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RESEARCH ARTICLE

Building inspection in multi-dwelling housing and the perception of building quality

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Abstract

Principal-agency problems due to hidden incentives might be amplified, for example, under circumstances when unjustified trust in an inspector is associated with higher perception of building quality. This paper sets out to determine whether a significant difference exists in the owner's perception of the building quality based on the perception of the inspector and the inspection process within multi-dwelling housing. A principal-agent theoretical perspective and the question of trust is applied on data from a survey sent to 1563 housing cooperatives in Sweden and analysed using a one-sided ANOVA as well as Kruskal-Wallis and post-hoc Dunn's test. The major finding is that differences in perception associated with the company size of the developer, the timing of the inspection as well as the complexity of the process for the owners affects reported defect. The main implication is that efforts to address shortcomings related to the gap between the developer and the owner, in the context of building quality and perceived severity of defects, need to be customised to different owner groups. A better understanding of the inspection process by the owner improves active participation, which leads to efficient quality improvement. Society benefits from improved comprehension and utilisation of the results.

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Keywords

Quality, building inspection, trust, residential buildings, principal-agent

Introduction

The number of new multi-dwelling housing constructions labelled as energy efficient or low-energy by the developer is steadily rising in Sweden but studies show that in a number of cases the predicted energy performance of residential buildings before occupancy differs widely from the recorded energy performance (McElroy and Rosenow, 2019; De Wilde, 2014; Bagge and Johansson, 2013). The discrepancy may occur due to deviations from the stated design, expected occupant behaviour or building quality (Bordass, et al., 2001; Alencastro, Fuertes, and de Wilde, 2018; Dasgupta, Prodromou, and Mumovic, 2012). Building control and building inspections serve as a means of ensuring that basic standard requirements as dictated by statutes and building energy performance resolutions (see e.g. European Parliament, 2003; Murtagh, Achkar, and Roberts, 2018) and/or owner requirements are fulfilled.

Pre- and post-occupancy building inspection is characteristic of a principal-agent relationship which occurs when a person or entity delegates some decision-making authority to the agent, in this case the inspector (Jensen and Meckling, 1976). Any further decisions by the delegator (the principal) will depend on information supplied by the agent directly or indirectly. Markets with heterogeneous products such as in the building construction and housing brokerage sectors present situations in which, at a given time, the agent might have specific information which is relevant to the decision to be taken but which is unknown to the principal. An example of this information asymmetry is knowledge about the status of the building in the form of defects whereby the principal has to rely on the willingness of the agent to share the information. Thus, the principal's satisfaction with building quality relies on the inspector (the agent) to be trustworthy. As noted in Goeschl and Jarke (2017, p.320), "being trustworthy is not taking advantage of others when trusted while to trust is to rely on others not to take advantage of you". Trust reflects confidence in an exchange partner's reliability and integrity, which is associated with qualities such as being consistent, competent, honest, fair, responsible, helpful and benevolent (Morgan and Hunt, 1994).

Previous research has discussed inspection from a technical or legal perspective and has predominantly been based on inspection audits as the source of data on the occurrence and type of defects (Johnsson and Meiling, 2009; Forcada, et al., 2016). Studies on building defects have mainly focused on the occurrence of defects (Forcada, et al., 2016; Sommerville, 2007; Atkinson, 1999), the relationship between defects and customer satisfaction (Auchterlounie, 2009; Milion, Alves and Paliari, 2017; Fauzi and Abidin, 2012), diagnosis of defects (Kangwa and Olubodun, 2006; Sui Pheng and Wee, 2001), or the cost and remediation of defects (Hopkin, et al., 2017). Though the human factor and effect on building quality has been recognised by Sunding and Ekholm (2014) and Forsythe (2015), the correlation between the inspection process, the inspector and the owner has not fully been examined from the perspective of the owner's knowledge base and pathways to trust especially within multi-dwelling housing.

Owner-occupiers in the single-family home market are often the commissioners and close monitors of their housing construction. The building inspector is an agent of the owner-occupier. On the other hand, construction within the multi-family housing sector is often commissioned by a developer who also contracts the building inspector (the agent). However,

the guarantee inspection is carried out in the presence of the dweller (condominium owner or tenant) whose perceptions and eventual satisfaction with the inspector and the inspection process provide valuable information about the perceived quality of the building. This aspect is of interest in markets such as Sweden in which approximately one quarter of the total housing falls under the multi-dwelling tenant-owner tenure, "*bostadsrätt*". It is a form of limited equity cooperative whose legal structure in Sweden has been described as paradoxical (Ruonavaara, 2005) as well as unique and confusing (Scanlon and Whitehead, 2004). Decision-making for the housing cooperative is in the hands of a committee that might not have experience in property management (Bergsten and Holmqvist, 2013).

The purpose of this paper which is based on the application of a principal-agent theoretical perspective and the question of trust is to contribute to the discussion on the gap between the developer and the owner in the context of building quality and perceived severity of defects within the multi-dwelling housing cooperative sector. The paper presents a study on the correlation between the quality index presented in the paper and the actions as well as perceptions of the actors involved in the inspection process.

