Defects in new homes: an analysis of data on 1,696 new UK houses

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Abstract

Purpose – The clamour from UK house buyers over "snags" in new homes seems likely to continue unabated even though house builders are striving to resolve what may be perceived as a quality issue. This paper aims to discuss how the requirements, and hence the quality of new homes in the UK, are defined and the role the house buyer actually plays in this process.

Design/methodology/approach – Within the composite quality attainment process "snagging" is defined and discussed in detail along with the resulting quality cognitive dissonance likely to be encountered by the buyer. The results of detailed quantitative analysis of data on snagging from nearly 1,700 new homes are presented.

Findings – The snagging process shows how heavily the house buying process is geared towards the builder and that within this snagging process there are areas where the builder is absorbing costs, which reduce the potential profit on each house i.e. the absorbed snagging (snags remedied as the work progresses). The visible snagging at hand-over stage is a further depletion of profit and completely avoidable. The snags are damaging to the image of house builders, they detract from customer satisfaction and they reduce the potential profit available on each new house. The analysis provided in the paper shows that there is a direct relationship between the size of the property and the number of snags identified. Also, there are differences in the number of snags identified for each of the builders and within the company each site has variance on the number of snags discovered: the scale of snags peaks at 389 for a single property – significant in anyone's terms.

Research limitations/implications – Analysing the data was not a simple task due to the structure and variation within the data. It would be ideal to identify the exact factors that affect the number of snags in newly built properties. Collecting identical data with only one differencing factor would complete this. However, as the inspections were carried out randomly on request this was not possible with the present data.

Practical implications – The legal rights of new homebuyers are severely limited under UK law and this research highlights the need for both an improvement in quality and for buyers to ensure that they take steps to protect what is often the largest investment of their lifetime.

Originality/value – The volume of research into quality of new homes in the UK is remarkably scant given the size of the extent of the industry. The size of the data set for this paper is significant and allows fresh insights to be obtained.

Keywords Consumers, Housing legislation, Housing, Buildings, United Kingdom

Paper type Research paper

Background

The last decade has witnessed a constant clamour from both clients and government for improvements in the quality of the finished product delivered by the UK construction industry. Numerous working parties have come and gone with their published reports outlining methods for improving quality, e.g. Latham (1994) and Egan (1998, 2002). The majority have fixed their attention on commercial projects: where they have strayed into the housing domain, then they have limited themselves to

Structural Survey
Vol. 24 No. 1, 2006
pp. 6-21

0263-080X
DOI 10.1108/02630800610654397

social housing. The main reason for this, as noted by Egan (1998), is that the social housing sector has more similarities to the commercial sector than the private housing sector i.e. the builder/developer is usually dealing with one professional client.

This perceived singularity of approach helps ensure that customer/client requirements are set out and addressed from the start of the project, with clear guidelines as to the levels of acceptability for each element of the building on completion. Crosby (1984) extols this premise as being one of the basic tenets of total quality management (TQM), i.e. "Quality has to be defined as conformance to requirements, not as goodness".

The requirements Crosby speaks of are of course the requirements of the client. As previously mentioned this can be relatively easily facilitated in the commercial domain where one client engages construction professionals to refine/establish requirements and supervise the project, ensuring conformance is achieved in the end product. This is not the case however in the private house building sector. This sector has multiple clients all with differing perceptions and expectations, many have no previous experience in purchasing a new house and those that have, often perceive it to be an adversarial process.

Against this drive for client satisfaction we have to balance a multi-billion pound industry, one of whose largest companies sees their core business as being a retailer rather than a house-builder. This underlying presumption that new houses are now consumer products was espoused by Lorentzen (1996) when he argued that a home could be seen as a consumer product, albeit a very expensive one. We thus have a multi-billion pound industry, manufacturing very expensive consumer products, but with little research on customer requirements (Gann *et al.*, 1998; Mills, 2000; Leishman *et al.*, 2004).

Barker (2004) highlighted the low house building standards of a number of the leading house building companies, "The need to improve standards applies right across the industry: of the nine companies that performed worse than the industry average on this indicator, four – Persimmon, Barratt, Wilson Connolly and Westbury – were among the top ten house builders".

Indeed the volume of research specifically related to quality in new-build private housing is remarkably scant given the size of the industry. The research that is there focuses predominantly on regulatory defects i.e. contraventions to either building regulations or the warranty providers' standards. There has until now been no in-depth research into customer requirements (other than marketing efforts geared towards very superficial, materialistic issues). The underlying issues of what the buyer expects and what they want from their new house, i.e. the must have, they should have and, the nice to have, have been glossed over. The importance of the matter is shown by the fact that the last three Housing Forum/MORI (2000, 2001, 2003) customer satisfaction surveys report an increasing number of new home purchasers as being unhappy with their new home, the recorded levels of satisfaction showing a downward trend.

