their thinking and practices and, to a greater extent, they evaluate innovative solutions with a conservative eye. The other side of this coin, according to Lampel et al. (1996), is that those with a lack of internal experts are forced to give the contractors greater freedom and are less likely to interfere in design and implementation.

In an area with rather weak end-users (principals) in terms of information and knowledge (e.g. households buying a new condominium or a single-family house), it is difficult for the buyers to control the performance, quality and robustness of the facility. This information asymmetry between the principal and agent can be especially serious and can lead to situations where the agents sacrifice long-term quality and/or introduce innovative solutions even though there is limited information about the long-term effect this will have.

A fundamental component of moral hazard is, as mentioned, the problem of information asymmetry (Milgrom and Roberts, 1992). Accordingly, information can be used to reduce these uncertainties by increasing the flow of information. Milgrom and Roberts (1992) along with other researchers (see e.g. Johnson and Houston, 2000 and Wathne and Heide, 2000, 2004) suggest, for example, that by increasing the resources devoted to monitoring and verification, inappropriate behaviour can be prevented by stopping it before it occurs. Furthermore, Milgrom and Roberts (1992) argue that monitoring may also be used to support a system of rewards for good behaviour.

2.2.2 The role of owner type

The residential construction sector has a long history of different types of firms. It is a sector where some actors – private and public – build rental housing that they plan to own for a long time. But there is also a large sector with developers of condominiums and single-family houses, who sell the completed dwellings to individual households, where the long-term responsibility for the developer is rather small. In the same way as a contractor without responsibility for maintenance might choose a cheaper and, in the long-term, riskier technique, a developer of condominiums is in the same situation and might be tempted to make the same kind of short-term choices. This can lead to problems where agents sacrifice long-term quality in order to increase their short-term profit (Anund Vogel, 2013).

The risk of severe shortcomings, for example construction failures or bad quality, seems to be greatest in the sector that builds new condominiums or single-family houses (Anund Vogel, 2013). A survey by the Swedish Building Centre in 2010 reveals that actors within this sector take poor account of life-cycle cost. It is argued that the process is characterised by a choice of cheaper and riskier solutions in order to lower the production costs, even though the LCCs might be higher. The incentive for the

developer is rather weak when the facility is transferred to the buyers with potentially less knowledge or lacking in information. Riskier solutions may, for example, be equivalent to using new innovations and new techniques, which lower the cost in the construction phase but might later lead to higher costs.

In a judgment by the Swedish Court of Appeal in 2013, concerning the above mentioned innovation for façades, it was established that the developer/contractor was not the party who should take financial responsibility for development faults. The Court of Appeal argued that no developer/contractors should take general responsibility for development faults, which the façades were considered to be. The court based its decision on evidence that the façades were professionally and properly constructed, and no consideration was given to the lack of construction knowledge on the part of the client. The developer/contractor has no responsibility to guarantee any new innovations. Even though it proved to be a bad construction, the contractor was not to blame. As a result, developers have weak incentives to increase the information flow about the construction, as the buyer of the condominium takes the major part of the risk. Innovations will be introduced in cases such as the above, but how can we control for their robustness and adequacy and ensure that these innovations are good ones and not bad when the risk is in the hands of the uninformed and unknowledgeable buyer?

2.2.3 The role of contract and procurement types

Long-term orientation enhances the performance outcome in a buyer-seller relationship (Ganesan, 1994; Noordewier et al, 1990). Andersson and Weitz (1989) refer to such long-term orientation in relation to commitment, indicating that a mutual commitment results in independent members working together to better serve the customer´s needs and increase mutual profitability. It is often said that long-term contracts create strong incentives to design and implement new and better technology and enhance the quality of the sector. A central purpose of these contracts is to give the contractor more opportunities and higher degrees of freedom and hence stronger incentives to find new techniques that might also lower operation and maintenance costs (Håkansson et al, 2006; Smyth, 2010; Woodward, 1997).