The inspection process and perceived quality of the building are examined through the following sub-research questions:

RQ1. How does owners' perception of the inspector as trustworthy affect the perceived quality of the building under various characteristics within multi-housing sector in Sweden?

RQ2. How does owners' understanding of/trust in the inspection process affect the perceived quality of the building under various characteristics within multi-housing sector in Sweden?

The structure of the remainder of the paper is as follows: the next section contains a brief literature review on the concept of quality in relation to defects and customer satisfaction. This is followed by a section on the principal-agent perspective and the principal-agent relationships during housing building inspection in Sweden. The section thereafter holds a description of how data was collected and analysed followed by the presentation and discussion of the results before the paper ends with some concluding remarks. The study is on multi-dwelling housing within the cooperative housing sector in Sweden and for the purpose of this study, building quality is delineated by the defects reported by the owners who are represented by the cooperative's governing board members.

Building quality, trust and customer satisfaction

The literature offers different approaches to defining quality, from subjective judgement (Holt and Rowe, 2000; Mohr-Jackson, 1998) to specific and more objective measurements such as a customer's satisfaction with a product's performance (Barrett, 2000), or compliance with the set of requirements and goals specified by the client, agreed with and achieved by the contractor (Chan and Tam, 2000; Crosby, 1984; Lützkendorf and Speer, 2005). Milion, Alves and Paliari (2017) investigated the relationship between reported defects and customer satisfaction, and concluded that the occurrence of defects only partially affects customers' satisfaction and that to a large extent customer dissatisfaction can be linked to developers' post-occupancy service and repair process after a claim was reported.

Hopkin, et al. (2017) found a significant difference in how the house owner, the house builder and the building inspector perceive the levels of importance of defects encountered in the buildings. Homeowners prioritised as important the effect that defects had on functionality and the great inconvenience caused in the owners' daily life. The major concern for the builders and the inspectors was for the costs related to a complaint. All the actors took into consideration the disruptive consequences of defects but the approach towards ranking those defects was different, which has an impact on the house buyer's satisfaction and perception of quality.

Sommerville (2007) argued that the residential sector of the construction industry has two types of customers. The first category consists of the professional customers, the procurers involved in commercial projects, who are knowledgeable and able to set requirements to be complied with. The second group are the private customers, the end-users, private new house buyers who possess a multitude of perceptions and differing expectations of the finished product. These buyers are rarely involved in setting the specifications used during quality control as these are often given by the developer. Consequently, validation of building quality by the end-user, defined in Crosby (1984) as the accepted level of compliance to a customer's requirements, is rarely applicable in this case. The end-users are often inexperienced or lacking technical knowledge and missing the vocabulary and phrases as well as expressions needed to communicate with industry professionals. The absence of a standard lexicon widens the gap between the customer and the developer and can further affect customer satisfaction (Sommerville, 2007). Forcada, et al. (2016) found that even in cases where the same terminology was used when describing the nature of defects during the construction, handover and post-handover stages, the types of defects differ. Disputes can even arise between industry professionals, who do not always place the defects in the same classification (Georgiou, 2010). A comparable problem occurs even at the design stage when architects and the clients use similar words to describe greatly differing aspirations as noted in Cole-Colander (2003).

Studies such as Georgiou, Love and Smith (1999) showed that during post-handover inspection housing owners are more likely to identify defects related to functional quality, aesthetics, cleanness and final presentation. The observable defects are usually related to the omission errors caused by subcontractors' tight schedule, mishaps in processes or low quality of workmanship, as most design defects are detected and solved in the construction stage or handover. If the design defects remain, they are not visible until the operation phase. Auchterlounie (2009) noted that private house owners might be aware of technical defects which they do not prioritise in their reporting because they believe and trust that professionals have supervised as well as inspected the technical aspects. The study finds the perception of building quality to be an outcome of the interaction and communication between the developer/builder, the owner/end-user and the inspector.

This study complements earlier ones such as Forcada, Macarulla and Love (2012) that analysed whether a significant difference existed in the quality of the two main residential building types, flats and detached houses, as well as Rotimi, Tookey and Rotimi (2015) that evaluated defect reporting. The study explores whether a significant difference exists in the owners' perception of the building quality, when considering their perception of the inspector and the inspection process in a housing sector. A majority of the tenant-owner cooperatives (TOCs) are initiated by a developer, often a building firm that later populates the development through advertising and sales campaigns. Representatives of the developer sit on the initial governing board in such TOCs. A Swedish government inquiry (Boverket, 2018) notes that

the number of developers in the market has exploded since 2000 from a handful to several hundred with a correspondingly high level of reported construction faults and defects, raising concerns about principal-agent problems such as hidden incentives and the consequences for the less knowledgeable owner-buyers. This background forms the basis for choosing to apply a principal-agent perspective to the study presented in this paper.