There is strong evidence that consumers are becoming more demanding in terms of what they expect from goods and services (Disney, 1999; Gruska, 2000), and that they are becoming more vocal when they are dissatisfied (Zeithaml *et al.*, 1990). Leishman *et al.* (2004) analysis of people's reasons for buying new rather than second-hand homes suggests that many people do so for mainly practical reasons. What is clear is that the homebuyer establishes a cognitive map of what they seek in a new home and this map is often at variance with the house builder's.

Dissonance in the quality expectation paradigms

Cognitive dissonance is a well-known psychological phenomenon proposed by Festinger (1957). Cognitive dissonance can be brought on when a person holds a belief, attitude or opinion (cognition) and is then exposed to another cognition at variance to the first. This sets up inner psychological tension between the cognitions and in order to relieve this tension the person may actually change their initial belief (Festinger, 1957). Clow *et al.* (1998) and O'Neill and Palmer (2004) highlight the impact of cognitive dissonance on consumers as a factor that modifies the way in which people actually report dissatisfaction, giving a higher positive result than is warranted by the actual level of satisfaction.

The quality dissonance in the case of the new homebuyers revolves around the level and range of defects, or more commonly termed in the industry, "snags" encountered within the new home (Sommerville and Craig, 2005). This dissonance may well arise from the fact that the buyer thinks they are setting the quality requirements when in fact they are only a purchaser of what may be perceived as a second-hand set of requirements.

The setting of requirements for the new UK home

It may be argued that "snagging" has assumed a degree of acceptability, even though it is an unwelcome feature of modern house building. The term is widely applied within the UK construction industry: extraction of definitions of the term from within a range of built environment literature includes: rework, non-conformance, repairs, quality failures, quality deviations and defects (Love, 2002). A definition of snagging that may be more acceptable across the broader spectrum of house builders is the identification and rectification of errors, defects and omissions within a new house.

Love and Li (2000) see rework as being "the unnecessary effort of re-doing a process or activity incorrectly implemented the first time". The process of "snagging" has been defined (by independent UK body Inspector Home) as "the act of checking a new home for difficulties with the quality of finish and workmanship". These definitions concur with Ong (1997), who suggests that by its very nature the composite house building process often leads to minor defects being found in the finished article.

However, it may be argued that these definitions suffer from the same inherent flaw – they presume the buyer is the requirement setter. In the case of the UK housebuyer this perception could not be further from reality.

To date, the actual process of setting new home quality requirements has rested with the builder. This process has become enshrined in not only what the builders do but also how the mortgage lenders operate.

After extensive research of the mechanisms actually operated by the majority of UK house builders, the composite requirements and quality setting process can be modelled as shown in Figure 1. From Figure it is clear that the actual buyer has very little role in the definition of the functional requirements of neither the new house nor its quality standards. The quality standards are set and managed by the builder – in some cases, even the inspection of the house for habitation approvals is significantly controlled by the builder.

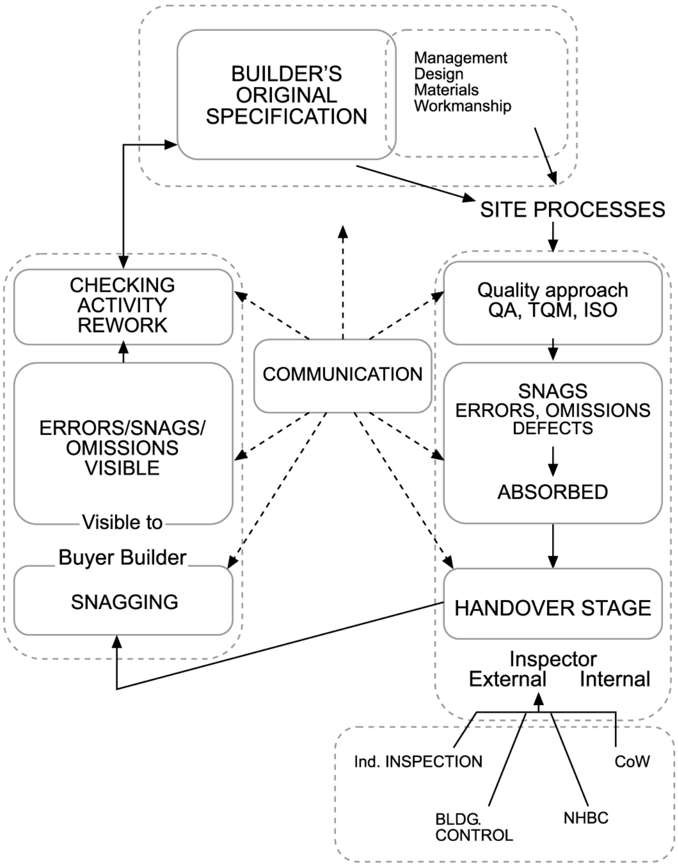


Figure 1.
The new-house quality setting pathway

From Figure 1 it can be seen that there are two major opportunities for the builder to rectify defects – prior to the handover of the property (when a range of inspections take place) and at handover. Prior to handover, the snags may be perceived as "absorbed", since they are generally dealt with by particular trades as they progress from one task to another or as other trades move in and highlight work required in order that their progress will not be delayed. At the handover stage the "snags" may be perceived as visible since they will have been brought to the attention of the builder and also the buyer will either have noticed snags themselves or had some form of inspection carried out which brings snags to their attention.