The tendency in the literature is to point out the advantages of bundling design and construction in order to create more incentives to be innovative, i.e. DB contracts (Nyström et al., 2014; Lloyd-Walker et al., 2014). One further step to increase the innovations is to include the maintenance phase. However, the innovative environment is not necessarily easy to achieve (Lind & Borg 2010, Leiringer et al, 2009). For example, even if a private firm works both with construction and maintenance, this is typically carried out by different divisions in the firm and sharing knowledge between these units is not unproblematic. Also, if PPP projects are sold after a few years to investment funds, for example, the incentive effects become even more unclear. The original owner must know that it can be difficult for the buyer to know the long-term characteristics of the facility. There might also be incentive problems within such a fund. Another argument is that DB contracts, for instance, do not necessarily take holistic responsibility with sustainable solutions as the contractor might be tempted to choose a

design that is cheaper. Also, putting all the responsibility on the contractor can reduce the willingness to innovate as the risk may be seen as too high.

A difficulty in construction projects is how to monitor the performance of the contractor. In DBB contracts, the performance of the contractor is rather well defined and almost every detail is specified in measurable terms, and thereby the performance can be measured. When it is time for the final inspection of the completed construction, this can be measured and checked according to predetermined documents. However, even though precautions have been taken by the client and the contractor obtains an approval in the final inspection, doubt about the quality is present and thus even rather detailed work instructions have their drawbacks. As DBB contracts typically come with a limited guarantee, it is especially important that the client can monitor the contractor and observe that the work is properly done. An experienced client with high technical competence should, however, be able to monitor the right things. In the DBB model, the client has complete responsibility for the introduction of innovations and also has to take full responsibility for these. From the perspective of good versus bad innovations, DB contracts seem more problematic as the contractor has influence over the technical solutions while the client has to pay the future costs if something goes wrong after the guarantee has expired.

The possibility of monitoring and the use of long-term guarantees can be replaced by some other incentive mechanisms (see e.g. Eriksson & Lind 2015). Even if it is difficult in the short run for the client to monitor all aspects of the quality of the work, the client might not be afraid of poor work standards as the client can, for example, punish the contractor by not commissioning any work in the future if it is later found that the contractor had done a bad job.

3. Method

Several approaches were used to obtain information about incentives and the choice of construction techniques in housing. This paper tries to combine a literature review with an on-line questionnaire and interviews.

In the first step, an on-line survey was carried out. The goal of the survey was to obtain an indication from the actors that build for their own management of how they look at new techniques and innovation strategies. Information about the actors' role and the role of ownership types in the context of innovation was obtained by an on-line explorative questionnaire addressed to 51 housing firms that build rental housing, 32 municipal housing firms and 19 private housing firms. The survey was conducted both to investigate how the firms, which build for their in-house management, are looking at implementations of new techniques but also to see how they use and look at procurement contracts to influence the goal of increased innovation. The rental housing firms were also asked if they believed that there was any difference between their view of innovation and the view among firms that build condominiums. It was not judged to be meaningful to ask these firms directly about their strategies, and even if there might be some bias in asking the rental housing firms about their "competitors", it could also be argued that there is solidarity in the sector that could lead to a bias in the other direction.

In an early stage of the study, an attempt was made to find data that would link certain risky construction techniques with owner type, but this proved to be more difficult than expected, so a more indirect approach had to be taken.

Each question was multiple-choice in structure and respondents had the possibility to add comments to their answer for clarification and/or explanation. The survey questionnaire was sent to people with senior management positions but they had the opportunity to forward the survey questionnaire to a third person if necessary to answer the questions. The survey was conducted and the answers were collected during October 2010. Twenty-five people, a response rate of 49%, each representing a firm, completed the on-line questionnaire and one person started but did not answer any of the questions. Out of the 25 respondents, six came from private housing firms and 19 were answers from the municipal housing firms. For the main questions in this paper, 22 respondents answered, a missing value of 3.

Second, for a deeper understanding, three face-to-face semi-structured interviews were performed, based on the questions asked in the on-line questionnaire. The interviews were conducted in January and February 2011, with three clients that have procured long-term contracts or other holistic driven contracts (bundled contracts), e.g. private public partnership and design build (DB) contracts with maintenance responsibility. Each interview lasted for approximately 60 minutes.

To analyse the possible ways of allocating risk connected to innovation, we combine results from the survey questionnaire that are connected to the role of clients and procurement with the interviews.