Principal – agent perspective

It is rational, according to agency theory, to assume that the interests of the agent will differ from those of the principal and that the agent will choose the actions that maximise his or her utility (Jensen and Meckling, 1976). The heterogeneous nature of real estate produces situations in which the person or entity offering a service or product (the agent), for example a developer or broker, knows more about the property than the person requiring the same (the principal), for example, a home buyer. From a principal-agent perspective, the developer of multi-family cooperative housing is interested in selling all of the flats produced and with as little post-occupancy rework as possible. Thus, it could be assumed that some developers might utilise the exisiting information assymetry in engaging inspectors that are inclined to the developer and not neutral in their interaction with the owner during the inspection or in other ways exploit the lack of understanding of the process. Principal-agent relations come with costs related to monitoring the performance of the agent to ensure that it is in line with the principal's interests. But, as noted in Davis, Schoorman and Donaldson (1997), if the principal has trust in the agent then there will be less need for monitoring and subsequently the agency costs will be mitigated.

According to Rodgers (2010), trust in a building inspector or any other agent will take one of three pathways: rational-based, rule-based, or category-based, where trust as a rational decision will occur in a situation when there is complete understanding of the other party's incentives and goals, even when there is no information to use for a qualified judgement. This is more likely to take place between a knowledgeable principal and an expert agent such as is the case with professional procurers/developers and the inspectors. In immature markets, where the information available is unreliable or irrelevant, participants will disregard it and base their judgement on strictly forcible normative rules or the legal system to predict possible outcomes of relationships. The decision to trust, distrust or not trust follows thereafter and an already trustworthy relationship will become stronger in a setting with enforceable standards. Category-based trust arises in a situation when preformatted information is a basis that influences the decision to trust. This is common, for example, when dealing with agents who are members of a trade cooperation network rooted in the use of shared information, such as chartered certification agencies like RICS which is well recognised and thus provides the pedestal for the trust (Rodgers, 2010).

PRINCIPAL-AGENCY RELATIONS DURING BUILDING INSPECTION WITHIN THE TOC HOUSING SECTOR

The major building inspections during construction are the statutory control (Figure 1A), the final pre-handover inspection (Figure 1B) and a post-handover guarantee inspection (Figure 1C) that takes place before the expiry of the shortest guarantee period.

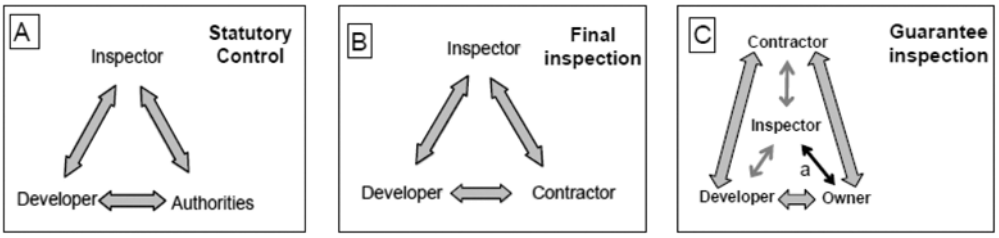

Figure 1 Relationships during building inspection (source: Authors)

This study focuses on the guarantee inspection which is defined as "building inspection with the aim of investigating to what extent errors in a contract occurred during the warranty period applicable to the contract" (Boverket, 2007, s.43). The guarantee period is usually shorter for materials and appliances than for workmanship and the contractor is liable even longer for some defects. Building inspection as defined in Rotimi, Tookey and Rotimi (2015) refers to pre-handover defect reporting depicted in Figure 1B.

In this study "inspection process" refers to the performance of the two-year (or five year) post-handover guarantee inspection in an activity that resembles the quadripartite connections depicted in figure 1C. In Sweden this process is quite formalised and has checklists but is based on industrial agreements not laws, with the inspector contracted by the developer. The process aims at noting defects that have arisen during the post-handover period and which the contractor is liable to rectify. Crucial at this stage is to determine whether the complaint is justified on non-contractual grounds or has a completely different cause. Furthermore, parts that have been approved during the final inspection (figure 1B) cannot be noted by the inspectors as errors during the warranty inspection. The contractor does not need to remedy any errors that an inspector has missed during the final inspection. The inspector is expected to act professionally and in a manner that takes into consideration the owners' views. In some cases, the contractor is a subsidiary to the developer who engages the inspector. Furthermore, in newly constructed estates the developer will have representatives on the board of the TOC (the owner) for up to two or three years. Though the TOCs (the owners) are free to engage an expert to assist during the inspection, not all do so.

The focus of this paper is primarily on the relationship between the inspector and the less-knowledgeable owner and how this relates to the owner's perception of the building quality. Based on the view in Davis, Schoorman and Donaldson (1997) that trust affects satistaction, the contribution of this study is that it highlights the importance of taking into account the possible hidden incentives in the interaction "a" in figure 1C as a compliment to decisions based on other measures of building quality.