The latter type – visible-snags are the general industry focus and the ones which receive most media attention and yet they may be the lesser evil. The absorbed snags can be viewed as a direct form of waste and may be significant in value. Without detailed evaluation of the costs of reworks to these absorbed snags the industry is unable to quantify its losses.

For the sake of simplicity, we have assumed that snags which arise within the overall process of construction can be attributed to a number of sub-processes which act as indicators/initiators/moderators of other snags.

The morphology of snags

In general, defects or snags occur throughout the complete build cycle of the new house. They become patent at two key points: those which are "absorbed" during the construction/building process and which are usually corrected before practical completion; and, those which are "visible" to the contractor and home buyer once the home is deemed ready for occupation.

There tend to be three common characteristics of snags:

(1) Technical, when workmanship, material or design of an element of the building reduce its ability to function properly.

(2) Omissions, parts or features of a home that are simply "omitted".

(3) Aesthetic, when the appearance of a building element is adversely affected (Georgiou *et al.*, 1999).

What has not been discussed anywhere in the literature is the relative weight of each of these elements i.e. are aesthetic snags more important and costly than design snags? Within the need for consideration of some form of relative weighting, thought should also be given to the visibility of snags i.e. those visible to the buyer (the end-user) may become more important and problematic than those visible to the contractor.

House-builders' contracts (the missives) would in the past have contained a provision that snagging items discovered would be rectified within a certain timeframe. However the Scottish Consumer Council (2005) reports that such clauses are now an exception rather than the norm. This suggests that UK homebuyers who have discovered snagging items after they have purchased their property will have to rely on the goodwill of the homebuilder to rectify the snags. There is nothing inherent within the contract to force the homebuilder to rectify the snagging: the buyer has minimal legislation or legal rights to fall back on. There is an implicit reliance on the house-builder having a robust quality assurance system in place.

New home quality assurance (QA) initiatives

Purchasers of new houses receive a very limited amount of consumer protection. New houses are exempt from the Sale of Goods Act 1979, as amended in 1994 and 2002. What consumer legislation there is does not cover houses and in effect means that new house purchasers have less consumer rights than someone who for instance, buys a tin of beans. New houses in the UK are generally sold with a ten-year warranty (the warranty providers, in the majority of instances, being either the National House Building Council (NHBC) or Zurich House Insurance). However, this warranty may rightly be viewed as an insurance policy, not consumer protection. It does very little to reinforce the drive for quality in new house construction.

The ultimate measure of construction quality is client satisfaction (Barrett, 2000), although one of the most perplexing issues that the construction industry faces is its ability to become quality focused (Love *et al.*, 1999). Those house-builders within the composite construction industry organisations that have addressed the issue of quality are predominantly quality assurance orientated (Sommerville and Robertson, 2000). Quality Assurance (QA) is a mechanism that can be used to ensure that appropriate controls are put in place to measure working activities (Love and Edwards, 2004). In the UK construction industry there is a presumption that to address quality an organisation must implement ISO 9000 (Barrett, 2000). ISO 9000 sets the minimum standard for a quality management system and many organisations have become ISO compliant as a result of pressure from their public sector customers (Kumaraswamy and Dissanayaka, 2000). However, this drive for ISO accreditation masks concerns rightly flagged by Moatazed-Keivani *et al.* (1999) regarding the overall benefits of ISO 9000 and the attendant onerous paperwork and bureaucracy.

Generally then, quality within the house-building sector of the construction industry can be defined as fitness for purpose, the achievement of agreed goals and the conformance to requirements (Chan and Tam, 2000). The management of conformance to requirements relies on collecting appropriate data with which to execute comparisons.

The collection of snagging data, or indeed the snagging process, has rarely been reported upon, thus there is a dearth of literature and data available. This paucity of background material is considered further in the methodology and statistical analysis section.

Aim and objectives of the research

The research aimed to discern if the clamour over snags in new homes was justified and to establish any underlying patterns with regards to the incidence and spread of snags in a number of new houses.

The objectives included:

(1) disseminating the background literature;

(2) applying an appropriate research methodology;

(3) defining the data sets on snags;

(4) analysing the data populations for underlying patterns and trends; and,

(5) reporting on the findings from the data analyses.