4. Results

4.1 Firm type and choice of technique

Implementing new techniques

A common attitude among the respondents is general caution about the implementation of new techniques and materials in projects. The established technical solutions are tested, reliable and thereby the risk for large problems are minimised. The private actors seem even more cautious than the municipal actors and emphasise the importance of tests done by the manufacturing industry (Table 1), but they also look at, and rely on, solutions and materials tested and used for a longer period by other actors. The results from the municipal firms indicate that they have a higher degree of variety in their approaches than the private respondents. Out of the municipal housing firms, seven respondents answer that their goal and ambition is to be in the frontline even if it means taking more risks, whilst others are more risk-averse, relying on tests done by others or by the manufacturing industry (Table 1). However, it emerged that a small group, three of the respondents, only municipal actors, do in-house tests on a small scale before they apply the technique on a larger scale in their own projects (Table 1).

Table 1. General view of implementing new techniques and new materials (more than one answer was possible)[2].

	All firms	Private firms	Municipality firms
	Response (Number)	Response (Number)	Response (Number)
We are careful and wait until others have tested it so we know that it works.	11	4	7
We want to contribute to the technical development and don't mind being the first on the market with new techniques and materials.	7	0	7
We do small-scale in-house tests before we introduce new techniques and materials.	3	0	3
We mainly look at tests done by the suppliers of goods and materials before we make any decisions.	8	2	6

[2]Out of the 25 respondents, 22 have chosen to answer these questions, a missing value of 3.

The municipal firms (11 out of the 17 respondents on this question) further agree with the statement that the motive for working with new technologies is partly lower cost and claim that it is often important to save money or time, which in turn is money. On the other hand, five of the 17 municipal respondents disagreed with the statement. In short, it is not necessarily a cost-driven decision, but rather a more general interest in implementing new and potentially better techniques. The private firms, on the other hand, had no clear opinion even though one respondent in this group partly agreed with the statement. Figure 1 shows how the centre of the mass is allocated in this question.

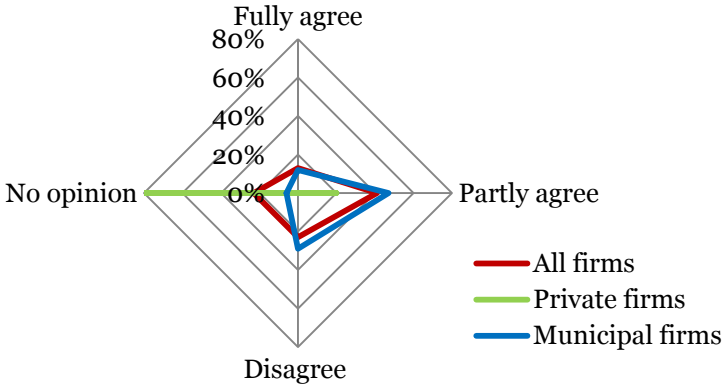

Figure 1: New technologies are mostly motivated by lower costs.

Regrets concerning technical choices

In the majority of comments made by the respondents, the main reasons for the regrets were related to a well discussed issue both in Sweden and worldwide: façade systems with thin plaster in combination with organic material (see for instance Jansson and Samuelson (2009) for more information about the specific façade technique). Municipal firms constituted the majority of those with experience of this façade and private firms largely seem to have avoided the technique. Those that have had no experience of this specific system point to its weakness, and they felt that the shortcomings and problems that appear at a later stage could be so serious that they chose a safer and historically more tested solution. A risk-averse approach has been their safeguard, they state.

Views on risk-taking behaviour among other developers

Seventy-seven percent of all respondents fully or partly think that developers that build to sell make riskier decisions about the construction than developers that build rental housing for in-house maintenance. However, the opinions of the municipal firms differ to some extent: three of the respondents in that category do not think that this is the case, six respondents stated that it is the case whilst seven stated that they partly think that developers of condominiums take more risks, and the rest had no opinion. This can be compared with the more homogeneous answers by the private actors, where four out of five gave a positive answer to the statement. Comments by the respondents are that the focus for the developers who produce to sell is on using materials and products that are visible and appreciated by the ordinary buyers (i.e. household) of the apartment or house. Even though differences can be seen in the answers, the weight lies more on the positive side (Figure 2).