Method

DATA COLLECTION

The results presented in this paper are based on data that was collected through a questionnaire sent to the chairpersons of governing boards in all of the 1563 TOCs with estates built between 2008 and 2013. The range was determined based on available information as well as a wish to include estates that had experienced at least one post-handover guarantee inspection (2013) or the five-year guarantee inspection. However, a number of responses indicated building production beyond the aimed building construction period. This might be due to the

fact that buildings were constructed in phases and consequently may have different handing-over dates. Considering the aim of the paper, the authors believed that it was reasonable to include responses stating building production year prior to 2008 but excluding buildings with occupation date after 2013. Furthermore, the study focused on housing that could be accessible without conditions and therefore TOCs owning special category estates labelled as senior, leisure and student housing were not included. This left a total of 394 completed forms from TOCs relevant to the study.

The survey, which consisted of 31 closed-end questions, requested among other things that participants rate their perception of the inspector's competence, fairness and independence from the developer, and the TOCs' degree of involvement in and comprehension of the inspection process. The respondents were also asked to indicate the perceived occurrence of defects according to the following scale: no defect appeared (1), defect appeared but was considered as a minor problem (2) or defect appeared and was considered as a severe problem (3). The total number of defects reported by each respondent was computed as the row average of the defects from the TOC's buildings in the survey. The defects included the building envelope/air tightness, drainage and plumbing, installations (HVAC), the finish, as well as appliances (Zalejska-Jonsson and Gunnelin, 2019). A *quality index* was created as a row average of all reported problems in the owned building(s). In the index, values closer to "1" suggest that there are no, or just a few, minor problems in the building(s) while the index's maximal value, "3", alludes to serious problems in the building as experienced by the owners.

DATA ANALYSIS

The study was based on the hypothesis that the TOCs perception of the inspector is correlated to the perception of building quality measured by the described *quality index*. Additionally, the authors tested whether the perception of the inspector and the inspection process varied depending on: the construction year as indicated by respondents in the survey, the TOC's geographical location in proximity to large cities, the size of the TOC measured in number of dwellings, the company size of the developer and that of the contractor (measured in the registered number of employees).

The null hypothesis of the equality of the means of the *quality index* in the subgroups was tested using the following:

H1. The mean of reported defects is equal regardless of the perception of an inspector

H2. The mean of the reported defects is equal regardless of the perception of the inspection process

In order to determine the probability of significant difference among three or more groups as a unit analysis of variance (ANOVA) is used for parametric data or Kruskal-Wallis test for non-parametric data (Baumgardner, 1997). However, as the results do not tell which group (if any) is different, post-hoc tests are needed in order to find out which of the significantly different pair(s) of groups in the tests are different. When a Kruskal–Wallis test is rejected Dunn's test, modified by for example the Benjamini-Hochberg comparison method, is the appropriate nonparametric pairwise multiple-comparison procedure (Dinno, 2015).

In order to test the hypothesis, a one-way ANOVA test was performed with the quality index as the dependent variable. The variable fulfils the normal distribution and independence assumption.

The Kruskal-Wallis test was used to test the difference in respondents' opinion in relation to geographical location, size of TOC (measured in number of dwellings) and size of developer as well as contractor (measured in number of employees). This non-parametrical test was used due to the categorical nature of data on which a post-hoc Dunn's test, the Benjamini-Hochberg comparison method was applied where relevant. The analysis was conducted using statistical package STATA 14.

Results

RESPONDENTS

Eighty-seven percent of those who responded represented TOCs located in large urban areas. The majority of the TOCs (64%) owned estates consisting of between 16 and 60 dwellings, which is consistent with the norm in Sweden. The computed alpha lambda to test the reliability of the survey answers based on 12 items in the survey was 0.84 and considered as satisfactory. The mean value for the computed quality index was 1.65 with a standard deviation of 0.348.

PERCEPTION OF THE INSPECTOR

The results shown in Table 1 indicated that sixty-eight percent of the respondents fully agreed with the statement that the inspector was fair, and that the inspector was perceived as competent. A clear majority also believed that the inspector had acted independently of the developer during the execution of the work and about the same number perceived the inspector as careful.

Table 1 Perception of the inspector.

Perception of the inspector	Disagree	Partly agree	Fully agree
The inspector was competent	5%	16 %	79 %
The inspector was fair	10 %	22 %	68 %
The inspector was autonomous	15 %	27 %	58 %
The inspector was careful	11 %	30 %	59 %
The inspector missed crucial defects	25 %	47 %	28 %

Morgan and Hunt (1994) found qualities such as being consistent, competent, honest, fair, responsible, helpful and benevolent to be symbols of trust. The results above provided an indication that there was trust for the inspector. This was followed by a Kruskal-Wallis test to analyse how the inspector was perceived by various subgroups and if the difference between the groups is so large that it cannot be taken to have occurred by chance. The result was found to be significant only for perception of inspector fairness when the respondents were grouped according to the category construction year (p=0.0058, Table 2). A post-hoc Dunn's test was thus carried out on construction year. This indicated that the difference is significant only

between responses received from TOCs with buildings constructed in 2006 in comparison to other buildings. Multiple pairwise comparison showed that the ranked value for responses from buildings constructed in 2006 was lower than that from other buildings, suggesting that TOCs in those buildings perceived the inspector to be less fair. However, the limitation of data restricted further analysis of this result.