Achievement of the objectives relies on adopting a robust and appropriate methodology.

Methodology and analysis approach

A detailed home inspection report was produced for each of the 1,696 houses inspected (over a period of 40 months) with the resultant dataset containing detailed information on 100,195 snags found within the 1,696 properties built by some 257 housebuilders.

Data available for extraction from the inspection reports included a host of information on: the name of the client, the location of the property, the type of property, the building company, number and type of snag and so on. For the sake of clarity in this paper the list noted above has been truncated. The variables within the datasets were coded for statistical analysis. The names of clients, inspectors and building companies are not specified for confidentiality reasons. Data analysis was performed using three different computer packages: Statistical Package for Social Sciences (SPSS), Minitab and Microsoft Excel.

At the outset of the data processing, descriptive statistics were derived for each variable in the data set to check for errors and to display the distributions for each variable. After the initial examination of the data it was clear that for many of the factors, such as builders and inspectors, there were a number of categories with very little data. These categories with low frequencies were then excluded from further analysis. This paper will include analysis on select variables contained in the dataset, which will give an initial picture of the extent of snagging in the UK house-building industry.

Distribution of snags

The first variable considered was the "number of snags" found in each of the 1,696 properties. Table I shows the basic descriptive statistics of the properties and the number of reported snags in each.

There is considerable variation in the total number of snags across the 1,696 properties: a standard deviation of 46.85 confirms this view. The maximum number of defects reported in a single property was 389: this property was built by company 27 in 2003, it was a five-bedroom house and situated in the north of England. Of the 389 reported defects, 380 were associated with a specific trade and related to "bad workmanship". Conversely, the property with the minimum amount of defects was a one bedroom flat, built by building company 17 and located in Wales. This property only had one reported defect; the company is perhaps to be commended. Figure 2 shows a histogram of the number of snags in relation to the number of properties.

From the histogram, it can be seen that the distribution of the snags in new properties is skewed: we can establish that a small percentage of the properties give rise to a significant number of defects, e.g. 228 properties (17 per cent of the data) generate 41 per cent of the total number of defects. These 228 properties having in excess of 100 defects each.

House size in relation to number of snags

Considering the different house sizes and the reported number of snags for all house types, further analysis was undertaken to identify any relationship between these variables. The majority of houses inspected were two bedroom properties; however reports included data on houses ranging from one to six bedrooms (the actual number of properties in each category is supplied in Figure 3). From analysis of the data, it became clear that as the number of bedrooms in a property increased, so did the number, and the range, of snags associated within each property type. This is shown in the interval plot in Figure 3.

No of snags	No of houses	Total snags	Mean	Min	Max	Median	St. deviation
1 to 20	259	3,796	14.66				
21 to 40	502	14,731	29.34				
41 to 60	356	17,705	49.73				
61 to 80	165	11,614	70.39				
81 to 100	126	11,379	90.31				
101 to 120	113	12,336	109.17				
121 to 140	65	8,496	130.71				
141 to 160	45	6,681	148.47				
161 to 180	22	3,745	170.23				
181 to 200	16	3,033	189.56				
201 to 300	22	5,010	227.73				
300 +	5	1,669	333.8				
	1,697	100,195	59.08	1	389	44	46.85