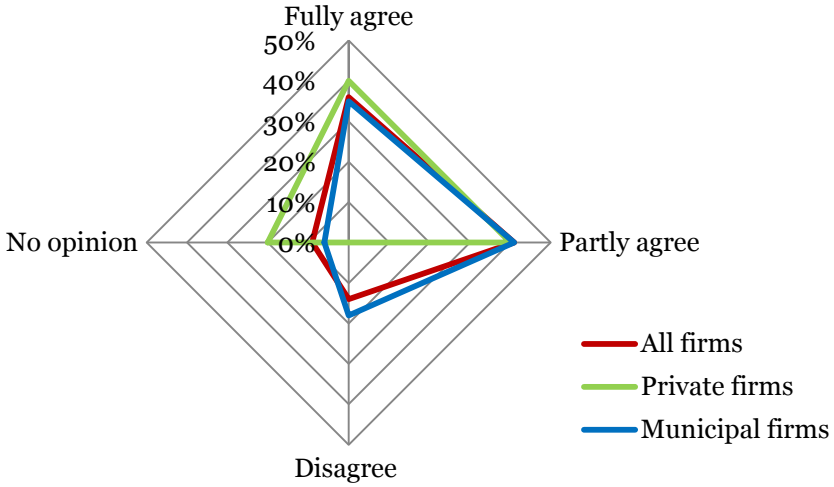

Figure 2: Developers of condominiums are risk takers when it comes to technical solutions than developers of residential houses with in-house maintenance.

4.2 Innovations and type of procurement contract

The comments in the survey and also from the interviews show that there is willingness, but still a lame willingness, to change the Swedish construction sector in order to increase innovation. In

general, the respondents think that performance-based contracts with functional demands are good, but it is still less risky to continue to fall back on the traditional norms and regulations.

Contracts with functional demands

The municipal firms stated that it is partly true that functional demands in contracts are a good way of increasing innovation in the sector. The private respondents are more hesitant in their responses and do not fully agree that this is the right way to go. All in all, approximately 70 % of the respondents, to some extent, agree that contracts with more degrees of freedom could be a good solution to increase innovation. However, the respondents noted that it is important that the client submits clear demands and descriptions and that the product development should be in close contact and dialogue with contractors, consultants and clients. The comments in the survey indicated that the private housing firms are more sceptical towards contracts with a more holistic approach than the municipal firms, and are more willing to highlight the knowledge that the client possesses. In general, they say that performance-based contracts create an incentive for the contractor to use their own techniques and materials. However, they stress that smoother cooperation between the client and the contractor is achieved if they work with well-known solutions and materials rather than implementing new alternatives. Even though there is a small difference between municipal and private housing firms, it can be observed that they are fairly unanimous about functionally driven contracts in different shapes.

Traditional design-bid-build contract

All of the respondents from private firms agree with the statement that DBB contracts actually provide better control of the project and reduce the risk of failure and carelessness. If the client has good knowledge and experience of construction, DBB contracts lead to better quality according to the respondents. However, seven of the 19 municipal firms consider it to be a false statement. On the other hand, almost as many of the municipal firm group partly agreed and stated that the carelessness might be as common as with other contract types but that the client has better control of the project when procuring a DBB contract, especially if some type of cooperation is created, e.g. partnering. The argument was also that if the client has long experience of construction and has knowledge of the characteristics and effects of various technical solutions, then they can decide exactly what they want and hire a contractor to carry out the work. As a whole, the municipal as well as the private housing firms see the client as the most knowledgeable actor in the relationship between them and the contractor. More than half of the respondents agree to a large extent that this is the case and add that the client could be the actor with best knowledge about the construction they order.

Even though innovations are important and something to strive for, the basic instinct is to be wary of trying new solutions without rigorous testing since it is irresponsible and could lead to failures and serious consequences. Such repercussions must be taken seriously and for the respondents, clients' risk-averseness is the leading concept, which seems to be the view especially among the private housing firms.