Table 2 Perception of the inspector, p-values, Kruskal-Wallis test with tiles.

Perception of the inspector	The inspector was competent	The inspector was fair	The inspector was autonomous	The inspector was rigorous
Construction year	0.1076	**0.0058**	0.3619	0.3103
TOC size (number of dwellings)	0.5869	0.4269	0.8888	0.6255
Geographical location	0.4194	0.4023	0.3467	0.8662
Developer size	0.1758	0.2011	**0.0359**	0.6242
Contractor size	0.2119	0.7959	0.2097	0.8558

By virtue of size it could be expected that large developers commission more inspections and it could be assumed that this might have an effect on long-term relationships with inspectors active in the particular market, leading owners to have some doubt about independent behaviour. The results of the Kruskal-Wallis test (p=0.0359, Table 2) indicated that only the developer's company size had a statistically significant effect on the perception of the inspector's assessment as autonomous. However, the post hoc Dunn test using the Benjamini-Hochberg comparison method showed no statistically significant difference for comparison between the different groups based on developer size. Though the result for the large developers appeared to be consistent with the assumption based on general beliefs, there is a need for more research related to the mistrust in inspectors commissioned by the smallest developers since any perceived lack of autonomy has an effect on the perceived level of trustworthiness as defined by Goeschl and Jarke (2017).

PERCEPTION OF THE INSPECTION PROCESS

According to 90% of the respondents, the TOCs had been involved in the inspection process. However, one in five of the TOCs had perceived the inspection process as complicated and difficult to follow. Forty-six percent of all the TOCs in the survey (Table 3) did not have external support during the inspection but relied only on the competence of members on the TOC's governing board. A majority of the participants in the survey (76%, Table 3) had followed a checklist. Though the inspector is compelled to register notations made by the participating parties only 32% of the respondents reported that the remarks voiced by the TOC had been noted and just about every fourth TOC (26%) indicated high satisfaction with the inspection process.

Table 3 Perception of the inspection process.

Perception of the inspection process	Disagree	Partly agree	Fully agree	mean value
the inspection process was complicated	37 %	41 %	22 %	1.85
we were involved in the inspection process	10 %	33 %	57 %	2.46
the inspection process was standardised and not applicable to our property	48 %	37 %	15 %	1.67
we have followed a checklist	24 %	36 %	40 %	2.15
we had external support of an expert	46 %	19 %	35 %	1.88
all our comments were noted	21 %	47 %	32 %	2.10
we are in general satisfied with the inspection process	31 %	43 %	26 %	1.94

A more detailed analysis of the results revealed that uncertainty as to the inspection process as well as the inspector's disregard of the TOC's comments had a significant effect on general satisfaction with the process. The use of checklists, notation of remarks and other routines expected by the participating TOCs strengthen the degree of rule-based trust in the process and the inspector.

Table 4 shows results of how the inspection process was perceived based on various categories of respondents. The analysis of the respondents' answers based on the construction year revealed that there was a statistically significant difference in how the inspection process was perceived, especially in terms of the suitability of the process and ease as well as on how well the inspector noted the comments given. However, the interpretation of the results is intricate. The guarantee inspections generally take place two and five years after occupancy, whereby the older TOCs may have a better understanding of the inspection process.

Table 4 Perception of the inspection process, p-values Kruskal-Wallis test with tiles.

Kruskal-Wallis test with tiles	the inspection process was complicated	we were involved in the inspection process	inspection process was standardised and not applicable to our property	we have followed a checklist	we had external support of an expert	all our comments have been noted	we are in general satisfied with the inspection process
Construction year	**0.0284**	0.3541	**0.0093**	0.1010	0.5602	**0.0093**	0.1022
TOC size (number of dwellings)	0.1159	0.7863	0.0665	0.4312	0.9595	0.8271	0.8332
Geographical location	0.3777	0.0475	0.7563	0.2300	0.6287	0.2507	0.0869
Developer size	0.1232	0.5553	0.7276	0.9898	0.9579	0.8777	0.0668
Contractor size	0.9120	0.8115	0.4491	0.5389	0.4912	0.6750	0.8799

The pairwise comparison test showed a statistically significant difference between the perception of the inspection process as complicated by TOCs built in 2006 in comparison to those constructed in and after 2011. Likewise, there was a statistically significant difference in the perception of the process as standardised for TOCs built in 2012 compared with those constructed in 2007 and in 2011.

TRUST AND THE PERCEPTION OF BUILDING QUALITY (HYPOTHESIS H1)

The results presented in Table 5 computed with the ANOVA test, $p<0.000$) indicated that the null hypothesis of equality of mean of *the quality index* for trust of the inspector based on perception of the inspector's competence, fairness, as well independence and rigorous assessment (H1) could be rejected.

Table 5 Perception of building quality (mean values), in relation to impression of an inspector.