Table I.
Distribution of snags across 1,696 properties

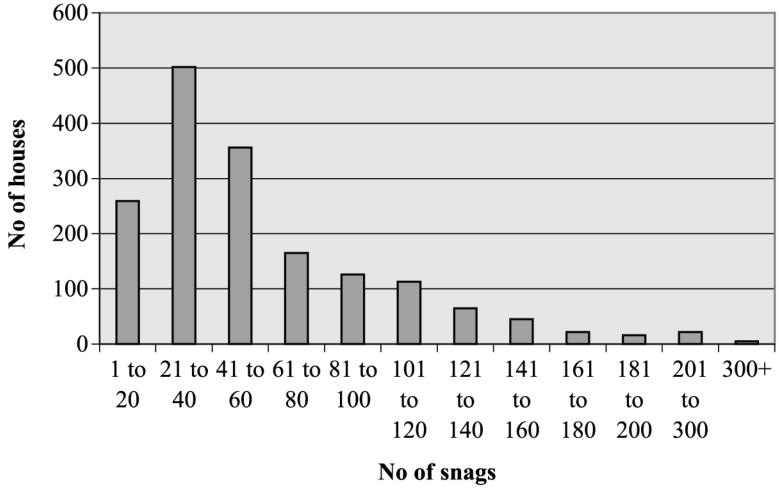


Figure 2.
Number of snags by the number of properties

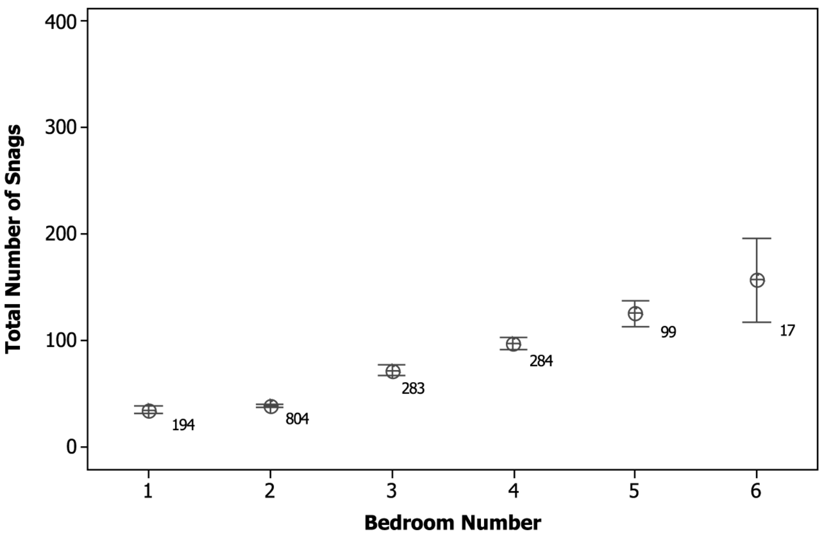


Figure 3.
Interval plot of number of snags by the number of bedrooms (95 per cent CI for the mean)

Although it might be reasonable to expect an increase in the incidence of snags as the bedroom number increases, the full extent of this increase was not expected and further analysis was then conducted using a regression technique: the average number of snags for each of the six house types were used: these are shown below in Table II.

The regression analysis was undertaken and the line of fit produced to estimate the number of snags as shown in Figure 4. This graph can be utilised in a broad range of house types and from it the projected average number of snags likely to be encountered in any size of house can be found. Utilising the equation:

$$\text{Average number of snags} = 16.64 + 10.92 * \text{No. of beds} + 2.109 * \text{No. of beds}^2$$

The calculated R^2 (adj) value of 98.2 per cent indicates that the model fits extremely well and therefore an appropriate estimation on the number of snags likely to be found in any property can be calculated.

Statistical analysis relating to the building companies

There are 257 different building companies included in the data set, encompassing well-known companies and a number of the top 20 house builders (by volume). A total of 55 per cent of the builders had only one of their properties inspected: therefore, these companies were excluded from analysis. Figure 5 shows the builders with the ten highest numbers of inspections and these were the only companies considered in the following analysis.

Table III indicates variability within the number of properties inspected for each builder, ranging from 30 to 431 inspections. The total number of inspections carried out on the properties built by these companies constitutes 55 per cent of the total 1,697 inspections with 25 per cent of all of the inspections coming from one specific building company. Table III shows descriptive statistics for the number of properties built by the builders being considered.

Table II.
The average number of snags for each house size

Number of bedrooms	Average number of snags
1	34.08
2	37.61
3	71.46
4	96.64
5	124.80
6	156.50