5. Analysis and policy proposal

5.1 Analysis

The survey and the interviews presented in section 4 indicate that the municipal housing firms are more willing to be in the frontline and use new techniques. In some cases, they also conduct in-house tests. Private firms, on the other hand, are more risk-averse than the municipal firms and are also to some extent more restrictive in implementing new untested materials and components. Even though small distinctions between municipal and private housing firms can be observed, they are fairly unanimous on the issue of the developer's risk-taking but also on how they act on innovations and new technical implementations.

There are also indications of two major issues. First, developers that build for uninformed clients are believed to take more risk by choosing innovations that are not so well tested. This may well lead to the specified goal of increasing innovation in the sector, but not the right kind of innovation. Second, the respondents point to another vital problem: the risk that there will be few "good" innovations. Here, the problem is that the risk-averse firms that build rental housing for in-house maintenance will only use established techniques. The root cause of the risk-averse behaviour is that too much is at stake. Relatively small private housing firms with a good reputation cannot afford either in terms of costs or reputation to have projects with new techniques that go wrong. They are very careful and do not want to implement new techniques before they have seen that they are robust. In this environment, there will be no innovations, even if there are those that would prove to be "good" innovations that reduce life-cycle costs.

Innovations are necessary for firm performance. We want innovations and they should be good. Let us assume, as for example in Widén et al (2014), that bad innovation can be seen in two ways: either a bad innovation is something that goes wrong in the implementation phase, or it is an innovation that becomes bad later during the usage phase. The first could be seen as a failure that is covered by legislation and will be handled by the developer and their insurances. The second one is more difficult in the sense that the developer has done nothing wrong: they have built according to norms and standards but the construction proves to be a bad solution, which is a well-known risk of innovations. This problematic situation was handled in the judgement by the Swedish Court of Appeal, mentioned earlier. One option is then to say that the end-consumer (the household buying the apartment or house) should be able to rely on the developer, and rely on the fact that they construct with good quality. From this point of view, one could say that this is a technical risk that the developer as a professional actor should take. On the other hand, as mentioned earlier, could we really put that much responsibility on the developer and does that create an environment that encourages innovation? If there has been no negligence on the part of the developer, should it not then be the client that takes the risk and by means of insurances guard against possible future inconvenience? Such insurances are, however, problematic and can also lead to too few innovations if the insurance firms only accept established solutions. On the other hand, with more liberal insurance firms, it could lead to careless and risk-taking developers because the developer no longer needs to take this responsibility.

To create an environment that encourages innovation, clarifications are of importance both for allocations of risk, risk diversification and some sort of guarantee that a certain innovation is good. Otherwise, either the wrong innovation could be implemented with costly consequences, or the opposite, no one will take the risk of implementing new solutions that are not thoroughly tested.

5.2 Proposed system for innovation

If the fundamental problem behind the risk of "bad" innovations is asymmetric information, methods to reduce this asymmetry would be especially interesting and this is the idea behind the proposal below.

Within many industrial areas, rigorous tests are made and product declarations are a natural part of product delivery of, for example, aircraft equipment or pharmaceutical products. The two proposed steps presented below are intended for the construction sector that sells to uninformed customers.

The first part is a demand for a product declaration which clearly describes how well-tried and tested the used products really are. The second part is that if an innovation is tested to some extent and if the government believes that this in a potentially important innovation, the public in terms of the government can carry the risk, or at least the risk is shared between the actors involved.

According to Xiang et al. (2012), a vital problem in the sector is imperfect information, since information is an important tool to eliminate uncertainties. The first part is an attempt to decrease the information asymmetry by signalling the reliability of the innovation to all the actors involved. But it is also an opportunity for all the actors to decide how much risk they are willing to take. One way of handling this is through an independent expert board of researchers and experts from the industry who, at the first level, issue an independent statement on the innovation, a statement which means that, based on their expertise, they can classify and approve the innovation. In addition to this, tests of the long-term conditions can to be conducted in order to achieve full-scale transparency.

Figure 3 shows an example of a possible classification system for innovations where the green encompasses covers all innovations that are tried, approved and tested over a longer period, thus signalling a product or solution with a low risk of failure. At the other end of the scale, the red encompasses ‘not tested innovations’ and the uncertainties and risk that follow. In between are innovations that are approved by a board of experts but that have not been on the market long or in a long-term testing environment.