Hypothesis H1	ANOVA r-squared	p	N	*quality index* mean values per group		
				disagree	partly agree	agree
The inspector was competent	0.0593	0.00	338	1.74	1.82	1.60
The inspector was fair	0.0661	0.00	327	1.82	1.75	1.58
The inspector was autonomous	0.0572	0.00	326	1.79	1.72	1.57
The inspector was rigorous	0.0853	0.00	344	1.92	1.67	1.58

The results presented in table 5 are based on a scale of 1 to 3 with increasing severity as presented under the section on data collection. The conclusion to reject the null hypothesis was based on the fact that fewer severe defects were reported by the TOCs when the respondents perceived the inspector as competent and fair (mean values 1.60 and 1.58, respectively). On the other hand, the mean for reported defects was 1.74 when the inspector was perceived as lacking competence and 1.82 when the inspector was deemed as unfair (table 5). Findings suggested that the representatives of a TOC were less likely to report that the problems experienced in the buildings were severe when the respondents had trust and confidence in the inspector.

PERCEPTION OF BUILDING QUALITY IN RELATIONSHIP TO INSPECTION PROCESS (HYPOTHESIS H2)

Results in Table 6, which are also based on the same scale as those in table 5, indicated that the null hypothesis that the mean of *the quality index* is equal regardless of the perception of the inspection process could be rejected. The results showed that a better understanding of, and involvement in, the process as well as detailed notation of remarks during the inspection process were statistically significant factors that correlated to the perception of building quality. Furthermore, analysis showed that there were differences within the subgroups. TOCs

in which owners felt involved in the inspection process and believed that their comments had been noted indicated fewer severe defects (mean value 1.58 and 1.53, respectively, Table 6) than the owners who felt excluded from the process and believed that their comments had been ignored (mean value 1.74 and 1.78, respectively, Table 6). The mean value of *the quality index* in TOCs where the survey participant perceived the inspection process as complicated was higher (1.80) than for TOCs whose respondents considered the inspection process as easy to follow (mean value 1.52, Table 6). Likewise, the TOCs in which the inspection process was perceived as standardised and not applicable to the property also reported a larger degree of defects with severe consequences.

Table 6 Perception of building quality (mean values), in relation to the inspection process.

Hypothesis (H2)	ANOVA r-squared	p	N	*quality index* mean values per group		
				Dis-agree	partly agree	agree
the inspection process was complicated	0.1002	0.000	324	1.52	1.67	1.80
we were involved in the inspection process	0.0347	0.000	354	1.74	1.71	1.58
inspection process was standardised and not applicable to our property	0.0216	0.012	318	1.59	1.68	1.73
we have followed a checklist	0.0107	0.070	312			
we had external support of an expert	0.0033	0.643	344			
all our comments have been noted	0.0636	0.000	345	1.78	1.65	1.53
we are in general satisfied with the inspection process	0.0927	0.000	356	1.78	1.62	1.51

Thus, according to the survey results, how the inspection process was perceived by the owner also appears to have had a correlation to their perception of building quality.

Concluding comments

The relationship between trust in the inspector and the number of defects reported has been explored in previous studies. However, there is restricted literature on the principal-agency aspect of utility losses due to adverse selection and moral hazard in housing sectors, in which consequences of untrustworthiness towards the less-knowledgeable owner-buyer might become evident long after post-handover inspections.

Results from the study indicate that nearly a half of the TOCs relied on their own competence during the inspection and were dubious about the inspection process. Thus, in a

situation where building quality is based on the confidence towards inspector's accuracy and fairness, and the owners' blind assumption that the inspector notes and reports technical faults, it is apparent that developers who are mostly interested in short term profit may benefit from the presented principle-agent dilemma.

The number of developers active in the residential sector in Sweden has exploded at the same time as numbers in other sectors have remained close to constant. There is reason to believe that an inspector might be tempted not to disclose certain quality issues for the benefit of the developer. If TOCs are not able to actively participate in the inspection process because they cannot grasp perplexity of the process or adequately communicate their concerns, the risk for defects left unseen and not reported increases. In many cases, it takes a number of years for symptoms of defects to be visible and noticed by occupants. With time, the complexity of the problems and cost of rectification increases substantially.

Deteriorating building quality has negative consequences from economic, environmental and social perspectives. Building quality has effects on energy performance, which raises operational costs; additionally, need for acute reparations intensifies and maintenance costs will increase. Furthermore, it is rational to postulate that repercussion of hidden defects in the buildings leads towards "lemon market" (Akerlof, 1970). Therefore, there is a need to advance efforts to raise the knowledge level and how it is passed on to new governing board members in the TOCs.

A major implication of the study is that efforts to address shortcomings related to the gap between the developer and the owner, in the context of building quality and perceived severity of defects, are not location specific, but need to be customised to different owner groups. A better understanding of the inspection process by the owner correlates to the effective participation and leads to an improved building quality. This adds to the list of factors previously discussed in the research community, for example, a lack of common terminology (Sommerville, 2007; Forcada, et al., 2013) and perception of rectification costs (Milion, Alves and Paliari, 2017).