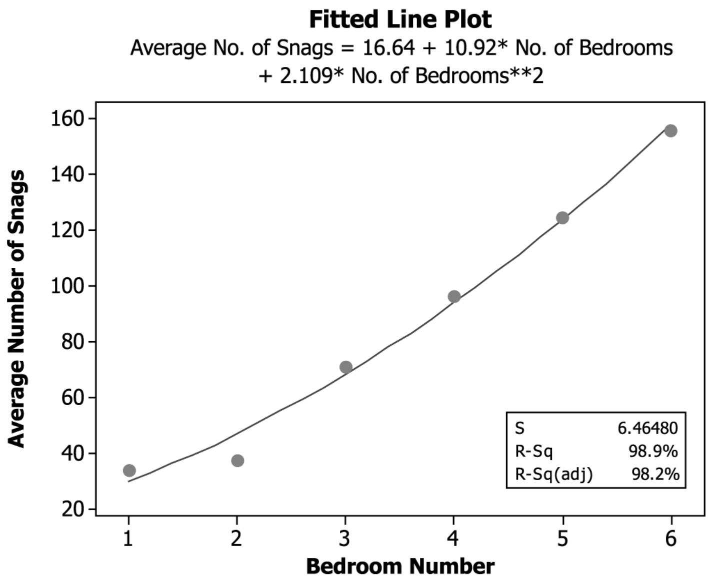


Figure 4.
Regression analysis on the average number of snags

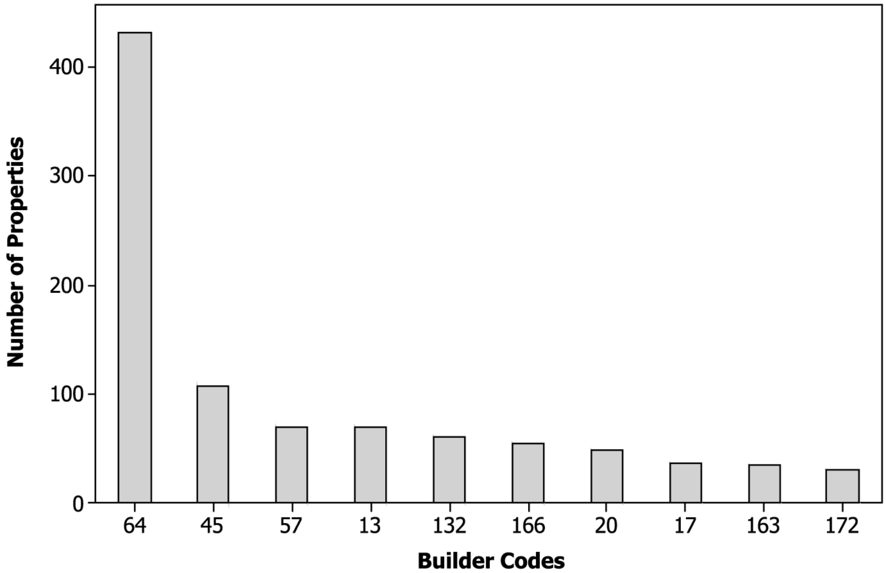


Figure 5. Bar chart of the number of properties built by the ten builders with the highest number of properties inspected

Table III. Descriptive statistics for ten builders

	Minimum	Maximum	Mean	Total	Median
Number of properties	30	431	94.2	942	45

Effect of builders on distribution of snags

To investigate whether there was any difference in the number of snags being found in properties constructed by different builders, the ten companies with the highest number of properties were examined. These were Builders 13, 17, 20, 45, 57, 64, 132, 163, 166, 172 and the numbers of properties within these ten builders are shown in Figure 5.

The descriptive statistics for the number of snags reported in properties constructed by the builders, being analysed, are shown below in Table IV. The mean number of snags for each builder ranges from 26.8 to 99.13. The amount of variability within the number of snags as measured by the standard deviation for the number of snags reported in properties by the builders' ranges from 19.72 to 60.03. This variability can be seen in Figure 6 which also states the number of properties reported on for each of the builders.

Builder 166 has the highest average number of snags, having had 55 properties inspected; builder 20 has the lowest average number of snags, with 49 properties being inspected. Builders 20, 64 and 163 seem to have a particularly low variability in the number of snags compared to builders 17 and 166 for example. The low variability in the number of snags for Builder 64 should be recognised as it contained the largest number of properties (at least more than four times the amount in comparison to the rest). The distribution of number of snags does appear to be skewed for most builders with the exception of Builder 57.

Table IV.
Descriptive statistics for the highest ten building companies

Variable	Builder codes	N	Mean	SE mean	St. dev	Minimum	Median	Maximum
No. of snags	13	69	83.09	5.9	48.99	10	70	205
	17	36	54.36	8.96	53.79	1	23.5	232
	20	49	26.8	5.23	36.6	7	19	237
	45	107	54.54	4.37	45.24	7	41	265
	57	70	57.9	6.66	55.76	6	40	342
	64	431	36.72	0.95	19.72	8	33	136
	132	60	81.83	6.48	50.19	10	67	216
	163	35	50.6	4.02	23.81	24	46	131
	166	55	99.13	8.09	60.03	19	86	307
	172	30	64.17	7.98	43.7	11	54	193