However, it is not only the industry that benefits from innovations: the government is also an important factor in facilitating innovations for society at large and should take their share of the responsibility. Otherwise, it may seem hard if the developer has to take full responsibility for innovations, both for development costs and the financial responsibility if something goes wrong as that can be a hampering factor for innovations. Of course, as always when it concerns taxpayers´ money, they should be handled carefully. If we start from Figure 3, and the ambition to stimulate "good" inventions, then the government can take part of the risk in a transparent way, both when a

technique is classified as "green" and when it is classified as "yellow". It could also be the case that the innovation is classified as green, but nevertheless proves to be bad due to a development fault. Then the government can step in and share the responsibility with all the actors in the project according to a stylised approved model. One example of this comes from Sweden where the government provides subsidies for homeowners to reduce the level of indoor radon.

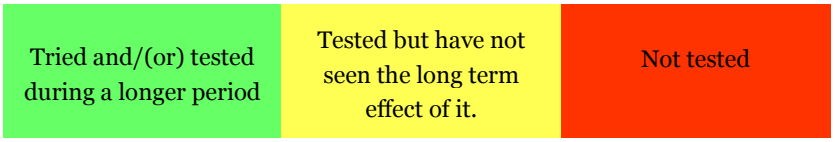

Figure 3: Classification scale of new technical innovations, first step.

Techniques classified as yellow in Figure 3 may also be of government interest. If the expert board classifies the innovation as yellow, the government can evaluate the technical and economic effects and see the relevance of these two perspectives. Then the government provides a warranty even in these cases and thereby shares the risk even though the long-term effect of the innovation has not yet been seen. The system can therefore be developed to include one more category as in Figure 4. The yellow category in Figure 4 encompasses innovations that are partly tested and approved by experts and where the government finds that the innovation is important for society, and is therefore willing to take some of the risk. The orange category contains innovations whose value the government considers is too low for them to take a risk, but it is still partly tested and approved by an expert group (Figure 4). Innovations classified as red remain as techniques that are riskier and no guarantee or help from government will be provided.

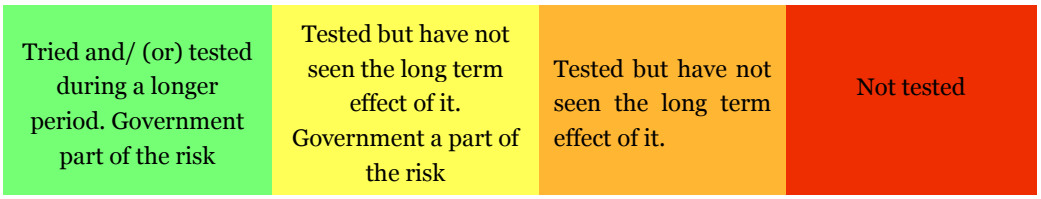

Figure 4: Classification scale for new technical innovations, second step.

This scale and classification system should open up for more transparency with regard to innovation so that the client and the developer are aware of the related uncertainties and risk, and the asymmetric information is consequently reduced.

6. Conclusions

The contribution of this paper to the existing body of knowledge is its focus on how to separate ‘good’ innovations from ‘bad’ and the proposed classification scale for new technical innovations and techniques used when constructing a house. This offers advantages both for increasing transparency and allocating risk associated with innovation and technical developments.

Housing firms with in-house operation and maintenance can be said to be risk-averse and even though contracts have been proposed which, at least according to theory, will create incentives to innovate, the incentive seems rather weak as a compensation for the clients' risk aversion. If the common perception amongst housing firms with long-term ownerships compared to developers of condominiums is that the risk and the eventual costs are high, then no innovation will take place.

The new scale and classification system should open up for more transparency with respect to innovation so that the client and the developer are aware of the related uncertainties and risk, thus reducing the information asymmetry and thereby mitigating some of the problems of moral hazard. Also, with this model, controls may contribute to distinguishing good innovations from bad, or if faults still arise, not only will the innovation be stopped for further use, the financial risk of rectifying the damaged construction will also be placed on the government.

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