There are incentives with a positive outcome for developers as well as owners to invest in efforts geared towards increasing the trust in, and understanding of, the guarantee inspection by the sizeable group of largely uninformed homebuyers within the single and/or multi-dwelling housing sectors through different pathways as described in Rodgers (2010). The study's conclusion is that a better understanding of the inspection process by owners would improve participation and raise the value of carrying out the process.

References

Alencastro, J., Fuertes, A. and de Wilde, P., 2018. The relationship between quality defects and the thermal performance of buildings. *Renewable and Sustainable Energy Reviews,* 81(1), pp.883-94. https://doi.org/10.1016/j.rser.2017.08.029

Atkinson, A., 1999. The role of human error in construction defects. *Structural Survey,* 17(4), pp.231-36. https://doi.org/10.1108/02630809910303006

Auchterlounie, T., 2009. Recurring quality issues in the UK private house building industry. *Structural Survey,* 27(3), pp.241-51. https://doi.org/10.1108/02630800910971365

Bagge, H. and Johansson, D., 2013. Prediction and Verification of Energy Performance in Energy Efficient Multi-Family Dwellings. *ASHRAE Transactions*, 119(2).

Barrett, P., 2000. Systems and relationships for construction quality. *International Journal of Quality & Reliability Management,* 17(4-5), pp.377-92. https://doi.org/10.1108/02656710010298409

Baumgardner, K.R., 1997. A review of key research design and statistical analysis issues. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontology,* 84(5), pp.550-56. https://doi.org/10.1016/s1079-2104(97)90272-9

Bergsten, Z. and Holmqvist, E., 2013. Possibilities of building a mixed city – evidence from Swedish cities. *International Journal of Housing Policy,* 13(3), pp.288-311. https://doi.org/10.1080/14616718.2013.809211

Bordass, B., Cohen, R., Standeven, M. and Leaman, A., 2001. Assessing building performance in use 3: energy performance of the Probe buildings. *Building Research & Information,* 29(2), pp.114-28. https://doi.org/10.1080/09613210010008036

Boverket, 2007. *Application of long warranty periods - The guarantee project (in Swedish),* Karlskrona: Boverket – the Swedish National Board of Housing, Building and Planning.

Boverket, 2018. *Mapping faults, deficiencies and damages in the construction sector - Report 2018:36 (in Swedish),* Karlskrona: Boverket – the Swedish National Board of Housing, Building and Planning.

Chan, A.P. and Tam, C.M., 2000. Factors affecting the quality of building projects in Hong Kong. *International Journal of Quality & Reliability Management,* 17(4/5), pp.423-42. https://doi.org/10.1108/02656710010298445

Cole-Colander, C., 2003. Designing the customer experience. *Building Research & Information,* 31(5), pp.357-66. https://doi.org/10.1080/0961321032000088025

Crosby, P.B., 1984. *Quality Without Tears: The Art of Hassle Free Management.* New York, NY: McGraw-Hill.

Dasgupta, A., Prodromou, A. and Mumovic, D., 2012. Operational versus designed performance of low carbon schools in England: Bridging a credibility gap. *HVAC&R Research,* 18(1-2), pp.37-50.

Davis, J., Schoorman, F. and Donaldson, L., 1997. Toward a stewardship theory of management. *Academy of Management review,* 22(1), pp. 20-47. https://doi.org/10.2307/259223

De Wilde, P., 2014. The gap between predicted and measured energy performance of buildings: A framework for investigation. *Automation in Construction,* Issue 41(2014), pp.40-49. https://doi.org/10.1016/j.autcon.2014.02.009

Dinno, A., 2015. Nonparametric pairwise multiple comparisons in independent groups using Dunn's test. *Stata Journal,* 15(1), pp.292-300. https://doi.org/10.1177/1536867x1501500117

European Parliament, 2003. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. *Official Journal of the European Communities,* 1(4.1.2003), pp.65-71.

Fauzi, S.N.F.M. and Abidin, N.Z., 2012. The relationship of housing defects, occupants' satisfaction and loyalty behavior in build-then-sell houses. *Procedia-Social and Behavioral Sciences,* 62, pp.75-86. https://doi.org/10.1016/j.sbspro.2012.09.014

Forcada, N., Macarulla, M., Gangolells, M. and Casals, M., 2013. Posthandover housing defects: sources and origins. *Journal of Performance of constructed facilities,* 27(6), pp.756-62. https://doi.org/10.1061/(asce)cf.1943-5509.0000368

Forcada, N., Macarulla, M., Gangolells, M. and Casals, M., 2016. Handover defects: comparison of construction and post-handover housing defects. *Building Research & Information,* 44(3), pp.279-88. https://doi.org/10.1080/09613218.2015.1039284

Forcada, N., Macarulla, M. and Love, P.E., 2012. Assessment of residential defects at post-handover. *Journal of construction engineering and management,* 139(4), pp.372-78. https://doi.org/10.1061/(asce)co.1943-7862.0000603

Forsythe, P., 2015. Monitoring customer perceived service quality and satisfaction during the construction process. *Construction Economics and Building,* 15(1), pp.19-42. https://doi.org/10.5130/ajceb.v15i1.4172