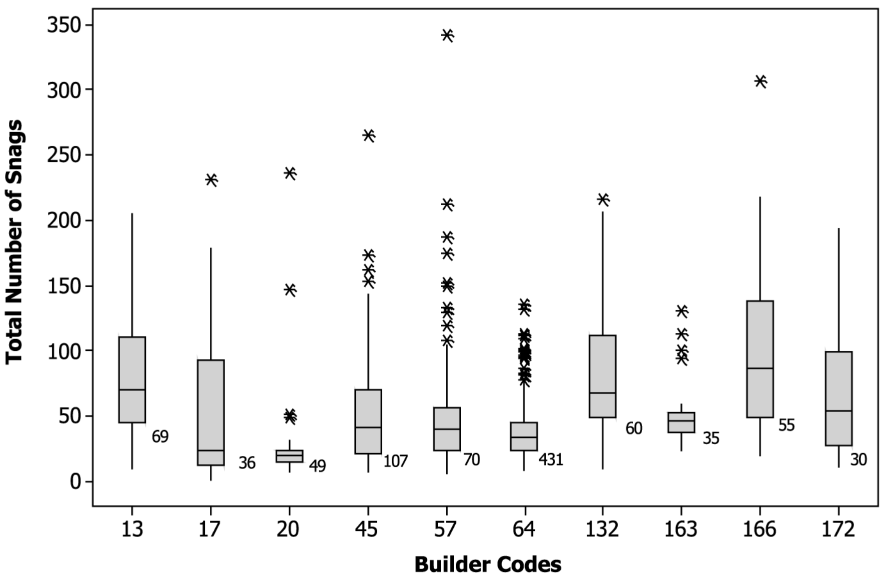


Figure 6.
Boxplot of the total number of snags for the building companies

To test whether there was any significant difference in the average number of snags across the builders, the distribution of snags for each builder was examined. The Anderson-Darling normality test was applied to investigate whether the data followed a normal distribution and Levene's test was utilised to investigate the equality of variances. Results from these examinations were then used to determine further analyses on the data. The assumptions for a parametric ANOVA test were not supported and a non-parametric Kruskal-Wallis test was conducted (the hypotheses and testing decisions for these tests are not considered within this paper, they are available in numerous statistics publications). Suffice to say that from conducting these tests on the ten builders it was concluded that only two of the builders (166 and 172) follow a normal distribution.

The plot of the variances of each builder is shown in Figure 7, which indicates some difference in the variances of the number of snags for each builder.

One of the assumptions underlying the Kruskal-Wallis test is that the populations have similar shapes to each other: a dot plot was produced (Figure 8) which shows that

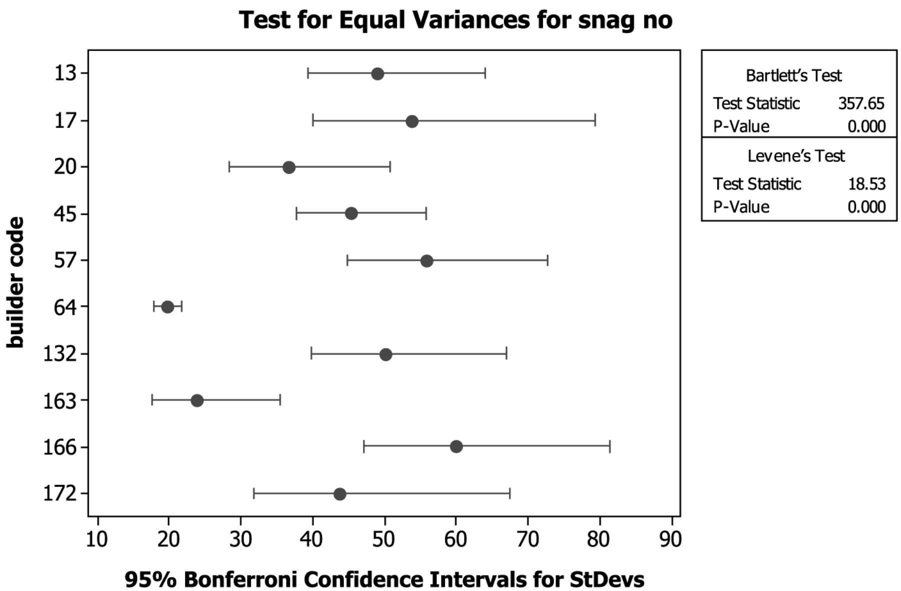
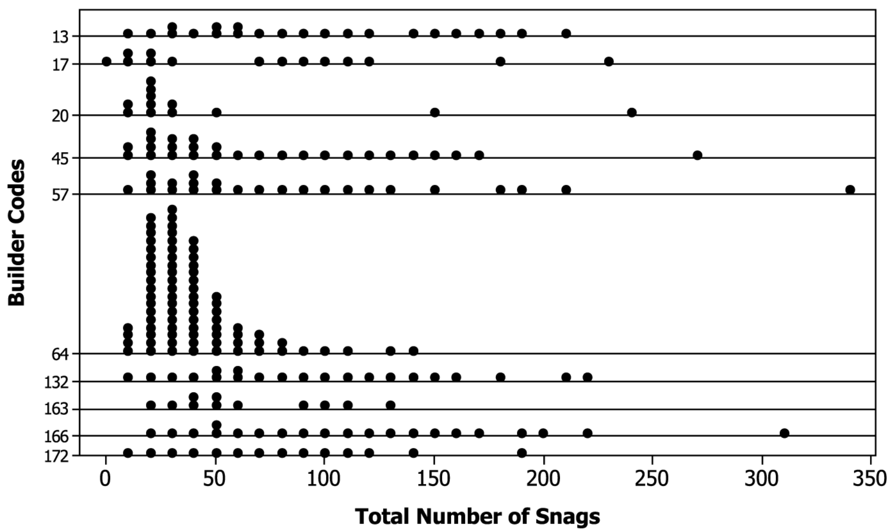


Figure 7. The distribution of snags for each builder



Note: Each symbol represents up to 6 observations

Figure 8. Dotplot of the total number of snags for the builder codes

the shapes of the ten populations are similar to each other except for possibly two of the builders (132 and 166).