Georgiou, J., 2010. Verification of a building defect classification system for housing. *Structural Survey,* 28(5), pp.370-83. https://doi.org/10.1108/02630801011089164

Georgiou, J., Love, P.E.D. and Smith, J., 1999. A comparison of defects in houses constructed by owners and registered builders in the Australian State of Victoria. *Structural Survey,* 17(3), pp.160-69. https://doi.org/10.1108/02630809910291343

Goeschl, T. and Jarke, J., 2017. Trust, but verify? Monitoring, inspection costs, and opportunism under limited observability. *Journal of Economic Behavior & Organization,* 142, pp.320-30. https://doi.org/10.1016/j.jebo.2017.07.028

Holt, R. and Rowe, D., 2000. Total quality, public management and critical leadership in civil construction projects. *International Journal of Quality & Reliability Management,* 17(4/5), pp. 541-53. https://doi.org/10.1108/02656710010298571

Hopkin, T., Lu, S.-L., Rogers, P. and Sexton, M., 2017. Key stakeholders' perspectives towards UK new-build housing defects. *International Journal of Building Pathology and Adaptation,* 35(2), pp.110-23. https://doi.org/10.1108/ijbpa-06-2016-0012

Jensen, M.C. and Meckling, W.H., 1976. *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure.* [online] Available at: http://www.sfu.ca/~wainwrig/Econ400/jensen-meckling.pdf [Accessed 04 02 2012].

Johnsson, H. and Meiling, J., 2009. Defects in offsite construction: Timber module prefabrication. *Construction Management Economics,* 27(7), p.667–81. https://doi.org/10.1080/01446190903002797

Kangwa, J. and Olubodun, F., 2006. Triggernomic Repair Process Analysis (TRAP) A methodology for better diagnosis of housing defects in the owner-occupier sector. *Structural Survey,* 24(2), pp.127-37. https://doi.org/10.1108/02630800610666664

Lützkendorf, T. and Speer, T.M., 2005. Alleviating asymmetric information in property markets: building performance and product quality as signals for consumers. *Building Research & Information,* 33(2), pp.182-95. https://doi.org/10.1080/0961321042000323815

McElroy, D. and Rosenow, J., 2019. Policy implications for the performance gap of low-carbon building technologies. *Building Research & Information,* 47(5), pp.611-23. https://doi.org/10.1080/09613218.2018.1469285

Milion, R., Alves, T. and Paliari, J., 2017. Impacts of residential construction defects on customer satisfaction. *International Journal of Building Pathology and Adaptation,* 35(3), pp.218-32. https://doi.org/10.1108/ijbpa-12-2016-0033

Mohr-Jackson, I., 1998. Conceptualizing total quality orientation. *European Journal of Marketing,* 32(1/2), pp.13-22. https://doi.org/10.1108/03090569810197390

Morgan, R. and Hunt, S., 1994. The commitment-trust theory of relationship marketing. *The journal of marketing,* 58(July 1994) pp.20-38. https://doi.org/10.2307/1252308

Murtagh, N., Achkar, L. and Roberts, A., 2018. The role of building control surveyors and their power in promoting sustainable construction. *Construction Management and Economics,* 36(7), pp.363-74. https://doi.org/10.1080/01446193.2017.1397721

Rodgers, W., 2010. Three primary trust pathways underlying ethical considerations. *Journal of Business Ethics,* 91(1), pp.83-93. https://doi.org/10.1007/s10551-009-0069-1

Rotimi, F., Tookey, J. and Rotimi, J., 2015. Evaluating defect reporting in new residential buildings in New Zealand. *Buildings,* 5(1), pp.39-55. https://doi.org/10.3390/buildings5010039

Ruonavaara, H., 2005. How divergent housing institutions evolve: A comparison of Swedish tenant co-operatives and Finnish shareholders' housing companies. *Housing, Theory and Society,* 22(4), pp. 213-36. https://doi.org/10.1080/14036090500375373

Scanlon, K. and Whitehead, C.M.E., 2004. *International trends in housing tenure and mortgage finance.* London: Council of Mortgage Lenders.

Sommerville, J., 2007. Defects and rework in new build: an analysis of the phenomenon and drivers. *Structural Survey,* 25(5), pp.391-407. https://doi.org/10.1108/02630800710838437

Sui Pheng, L. and Wee, D., 2001. Improving maintenance and reducing building defects through ISO 9000. *Journal of Quality in Maintenance Engineering,* 7(1), pp.6-24. https://doi.org/10.1108/13552510110386865

Sunding, L. and Ekholm, A., 2014. Problems and problem attention in the construction sector – understanding the influence of human factors. *Australasian Journal of Construction Economics and Building,* 14(2), pp.1-17. https://doi.org/10.5130/ajceb.v14i2.3925

Zalejska-Jonsson, A. & Gunnelin, R. H., 2019. Defects in newly constructed residential buildings: owners' perspective. *International Journal of Building Pathology and Adaptation,* 37(2), pp. 163-185. https://doi.org/10.1108/ijbpa-09-2018-0077