The result of the Kruskal-Wallis test has to be interpreted with caution since the assumption of similar shapes may not hold, even though other basic assumptions are met. The Kruskal-Wallis test, as applied, was used to investigate whether each category within each variable had an effect on the number of snags found in each property. It was an appropriate test since the testing involved the comparison of three or more averages and its assumptions were valid for the data. The Kruskal-Wallis one-way analysis of variance by ranks test is "Perhaps the most widely used non-parametric technique for testing the null hypothesis that several samples have been drawn from the same or identical population" (Daniel, 1990).

Statistical decision. If the test statistic is greater than the critical value H then the null hypothesis is rejected which states the different groups have equal mean snag numbers and conclude that at least one of the categories yields a mean number of snags which is different from that yielded by at least one of the other groups. Also, if the asymptotic significant value is less than the significant value of 0.01 this confirms the above decision. Otherwise, there is no relationship between the groups and the total number of snags.

A significant result ($p < 0.000$) was observed from the Kruskal-Wallis test shown in Table V, which indicates that there is a significant difference in the median number of snags reported in properties constructed by these builders.

Conclusions

The new homebuyer, as a consumer of the end product of construction processes, has little, if any, rights under current UK legislation. There needs to be a sea change in the legislation towards the buyer and this in turn will bring about benefits to the composite industry.

Quality initiatives within the industry have been promulgated and implemented under a number of guises and yet the end product – the new home – still has a number of snags, which causes the customer to be repeatedly dissatisfied. There are a number of approaches, which can be implemented to reduce these snags occurring, and indeed

Builder codes	N	Median	Ave rank	Z
13	69	70	679	6.58
17	36	23.5	406.6	−1.46
20	49	19	191.1	−7.41
45	107	41	474.8	0.13
57	70	40	495.5	0.77
64	431	33	397.2	- −7.7
132	60	67	668.8	5.81
163	35	46	561	1.98
166	35	86	724.8	7.12
172	30	54	566.2	1.94
Overall	942		471.5	
$H = 213.59$		DF = 9	$p = 0.000$	
$H = 213.65$		DF = 9	$p = 0.000$ (adjusted for ties)	

Table V.
Kruskal-Wallis test output

the NHBC seem placed in an ideal position to ensure complete eradication. Warranties and guarantees offered to new home buyers may be perceived as simply a licence to take additional funds from the already hard-pressed home buyer and the industry participants. What is required is a scheme that operates in their favour and at the same time provides a real incentive for house builders to reduce the number of snags found at hand-over to zero.

The snagging process outlined within this paper shows how heavily the house buying process is geared towards the builder and that within this snagging process there are areas where the builder is absorbing costs which reduce the potential profit on each house i.e. the absorbed snagging. The visible snagging at hand-over stage is a further depletion of profit and are completely avoidable. The snags are damaging to the image of house builders, they detract from customer satisfaction and they reduce the potential profit available on each new house

The analysis provided in the paper has given an insight into the scale of snags found from the inspection reports on newly built homes. A brief conclusion of the analysis follows:

- Evidence has been provided that a large number of snags can be found in newly built properties, which are assumed to be complete. The analysis shows that a small number of properties were found to report a very large number of snags (up to 389). The attributes of these properties were investigated to see if a logical explanation existed. However, there were no common factors to provide an explanation. Subjectively, other factors beyond the scope of this study may contribute to the large number of snags being identified in newly built properties. For example, the levels of supervision of the workforce, the experience of workers or the level of standard set by the site manager.
- A method, and formula, was provided to give an estimation of the number of snags in different house sizes. By using the average number of snags in each house type, the method produced appears to be reliable. This will be useful information for building companies and house buyers.
- Investigation on the building companies identified that there is a clear difference in the perceived "quality" from one building company to the next. Underlying reasons for a builder producing a greater average number of snags could relate to many factors, e.g. the attitudes of specific site managers and the experience of the employers. The results from the builder analysis provides evidence to suggest that further study of the building companies would be of much use to the building industry.

Analysing the data was not a simple task due to the structure and variation within the data. It would be ideal to identify the exact factors that affect the number of snags in newly built properties. Collecting identical data with only one differencing factor would complete this. However, as the inspections are carried out randomly on request this was not possible with the present data.

It is important to keep track of snagging information, a meticulous task which requires a great deal of patience and yet has the potential to unleash a wealth of meaningful data which can bring about improvement in the composite process that is "snagging". The results can be used in practice and the analysis can be built upon to further investigate this topical problem that affects the house-building sector of the UK construction industry.

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